Transformation of pig markets in Vietnam:
Will small-scale pig farmers be squeezed out?

(A new version of 2010 report updated by CAP's team)

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Introduction

In the last 20 years, globalization and regionalization has become a common trend in the world with the establishment of EURO, AFTA, NAFTA, CAFTA ... and other regional free trade agreement such as APEC. Vietnam is also an active countries in participating in regional associations and free trade agreements, particularly WTO, ASEAN[1], ASEAN plus three[2] and most recently, Vietnam is in the final negotiation round for joining TPP[3]. All of these associations and free trade agreement have a common point of reducing import tariff for most products. In this context, Vietnam's livestock production, especially pig sector, will face enormous challenges. With obsolete technology, small scale farming and has to import most material for animal feed production... production cost of Vietnam's pig sector is much higher than many other countries in partner countries. Therefore, Vietnamese government concerns that Vietnamese pig sector, especially small and medium scale producer will be squeezed out of the market.

At the first section of the report, we will describes the most updated data about current situation of pig production and consumption in Vietnam as well Vietnamese government policies on livestock production in Vietnam.

In the following section, by updating and revising the Vietnamese pig sector model (VPM) developed by IFPRI in 2010, we will make projections of the evolution of the pig sector in Vietnam over the next 10-20 years under alternative assumptions, including assumption when Vietnam join TPP and import tax for pig products reduce to answer the above question.

More specifically, this study attempts to address the following research questions:

- How will pig products tax reduction will affect pork demand, consumption, price and import/export of Vietnam.
- How will rising income & urbanization affect total pork demand and the composition of pork demand?
- How will shifts in pork demand influence pig producers, particularly small-scale producers? More specifically, will small-scale pig producers be squeezed out of the market?
- How will growth of pig production affect maize markets, specifically, will rising demand for feed lead to maize imports?
- How would alternative assumptions about income growth, productivity growth, and consumer behavior influence the evolution of pig sector?

1 Including: Indonesia, Malaysia, Philippines, Singapore, Thailand, Brunei, Vietnam, Laos, Myanmar, Cambodia.
2 Including: ASEAN countries, China, Japan, Korea.
3 Including: Brunei, Chile, New Land, Singapore, United States, Australia, Peru, Vietnam, Malaysia, Mexico, Canada, Japan.

Current situation of pig production and pork consumption in Vietnam

Livestock sector in Vietnam

After more than 25 years since the Doi moi policy which aims at moving Vietnam from a centrally controlled economy towards a more market-oriented one was ratified, Vietnam has witnessed tremendous success in terms of its social and economic development. The success is demonstrated by rapid growth of the economy (7-8 percent per year on average), accompanied with impressive poverty reduction, with the poverty rate declining from 70 percent in 1986 to 12.4 percent in 2011 (Phan and Coxhead 2010). Improved living standards, along with growing populations, have increased demand for high-quality food and foodstuffs in general and animal products in particular. In order to meet that demand, the livestock sector in Vietnam has developed remarkably in both head size and volume of meat produced.

The gross output of livestock in Vietnam has increased annually, reaching approximately 145 thousand billion VND (~6.88 billion USD[4]) in 2012. In the period 2005-2012, the average annual growth rate of livestock production was 6 percent. Nearly 90 percent of total output was attributed to meat products including domestic animals and poultry, in which domestic animals accounted for 70-80 percent (see Table 1).

Table 1: Gross output of livestock at constant 2010 prices by product (Billion VND)

Source: Statistical Yearbook of Vietnam 2012

Year	Domestic animal	Poultry	Non-meat product	Total	Year-on-Year Growth of Livestock Gross Output (%)
2005	74,749.1	9,820.0	10,019.7	95,252.9	11.4
2006	81,117.3	10,101.8	10,314.3	101,792.1	6.9
2007	84,157.6	10,440.8	11,347.0	106,454.8	4.6
2008	87,962.9	13,362.8	12,095.2	114,543.8	7.6
2009	96,192.2	15,972.4	13,223.1	126,614.4	10.5
2010	97,685.4	19,884.2	15,280.1	135,137.2	6.7
2011	99,494.9	25,760.7	13,606.6	141,204.2	4.5
2012	101,377.7	26,921.7	14,141.1	144,862.5	2.6

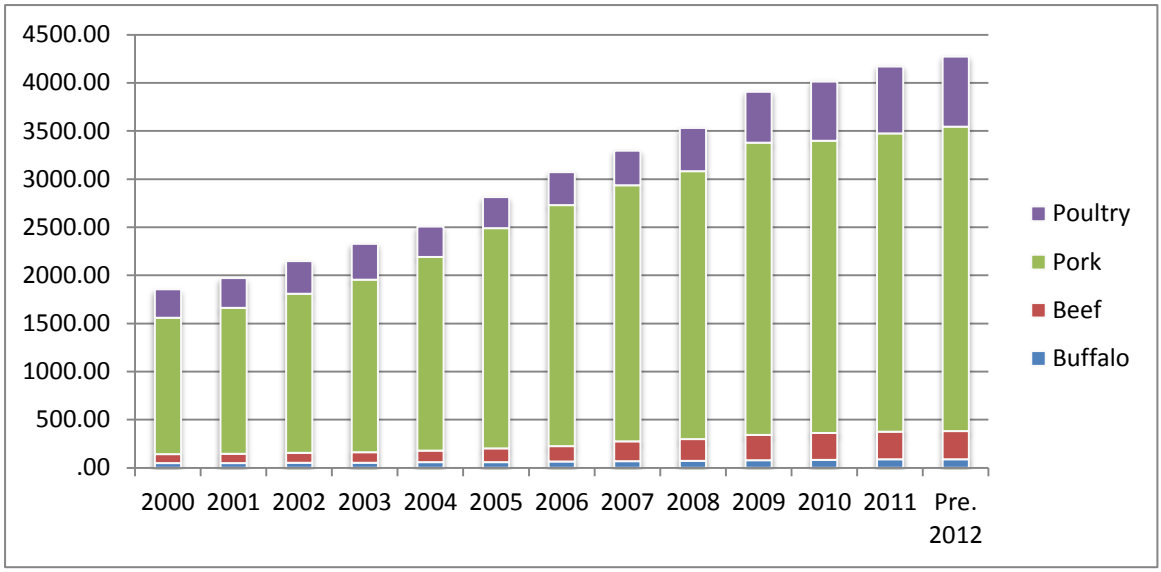
Total meat production in 2012 reached well over 4 million tons of all kinds of meat products, representing a doubling of the production in 2000(see Figure 2). Pork dominates meat production at

[4] Exchange rate in Feb, 2014

approximately 77.8 percent of total livestock production. The share of poultry meat is about 14.2 percent and all other kinds of meat including beef and buffalo meat occupy only 7.9 percent. This highlights the importance of pig production in the structure of Vietnam's livestock sector

Figure 1: Meat production in period 2000-2012 (Thousand tons)

Source: GSO, 2013

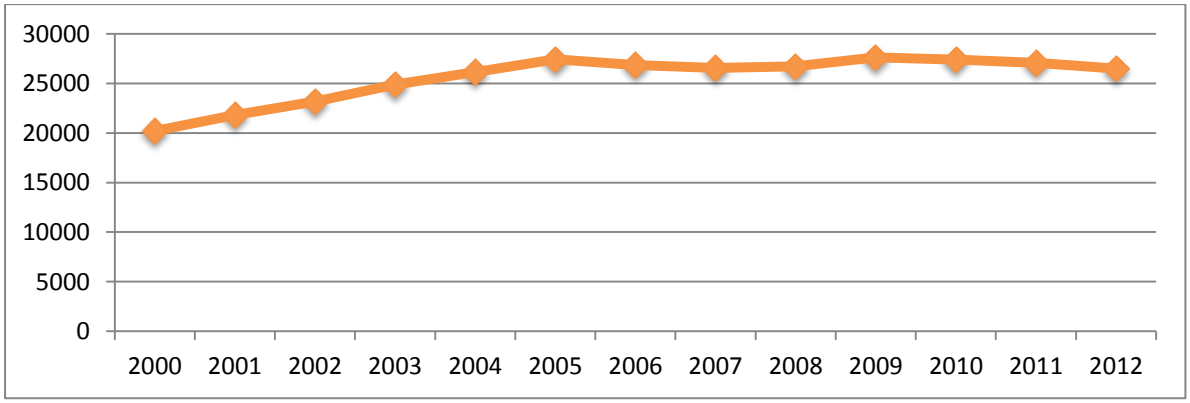


Pig production system in Vietnam

The number of pigs in Vietnam during the period 1995 to 2012 is shown in Figure 3. The number increased steadily between 1995 and 2004 with an annual growth rate of 6.3 percent. This number, however, has showed a declining tendency since 2005 due to the consequence of continuous animal disease outbreaks. For example, in the period 2005- 2006, foot and mouth disease (FMD) exploded in 40 provinces, with 12,571 infected cases causing 7,258 deaths. While disease outbreaks moderated afterwards, in 2010- 2012, Vietnam witnessed another explosion of both FMD and Porcine Reproductive and Respiratory Syndrome (PRRS) in a wide area causing 2,083 infected cases (Asian Pig Veterinary Society Congress 2013). As a result, in 2012, the total quantity of pigs in the whole country only reached 26.5 million head with total estimated pork production of 3.16 million tons (Agroinfo 2012).

Figure 2: Number of pigs in Vietnam in the period 2000-2012 (thousand pig heads)

Source: GSO, 2013



Figures 4 and 5 depict the distribution of pig population and the volume of pork supply in each of the 8 regions of Vietnam over two years (2006 and 2012). No major change occurred in the regional distribution of pig stocks. However, it can be seen that the relative numbers declined in the North Central Coast, increased significantly in the North East, and declined in the Red River Delta. A noticeable observation from the data is the relative decline in the importance of the Red River Delta and North Central Coast as suppliers of pork, with increases in the relative supply of pork from the North East.

Figure 3: Distribution of pig population by regions

Source: GSO, 2013

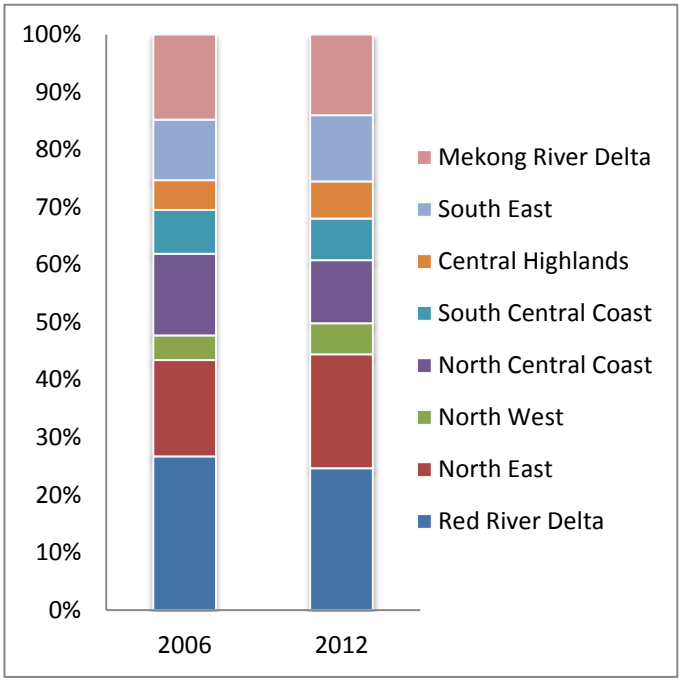
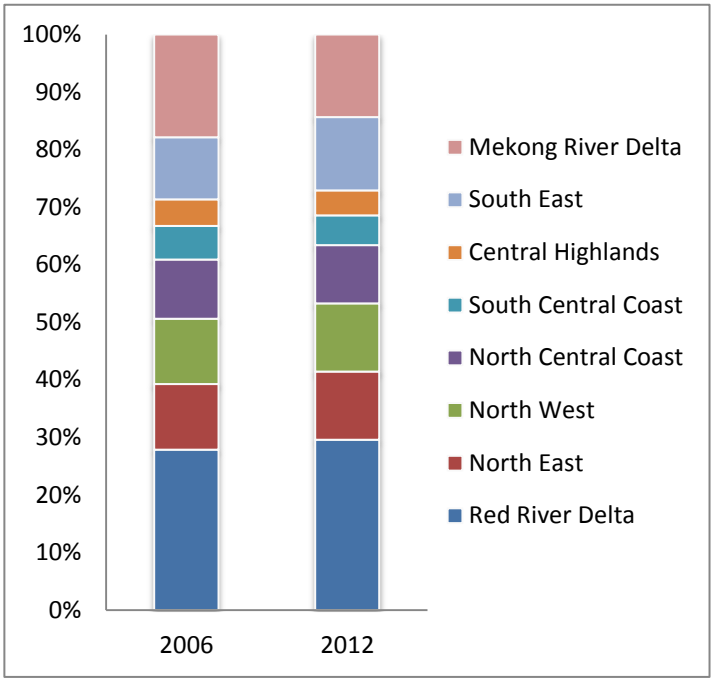


Figure 4: Distribution of pork volume by regions

Source: GSO, 2013



Vietnam's pig production is comprised mostly of backyard/household operations. Comparing the results from the Agricultural Censuses 2001 and 2011, we can observe the changing size-composition of the pig sector in Vietnam. During this period, the share in the national pig herd in small farms with less than 100 pigs fell from 98.1 percent to 82.6 percent while the share of large commercial farms with 100 or more pigs increased from 1.9 percent to 17.4 percent[5]. As part of its livestock development policy, the Vietnamese Government plans to adopt measures to increase the size of pig producing units (Ministry of Agriculture and Rural Development, Vietnam, 2007). This trend probably favors the development of specialized registered pig farms engaged in commercial industrial-style farms. Production units vary from being of a subsistence-type, to being semi-commercial, to being completely commercial units. Household pig production is often a sideline activity and a part of farm diversification in Vietnam. Considerable heterogeneity exists in production units although most units have become more involved in market transactions in recent times.

[5] Due to lack of information in the Agricultural Censuses, it is hardly to know that whether this is entry of commercialized production or whether this is a shift of small farms into large farms. A further study is needed to find out the answer.

Table 2. Distribution of pigs and farms by type of pig farm

Source: Calculated by based on Agro-Census 2001 and 2011

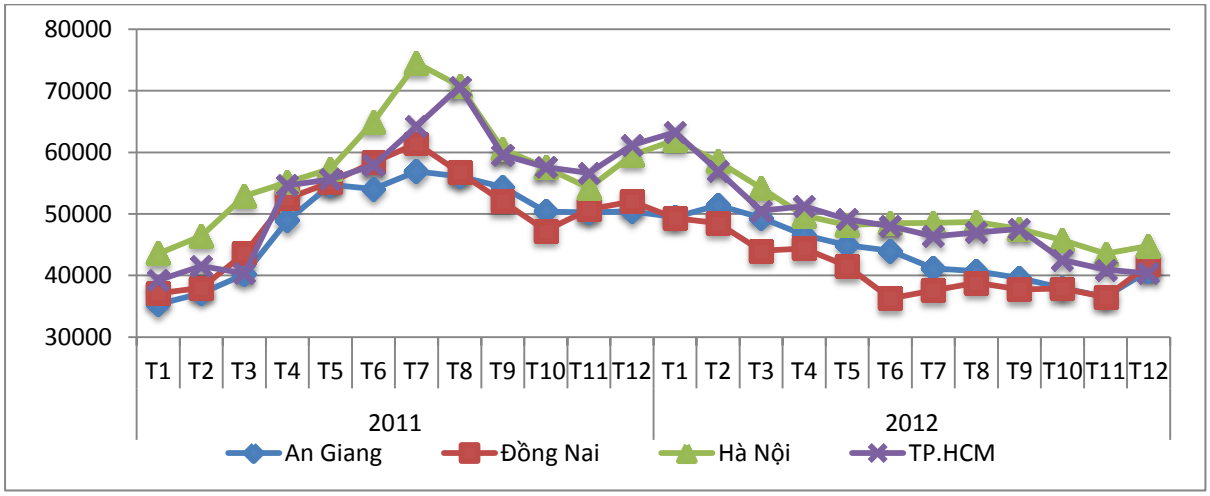
	2001				2011			
	Percent of pig farms		Percent of pigs		Percent of pig farms		Percent of pigs	
	Small farm	Large farm	Small farm	Large farm	Small farm	Large farm	Small farm	Large farm
Red River Delta	99.99	0.01	99.18	0.82	99.60	0.40	79.50	20.50
North East	100.00	0.00	99.81	0.19	99.93	0.07	94.10	5.90
North West	99.99	0.01	99.57	0.43	99.98	0.02	98.30	1.70
N. C. Coast	100.00	0.00	99.76	0.24	99.94	0.06	94.50	5.50
S. C. Coast	100.00	0.00	99.73	0.27	99.91	0.09	92.20	7.80
C. Highlands	99.99	0.01	98.85	1.15	99.60	0.40	81.40	18.60
Southeast	99.88	0.12	82.38	17.62	94.60	5.40	40.50	59.50
Mekong Delta	99.99	0.01	98.24	1.76	99.60	0.40	87.20	12.80
Whole country	99.99	0.01	98.14	1.86	99.70	0.30	82.60	17.40

Pork price in Vietnam has increased sharply at the first haft of 2011 and reach its peak in July and August in most provinces. This is the period when China increases their pig purchase (live pig) and many Vietnamese trader has bought live pig from South East, Central Coast, Red River Delta and Northern Highland and sell them at the border gate, it is estimated that the price at border gate is about 20,000 VND higher than domestic price[6]. From August 2011 to the end of 2012, pork price has decreased gradually toward level of Jan, 2011, except for a slightly increase in January 2012 when demand for pork for Tet holiday increased.

[6] http://dantri.com.vn/kinh-doanh/o-at-ban-heo-sang-trung-quoc-806920.htm

Figure 5: Price of pig (over 80kg) in selected provinces in Vietnam in 2011 and 2012 (VND/kg)

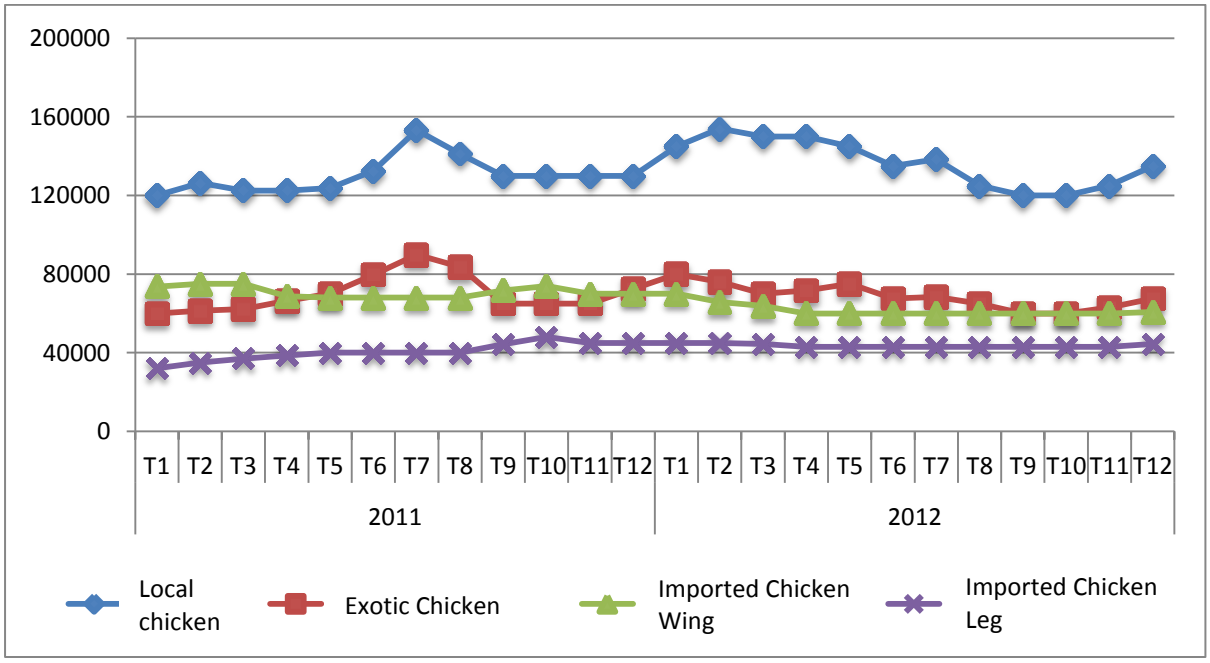
Source: Agroinfo



As a substitute of pork, price of chicken has increases slightly during July and August 2011 when pork price reach its peak. Chicken price also increase slightly during Tet holiday and fluctuated until the end of 2012. The price of local chicken is always around 60,000 VND higher than exotic chicken. Poultry production in Vietnam is also have to deal with imported chicken wing and chicken leg with very low price.

Figure 6 Price of chicken in 2011 and 2012 (VND/kg)

Source: Agroinfo



Pig meat consumption in Vietnam

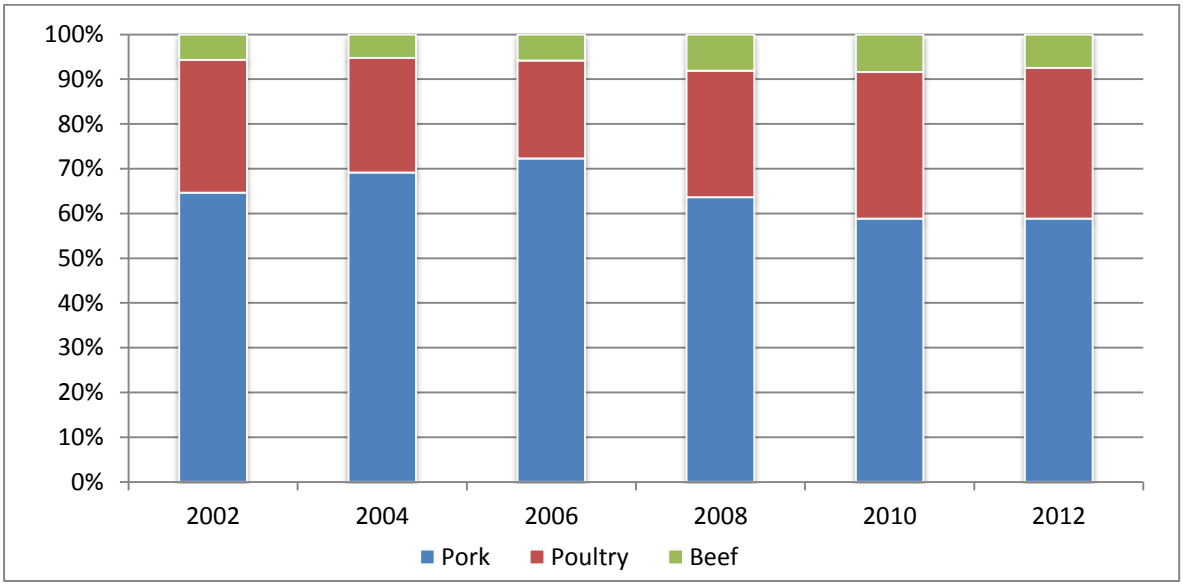
With more than 92 million people in 2013, Vietnamese population ranks 14th in the world and is a large market for animal products. Besides, Vietnam is also one of the countries with highest urbanization rate, in 2012, Vietnamese urban population is 31.94% (28.36 million people), 12.43

percent point higher than 1990 (GSO, 2013). The increasing population, especially in urban area has made consumption of livestock products, such as meat, egg and milk has risen dramatically in recent years.

According to Vietnam Household Living Standard Survey (VHLSS) from 2002 to 2012, most Vietnamese households consume meat products such as pork, beef, buffalo meat, poultry meat, and fish/shrimp, in which pork is the most important source of meat. More than 98 percent of households consume pork. Around 60 percent of total household expenditure on meat is allocated to pork, 20 percent went to poultry and the remaining 20 percent went to other meats. These shares are almost unchanged over the past several years. This consumption habit is similar to consumption trend in other Asian countries, for example China. Urban consumers constitute 25 percent of the total population, but they consume almost 50 percent of total pork produced in the country. In urban areas, pork accounts for 58 percent of meat consumed while in rural areas, pork accounts up for to 65 percent.

Figure 7: Share of meat consumption in Vietnam's households

Source: Calculated based on VHLSS 2002, 2004, 2006, 2008 & 2012



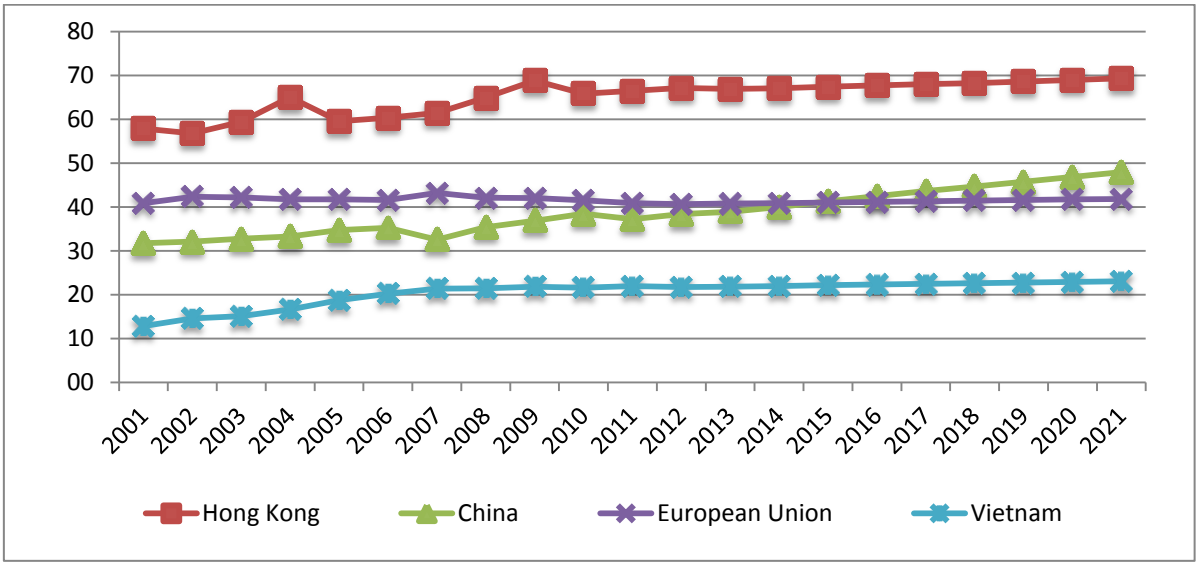
Vietnamese consumers prefer to buy fresh pork (and live or fresh poultry products) from daily markets. Thus, almost all pork produced in Viet Nam is sold as fresh meat to meet consumer preferences; processed meat accounts for less than 6 percent of meat sold, especially in rural areas. According to a study on "The supply and trend food in a number of provinces and cities of Vietnam" by the Information Centre for Agriculture and Rural Development (Agroinfo 2012), 93.3 percent of surveyed rural consumers bought meat in the temporary markets and only 13.2 percent of meat products have a quarantine stamp (included wet market). When purchasing meat, the most important criteria considered by rural consumer are cheap prices and the convenience of selling points.

In 2012, pork consumption was 23.1 kg/person/year, well below other countries like Hong Kong, China or European Union (FAOSTAT, 2013). The difference between Vietnam and other countries shows the potential market for domestic sales is still high. Thus, focusing on the domestic market over the next few years is still a good strategy for producers. Vietnam does not have a high comparative advantage in pork exports. The volume consumed in the richest income quintile is more than twice as much as in the poorest quintile. These results give a first indication that income growth is a major driver of

increasing pork consumption in Vietnam[7]. This tendency has not changed over years and is even projected to continue in the future.

Figure 8: Per capita pork consumption of several countries (kg/capita/year)

Source: FAOSTAT, 2013



Considering pork consumption by 8 economic regions in period 2002-2012 (Table 3), residents of Red River Delta has the highest pork consumption meanwhile the lowest consumption is observed in the North West. This figure also shows the similar tendency of pork consumption in all regions; namely pork consumption increased in period 2002-2006 then declined in 2008, reached the highest level in 2010 and once again decreased in 2012[8].

Table 3: Pork consumption/ capita/ year in Vietnam in period 2002-2012 by region

Source: VHLSS 2002, 2004, 2006, 2008, 2010, 2012

Region	2002	2004	2006	2008	2010	2012
Red River Delta	11.5	12.5	13.8	13.0	16.0	12.8
North East	10.1	12.2	13.4	11.1	16.5	12.6
North West	7.0	7.4	8.9	7.9	12.3	7.3
North Central Coast	7.1	8.6	9.2	7.9	11.5	8.9
South Central Coast	5.9	6.9	7.5	7.1	9.3	7.8
Central Highlands	7.0	8.0	9.4	8.3	11.2	9.6
South East	9.9	13.2	14.6	12.3	12.2	10.6
Mekong River Delta	7.7	9.6	11.9	8.7	11.5	9.3
Whole country	9.0	10.6	12.0	10.3	13.1	10.3

[7] Author calculation from VHLSS
[8] It seems due to the economic depression

Policy Issues related to livestock and pig sector

During the period 2001 – 2012, Vietnam's livestock policies focused on three pillars including: i) production (breeding, concentrated production planning…), ii) market (policy for pig export support) and iii) processing; specifically,

Policy on development for plant varieties, animal breeding and forestry varieties in the period 2000 – 2010 (Decision No. 225/1999/QĐ-TTg 10th December 1999 and Decision No. 17/2006/QĐ-TTg 20th January 2006) has brought many positive results in breeding sector, selecting and adding a large amount of new breeding, and greatly increasing the diversity of the gene pool in Vietnam. However, the dissemination of good breeding practices is quite limited. One of the main reasons is the large share of small scale production. Farmers do not have information about breeding, while the breeding system is underdeveloped, management efficiency is very low, and infrastructure is not compatible to practical needs.

Policies to develop pig farming for export (Decision No. 166/2001/QĐ-TTg 26th October 2001 of Prime Minister) encourage the development of zones for export of high quality pigs. However, pig industry in Viet Nam is fragmented and unplanned, low efficiency, high production cost and poor quality management. The supporting policies for pig production are not compatible, especially land, credit and market control policies. These are the reasons why Vietnamese pig products cannot compete in international market.

Policies to encourage new construction, expansion of slaughter and processing houses as well as poultry clusters production (Decision 394/QĐ-TTg 13rd March 2006 of Prime Minister) has obtained considerable achievements such as the establishment of some models of slaughtering and meat processing using industrial methodologies which ensure quality and food safety and hygiene.

In addition to livestock related policies applied for the whole country above, the government has established different plans for each economic zone.

Red River Delta

According to Decision 795/QĐ-TTg issued on 23rd May 2013 from the Prime Minister, pig and poultry will be the main commodities in livestock industry of Red River Delta in the period 2010 - 2020. These two commodities will be developed into large scale production. The processing industry is also encouraged through credit support policies. However, the development of these two commodities is mostly for local consumption from this economic zone instead of export. This is because it is very difficult for producers to compete in the international market in the upcoming period. Thus, focusing on the local market with the advantage of short distances is a wise selection.

Northern Mountainous and Midland (North East and North West)

According to Decision No.1064/QĐ-TTg issued on 8th July 2013 from the Prime Minister, pig and grass-eating animals such as goat, cow, and buffalo are designated as the main pillars for the livestock industry in the Northern Mountainous and Midland in the period 2010-2020. For the Northwest (including Hoa Binh, Son La, Dien Bien, Lai Chau), policy will support large-animal production, especially dairy cows and meat cows, and a focus in orientation towards high-quality processed products. For the Northeast, pig and large animals like cows and buffaloes will be the main pillars for livestock, almost of which targeting local consumption.

Central Highlands

At this moment, we have not found any documents in the overall plan for socio-economic development in the Central Highlands in the period 2010 – 2020. However, according to the Leadership Board on Central Highlands, the Central Highlands has invested in imported breeds like Debu, Brahman red, white ... to crossbreed, creating the foundation for good quality, high yielding breeds to replace low productivity local breeds. There is also a focus on supply for households and ethnic minority group officials. Currently, in the Central Highlands livestock clusters totally replace small-scale production for subsistence.

South East

South East has great potential especially in industrial plants and aquaculture, fisheries, and livestock around the city. Pig, poultry, and dairy cows are the main products, especially in Dong Nai provinces. However, according to our current understanding, there is still not an overall policy for this region. Instead, each province has its own policy for livestock development. This may lead to incompatibility among regions as well as supply and demand in the upcoming period.

Mekong Delta

According to the Plan on Agriculture Structure Transformation to 2020, vision to 2030 for Mekong Delta, the main types of livestock that need to be encouraged to develop in Mekong Delta are pig, poultry, meat cows, and buffaloes. The above document also stated that concentrated clusters are to be encouraged to develop both industrialized models and half-industrialized models of production. The development of concentrated clusters comes alongside the development of a modern processing industry to meet the local market. The international market seems not to be the priority in the upcoming period.

An overall strategy for the whole region is necessary to use livestock resources effectively, especially when domestic producers have to compete with international exporters based on WTO and other free trade agreements. For pork products in WTO, Viet Nam signed a commitment to reduce tariffs in which the rate for chilled pork and frozen pork decreased from 30 percent and 30 percent, respectively, in 2007 to 25 percent and 15 percent in 2012, respectively. However, the implementation of tariff reduction started from 2008, just one year after the commitment. These reductions in tariffs will cause a significant change in pork production while local producers have to compete with low-price importers. To overcome this problem, there must be a structural change toward large – scale and industrialized production. At this moment, the support policy for pork production seems to be inefficiency to increase competitiveness of local producers.

In the upcoming free trade agreement, TPP[9] for example, policy makers in Vietnam seem to be not well prepared for TPP especially in pork products. The TPP agreement has been postponed and unfinished in 2013. However, TPP can bring many opportunities for agriculture but not for pork products separately. When tariff and non-tariff barriers are removed, Vietnam local producers might face pressure from other countries in TPP. Support policy for this situation should be directed to improve competitiveness and large-scale production instead of through subsidies as now.

[9] Trans-Pacific Strategic Economic Partnership Agreement

Objectives

The overall objective of this study was to explore the hypothesis that changes in the pork demand and the growth of modern retail outlets will squeeze small-scale pig producers out of the market in Vietnam. More specifically, this study attempts to address the following research questions:

- How will rising income & urbanization affect total pork demand and the composition of pork demand?
- How will shifts in pork demand influence pig producers, particularly small-scale producers? More specifically, will small-scale pig producers be squeezed out of the market?
- How will growth of pig production affect maize markets; specifically, will rising demand for feed lead to maize imports?
- How would alternative assumptions about income growth, productivity growth, and consumer behavior influence the evolution of pig sector?

These issues were addressed by updating and revising the Vietnamese pig sector model (VPM) developed by IFPRI in 2010, and using it to make projections of the evolution of the pig sector in Vietnam over the next 10-20 years under alternative assumptions.

Section 2 describes the model and the data used to calibrate the model to represent the Vietnamese pig sector. Section 3 describes the results of the simulation exercises, starting with a base scenario using the most plausible assumptions and proceeding to test the sensitivity of the results to alternative assumptions. Section 4 summarizes the results of the study and draws some preliminary implications for policy.

Research methods

Methods

The VPM is an eight-region, three-sector, partial-equilibrium model designed to simulate the evolution of the pig sector over 20 years. The eight regions are the Northern Uplands, Red River Delta, North Central Coast, South Central Coast, Central Highlands, Southeast, Mekong River Delta, and the rest of the world. Trade between regions within Vietnam and trade between Vietnam and the rest of the world follow the rules of spatial arbitrage in that (a) the price difference between any two regions can be less than or equal to the cost of transport and marketing between the two regions and (b) if there is trade between regions, the price difference will be equal to the cost of transport and marketing. The direction of trade is endogenous, meaning that each region can export, import, or be self-sufficient in each commodity depending on the parameters of the simulation.

The three sectors are the traditional pig sector, the modern pig sector, and the maize sector. The modern pig sector is defined on the production side as large-scale commercial farms raising more than 100 head of pigs. On the consumption side, modern pork products are defined as chilled, frozen, and processed pork products, while traditional pork products are fresh, unprocessed pork. It was initially assumed that the modern pig sector can only produce modern pork products, while the traditional pig sector can only produce traditional pork products. However, the most updated data from GSO shows that in 2006 the supply of pork by large-scale farms almost matched the domestic

demand and export of modern pork, but the situation has changed very fast in the pig production system in Vietnam as the share of large-scale pig producers (by the old definition) in the total pork supply increases dramatically and accounts for 17.4% in 2011 (it is estimated that this share will be more than 20% in 2013). The fast development of large-scale pig farms is partly due to the current government efforts to promote environment-friendly and efficient large-scale livestock system. At the same time the modern retail outlets for food and particularly for pork grow at about 6% per year and the share of modern pork in total consumption seems to be around 3% in 2013. With the updated information, we needed to redefine the modern pig producers based on the production scale and the involvement in modern retail outlets, i.e. only those larger-scale directly produced pork for modern retail outlets could be considered as modern pig producers (i.e. need to change the definition of large-scale farms with 1000 or 5000 pigs or assume large-scale farms can produce at the same time both traditional and modern pork). Due to lack of detailed information about modern pork supermarket channel, for this exercise we assume the supply of modern pork by modern pig producer match the estimated domestic demand and export of modern pork in the base year.

The Initial plan was also to introduce some flexibility, allowing the traditional sector to produce modern pork products. However, the simulation results suggested that this flexibility would not have a qualitative effect on the conclusions.

The model is embedded in a loop that finds the solution 20 times, representing the 20 year time-scale of the simulation. Differences in the results each year are driven by growth in income, population, and technology. These growth rates are determined exogenously outside the model. The original plan was to include urbanization as an exogenous factor that would influence the evolution of the model over time. However, the demand analysis carried out by the project suggested that there were no significant differences between the income elasticity in urban and rural areas (see Toan et al, 2010).

The core of the model consists of eight sets of equations, as described below:

- The supply of each commodity in each region is a function of producer prices of all three commodities in that region. A double-log function is used to describe supply.
- Food demand for each commodity in each region is a function of consumer prices of all three commodities in that region, the income in that region, and the population in that region. A double-log function is used to describe food demand.
- Feed demand for maize in each region is a function of the retail price of feed in that region, the producer price of pigs in that region, and the volume of pig production in that region. Commodity-specific factors to allow modern pigs to require larger quantities of maize than traditional pigs. A double-log function is used to describe feed demand.
- An inflow equation to ensure that regional production of each commodity plus regional inflows plus imports are equal to the food and feed demand for that commodity in that region.
- An outflow equation to ensure that regional production of each commodity is equal to demand in that region plus regional outflows plus exports.
- A domestic price equation that ensures that the producer price in one region and the consumer price in another region is no greater than the marketing and transportation costs between the regions, after adjustment for weight change in processing.
- An import parity restriction that ensures that the consumer price of each commodity in each region is no greater than the import parity price, defined as the world price converted to local currency plus import tariffs plus transportation and marketing costs.
- An export parity restriction that ensures that the producer price of each commodity in each region is no less than the export parity price, defined as the world price converted to local currency minus export taxes minus transportation and marketing costs.

Because the model consists of a mix of equalities and inequalities, it is solved using mixed complementarity programming (MCP), which links each inequality to a complementary variable, which becomes positive when the inequality becomes binding. For example, the import parity restriction is an inequality, and it is linked to the import variable. When the import parity restriction becomes binding (the domestic price is constrained by the import parity price), imports become positive.

The model is programmed and run using the General Algebraic Modeling System (GAMS) software package with the PATH solver.

Data

The Vietnam Pig-sector Model is calibrated to represent the situation in 2013 using data and estimates from a variety of sources. Pig production in each region is based on estimate of live-weight production by the General Statistical Office. In 2013, there were an estimated 26.2 million pigs in Vietnam, yielding 3.3 million tons of liveweight production. The regions with the largest production were the Red River Delta with 1117 thousand tons and the Mekong River Delta with 506 thousand tons. The split between modern and traditional pig production is carried out by three-step procedure: 1) based on regional data from the 2011 Agricultural Census on the size distribution of pig farms to define the share of the herd in farms with more than 100 head of pigs in each region; 2) Calibrate the regional large-scale pig production to match the estimated regional demand for modern pork; 3) Define traditional pig production by region as residual of total pig production less modern pig production.

Per capita pork consumption in each region in 2013 is an estimate based on the 2012 Vietnam Household Living Standards Survey (VHLSS) and the growth pattern of pork consumption derived from 8 rounds of VHLSS 1992, 1998, 2002, 2004, 2006, 2008, 2010, 2012. According to this estimation result, per capita consumption is about 11.7 kg, though it is higher in urban areas (14.4 kg) than in rural areas (10.5 kg). The split between modern and traditional pork products is initially based on the ILRI Pork Consumer Survey carried out as part of this project. As described above, chilled, frozen, and processed pork were considered to be "modern pork products", while fresh pork was classified as "traditional pork products." According to the survey, modern pork products, as defined here, accounted for about 2 percent of the volume of pork consumption in 2006. The modern pork consumption in 2013 is derived from the 2% share found in 2006 and the estimated change over 2006-2013. As documented in the statistical year book of 2012, number of supermarkets increases by 1.7 times from 385 units in 2005 to 659 units in 2012. Taking account of this quantity improvement of modern retail outlets we assume that the modern pork consumption in term of its proportion in the total pork demand over period of 2006-2013 would be 1.5 times more, on the average accounting for about 3% in 2013. However, this proportion was applied differently by regions and proportional to their current level of production and consumption.

Prices of pork and maize in 2013 for each region were derived from VHLSS 2012 taking into account of the price changes between two years, 2012 and 2013. This change was obtained from the national aggregate prices in 2012 and 2013 collected by IPSARD's Information Center. Consumer prices for pork ranged from 68000 VND/kg to 84000 VND/kg, and for maize from 6000 VND/kg to 14000 VND/kg. Producer prices for pork ranged from 31000 VND/kg to 38000 VND/kg, and for maize from 4400 VND/kg to 13000 VND/kg. The margins between consumer and producer prices were calculated based on the price levels as mentioned above and the conversion rate from producer weight to consumer weight, e.g. 0.9 for maize and 0.5 for pork.

World prices of pork and maize and volumes of international trade were based various online information such as FAO, USDA and MARD. According to the USDA, Vietnam exported annually about 20 thousand tons of pork in the last three year 2011-2013, and imported around 1.7 million tons of maize in 2013. According to MARD in 2013 the volume of pork export is less than 10 thousand tons, thus in the base year we assume export of pork from Vietnam is around 10 thousand tons. Import tariffs for pork products and maize were based on published rates by the Ministry of Finance. The tariffs on imported pork and maize are 25% and 5%, respectively.

The income elasticity[10] of demand for pork is based on a demand analysis using consumer meat expenditure data collected as part of this project (Nguyen et al, 2010). This study estimated that the elasticity of fresh pork expenditure with respect to meat expenditure was 0.90. Assuming that the expenditure elasticity for meat is about 1.0, this figure was used as the income elasticity of fresh pork. The same study estimated that the elasticity for "other pork" (chilled, frozen, and processed) was just 0.67. This figure seems unrealistically low, perhaps a result of the small number of observations. For the model, we adopt an income elasticity of demand for modern pork products of 1.8, twice the elasticity of traditional pork products. In the absence of recent estimates of the income elasticity for maize in Vietnam, we use 0.25, a plausible figure given the fact that it is a less desired staple crop. Because of the uncertainty regarding these estimates, we later evaluate the sensitivity of the results to changes in these income elasticities.

With regard to the own-price elasticities of demand, we adopt the elasticity estimated by Nguyen et al (2010) for modern pork products (-0.78), but the estimate for traditional pork products (-0.65) seems too large. Given the dominance of fresh pork in meat consumption, it seems that fresh pork does not have close substitutes in consumption, so we would expect the price elasticity to be relatively low in absolute value. We adopt -0.30 for the VPM model.

In the absence of supply elasticities estimated for Vietnam, the Vietnam Pig-sector Model uses supply elasticities based on earlier estimates by SWOPSIM, a database of supply elasticities generated by the United States Department of Agriculture for the Philippines.

The per capita income for each region is based on per capita consumption expenditure estimated by CAP using the 2012 VHLSS. The 2013 population in each region is derived from the GSO's online database for 1990-2012 and preliminary estimate of the total population by GSO for 2013.

The projections require estimates of the growth in per capita income, population, and technology over time.

- Population: According to the historical data provided by the GSO, the annual population growth rate of Vietnam is 1.63 percent in 1990-2000 period, 1.14 percent in 2000-2010 period and 1.053 percent for the last three years. We assume population growth will remain 1.05% per year over the period of the projections.

- Income: According to the estimates based on data of several rounds of VHLSS, real per capita income in Vietnam grows at 8.6% per year over period of 2002-2010, however the growth slows down to 6% per year during the last three year period. For the model, we assume a 5 percent growth rate in per capita income. As described in the next section, we test the sensitivity of the projections to changes in the income growth rate assumption.

[10] The income elasticity of demand describes the percentage increase in demand given a 1% increase in income. Thus, if the income elasticity of modern pork products is 1.7, this means that a 1% increase in income will lead to a 1.7% increase the demand for modern pork products.

- Technology: Between 2002 and 2010, maize yields in Vietnam rose from 3.1 to 4.1 tons/hectare, equivalent to a 3.7 percent annual growth rate, but for the last three years maize yield growth rate reduces to 2.3% per year. For the VPM, we assume that the rate of productivity growth in the maize sector is 2% per year throughout the projection period. There are no comparable data to measure productivity growth in the pig sector, but we use the off-take figures measured by total pig slaughtered weights divided by total pig population as a rough proxy for productivity growth in the pig sector. The annual growth rate of pig off-take is 5.7% during the period of 2002-2010, but it reduces to 3.7% in the last three years. Thus, we assume that traditional pig sector follow a 3% annual growth in technology and modern pig sector has a higher growth in production technology, at 4% per year. We also test the sensitivity of the results to changes in productivity growth in the three sectors of the model[11].

These represent the main assumptions behind the Vietnam Pig-sector Model. However, these assumptions are not fully compatible with each other, especially between regions. The fact is that we do not have actual data on trade between regions. As mentioned somewhere above, the interregional trade will be defined endogenously by the model following the rules of spatial arbitrage (i.e. the price differences and the cost of transportation and marketing between regions determine the trade flows). To get the supply-demand balance for all regions in the base year, we need to run the model once to reconcile these discrepancies and this initial solution becomes the base scenario.

[11] Productivity growth refers to changes in technology that allow an increase in output for the same amount of inputs. For modeling purposes, we simulate productivity growth by a rightward shift in the supply curve.

Results

Under the base scenario with the combination of most likely assumptions about per capita income growth, population growth, production technology growth as well as world price growth, the Vietnam Pig Model could be used to predict some key features of Vietnam's pig market including demand, supply, price and export/import at national and regional level. In addition, we design several scenarios with different assumptions to see how the supply, consumption and trade will change over the next decade in response to changes in growth of per capita income, pig and feed production technology and so on. The detail information of the base scenario and other simulations are shown in Table 4. Summary of alternative simulations

Table 4. Summary of alternative simulations

Scenario	Assumptions
1) Base scenario	Per capita income growth: 5% Population growth: 1.05% Nominal exchange rate growth: 3%; Maize technology growth: 2% Traditional pig technology growth: 3% Modern pig technology growth: 4% World price growth for maize: -0.13% World price growth for pork: 1.75% Income elasticity of maize: 0.25 Income elasticity of traditional pork products: 0.90 Income elasticity of modern pork products: 1.80 Own price elasticity of supply for traditional pig: 0.45 Own price elasticity of supply for modern pig: 0.5.
2) Higher income growth	Same as base scenario except that per capita income growth is increased to 10%
3) No productivity growth in traditional pig sector	Same as base scenario except that productivity growth in traditional pig sector is reduced to 0%
4) Higher productivity growth in traditional pig sector	Same as base scenario except that productivity growth in traditional pig sector is increased to 10%
5) Higher productivity growth in modern pig sector	Same as base scenario except that productivity growth in modern pig sector is increased to 10%
6) No productivity growth in maize sector	Same as base scenario except that productivity growth in maize sector is reduced to 0%
7) Higher income elasticity in modern pork products	Same as base scenario except that income elasticity for modern pork products is increased to 2.7

8) Higher income elasticity and higher productivity growth in modern pig sector	Same as base scenario except that income elasticity for modern pork products is increased to 2.7 and productivity growth in modern pig sector is increased to 10%
9) Worst-case scenario for traditional pig sector	Same as in base scenario except that: Per capita income growth increased to 10% (base: 5%) Income elasticity of traditional pork reduced to 0.5 (base: 0.9) Income elasticity of modern pork increased to 2.7 (base: 1.8) Tech growth in traditional pig sector reduced to 0% (base: 3%) Tech growth in modern pig sector increased to 10% (base: 4%)

1. Base scenario

The base scenario is the combination of the most plausible assumptions, namely:

- Per capita income growth will be 5.0 percent per year (the annual growth rate of per capita income in Vietnam is decreasing from more than 8 percent during 2000-2010 to about 6 percent in the last three years. Thus it is expected to be 5 percent for the next period of 2013-2025).
- Population growth will be 1.05 percent per year (as the average population growth rate in recent years).
- Maize technology will be improved at 2 percent per year (this was estimated based on growth patterns of maize yields over the last decade (3.7 percent during 200-2010 period and 2.3 percent in the last three years).
- Traditional pig production technology will increase at 3 percent per year (this was estimated based on growth patterns of pig off-take during the last decade). For the growth rate of modern pig production technology, we assumed this was one percentage point higher than for traditional pigs.
- The assumptions about the income elasticity of fresh pork and modern pork products are the same as in original VPM 2010, i.e. 0.9 and 1.8 respectively.
- Furthermore, we assume that world price growth rate of maize and pork will be -0.13 and 1.75 percent per year, respectively (this is derived from the projection by FAO reported in the Outlook 2013).

Table 5 shows national demand and supply under the base scenario. In the model, there are three categories of supplies, i.e. traditional pig meat, modern pig meat, and maize. For the demand side, demand for pig meat is broken into demand for traditional pig meat and modern pig meat, and maize demand is also divided into food and feed. As shown in this table, in 2013, national demand for traditional pig meat is 1591 thousand tons (97.0 percent of the total), and the demand for modern pig meat is 49 thousand tons (3.0 percent of the total). As a result of the development of the supermarket system in urban areas and changes in consumption habits, the income elasticity of modern pork is much higher than traditional pork, leading to a higher annual growth of demand for modern pork than traditional pork (7.22 percent comparing to 4.59 percent). However, as most of the population still remains in rural areas, the structure of pig market hardly changes during 2013-2025 period, traditional pork will still account for majority of pork demand (97 percent in 2013 and 96.0 percent in 2025).

In 2013, total demand for maize is 6,073 thousand tons, of which 5,873 thousand tons (96.7 percent) goes into animal feed industry, and only 200 thousand tons were used as human food. Annual growth of maize as food is 1.69 percent and maize as feed is 4.41 percent. After 12 years, total demand rises to 10,095 thousand tons and the picture is basically the same with 97.6 percent demand is for maize as feed (an increase of 0.9 percentage points compared to 2013).

Table 5. National supply and demand under the base scenario (thousand tons)

Source: Simulation results 2013

Year	Demand				Supply		
	Traditional pig	Modern pig	Maize food	Maize feed	Traditional Pig	Modern Pig	Maize
2013	1591	49	200	5873	1591	59	4325
2014	1665	53	203	6127	1665	62	4419
2015	1741	57	207	6399	1741	66	4514
2016	1821	61	210	6683	1821	70	4612
2017	1905	66	214	6979	1905	75	4712
2018	1993	70	217	7288	1993	80	4813
2019	2084	76	221	7610	2084	85	4917
2020	2180	81	225	7938	2180	91	5026
2021	2280	87	228	8289	2280	97	5134
2022	2384	93	232	8655	2384	103	5245
2023	2494	100	236	9036	2494	110	5358
2024	2608	107	240	9435	2608	117	5474
2025	2728	115	244	9851	2728	124	5592
Share 2013	97.0	3.0	3.3	96.7	96.4	3.6	
Share 2025	96.0	4.0	2.4	97.6	95.6	4.4	

Looking at the supply side we can see that the supply of both traditional pig meat and modern pig meat is protected to increase sharply during 2013-2025 periods, while the supply of modern pig meat is expected to increase even faster due to the development of commercial farms and application of new technologies. However, despite the doubling in the quantity of modern pig meat, the market share of this product only increases by 0.8 percentage point from 3.6% to 4.4% over 12 years. The traditional pig sector still occupies the majority of the pig market (96.4% in 2013 and 95.6% in 2025). We can see that the supply of traditional pig meat is equal to the demand because fresh pork is a non-tradable commodity.

Maize supply for food and feed are basically the same, and thus we only have the supply for maize in general. Vietnam's maize production does not meet domestic demand, especially for the animal feed industry and Vietnam has to import maize from other countries. Limited resources (land, labor…) and competition from other sectors (crops with higher profit, livestock production, aquaculture…) makes the growth rate of maize production much lower than the growth rate of the pig production sector (2.98% comparing to 3.73% of traditional pig supply and 5.15% of modern pig supply). Hence, maize import quantities are increasing over time, as shown in Table 6. In 2013, Vietnam imported 1,748 tonnes of maize for the animal feed industry from five main markets, including: India, Cambodia, Thailand, Argentina and United State of America. In 2025, the predicted amount is 4,503 thousand tonnes.

Table 6. Exports and imports under the base scenario (thousand tons)

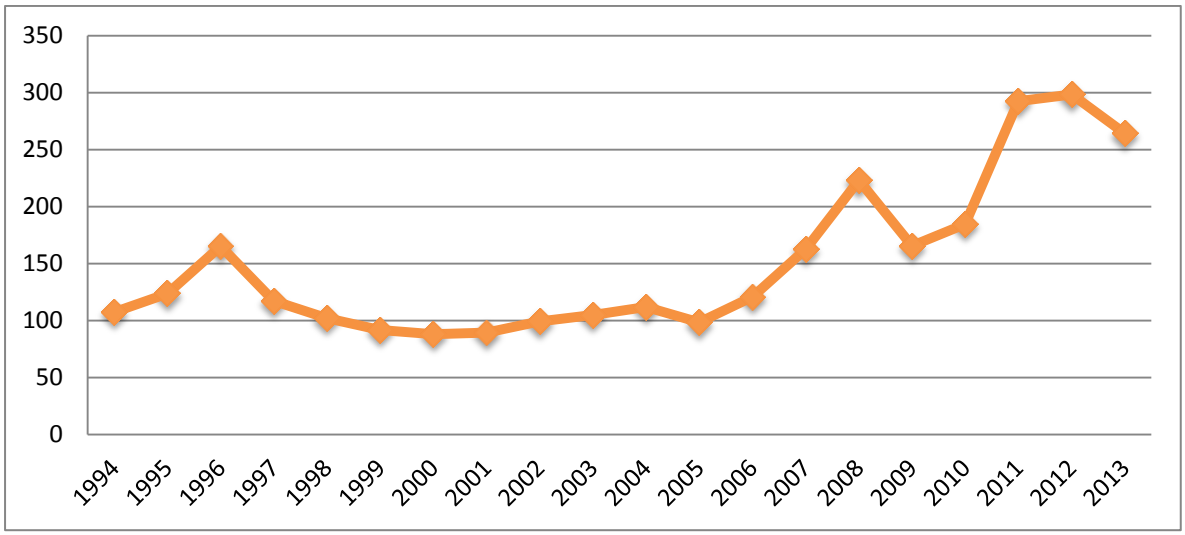
Source: Simulation results 2013

	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
Pork export	9.6	8.7	8.9	9.1	9.3	9.4	9.6	9.6	9.7	9.7	9.6	9.5	9.3
Maize import	1748	1912	2092	2281	2481	2692	2914	3137	3383	3642	3914	4201	4503

The amount of imported maize is predicted to increase in the coming years. However, maize prices in 2013 were much lower than 2012 and 2011 (as shown in Figure 9), and many feed producers have stockpiled maize. In 2014 these producers might use their stocks, thus the amount of imported maize would be much different from the predicted number.

Figure 9: World maize price (US$/ton)

Source: FAO 2013



Because of low costs (labor, land renting fee, environment fee…), Vietnam is projected to become a destination for many overseas pig producer companies. These companies would build large commercial farms and export their products to their home countries as well as serving the burgeoning supermarket system in Vietnam. However, as pig production and demand rise with in a similar direction, the quantity of exported pigs does not vary much during 2013 – 2025 period, remaining at 8.6 thousand tons to 9.7 thousand tons.

Table 7 shows the retail prices and farm-gate prices of pigs and maize. The difference between the pork farmgate price and retail price is larger than for maize. The retail price of traditional pork in 2013 is higher than modern pork because of these following reasons: traditional pigs have better meat quality, difficulty in raising traditional pigs, and the export focus of modern pork products, causing the price for modern pig products to be determined by international markets. However, the annual growth of the modern pork price is much higher than for traditional pork (4.78% compared to 3.45% in retail price and 5.15% comparing to 3.73% in farm-gate price). As a result, the price of modern pork becomes higher than traditional pork by 2017 for both farm-gate prices and retail prices. A possible explanation for this is that the traditional pig sector uses more homemade feed, while modern pig sector only use purchased feeds, whose prices are increasing sharply.

Table 7. National average prices under the base scenario (VND/kg)

Source: Simulation results 2013

	Consumer price			Producer price		
	Traditional Pork	Modern Pork	Maize	Traditional Pork	Modern Pork	Maize
2013	76575	74018	9120	34744	33563	6823
2014	79171	76250	9352	36041	34677	7032
2015	81872	79891	9581	37391	36497	7238
2016	84671	83706	9818	38791	38404	7451
2017	87572	87705	10061	40241	40403	7670
2018	90578	91895	10311	41743	42498	7895
2019	93693	96287	10568	43300	44693	8126
2020	96943	100890	10861	44925	46994	8419
2021	100288	105714	11133	46597	49406	8664
2022	103754	110769	11414	48330	51933	8916
2023	107346	116067	11702	50126	54582	9176
2024	111068	121619	11999	51987	57358	9443
2025	114926	127438	12304	53915	60267	9718

2. Higher income growth

In this scenario, we assume that per capita income growth over the ten year period is 10% instead of 5% per year. In that situation, we expected that people will consume more modern pork instead of traditional pork.

It can be seen from Table 8 that changes in income per capita growth leads to changes in supply and demand for all commodities. The demand for both types of pork is higher under this scenario than in the base scenario. However, the increase in demand for modern pork is higher than in the base scenario due to a shift in consumption, while the increase in traditional pork demand derives mainly from population growth. Demand for modern pork increases by 14.1% per year (6.9 percentage points higher than the base scenario), while total demand for modern pork in 2025 is 251 thousand tons, which is 5.1 times higher than 2013 and more than 2 times higher than the base scenario. Demand for traditional pork steadily rises by 7.3%, which is 2.7 percentage points higher than the base scenario.

Due to the higher growth rate, the share of modern pork products in total consumption in 2025 rises from 4.0% in the base scenario to 6.3% under this scenario.

Table 8. National supply and demand with higher income growth (thousand tons)

Source: Simulation results 2013

Year	Demand				Supply		
	Traditional Pig	Modern Pig	Maize food	Maize feed	Traditional Pig	Modern Pig	Maize
2013	1591	49	200	5873	1591	59	4325
2014	1708	59	206	6318	1708	62	4419
2015	1834	67	212	6815	1834	67	4514
2016	1970	75	218	7356	1970	75	4614
2017	2115	83	224	7949	2115	83	4714
2018	2271	92	231	8589	2271	92	4816
2019	2438	102	238	9279	2438	102	4920
2020	2617	114	245	10025	2617	114	5026
2021	2809	129	252	10815	2809	124	5134
2022	3013	151	259	11633	3013	133	5245
2023	3232	179	267	12507	3232	141	5358
2024	3467	212	273	13410	3467	149	5481
2025	3718	251	281	14416	3718	159	5599
Share 2013	97.0	3.0	3.3	96.7	96.4	3.6	
Share 2025	93.7	6.3	1.9	98.1	95.9	4.1	

In this scenario, as mentioned before, the production of traditional pig meat is equal to its consumption and goes up steadily by around 7.3% per year. Modern pork production increases annually at the rate of 8.9% which is higher than in the base scenario (6.5%).

The rapid growth in modern pork consumption outpaces production growth, and thus the export quantity decreases gradually until 2015. From 2015 to 2020, Vietnam neither exports nor imports pork, but in 2021, Vietnam starts to import pork for domestic consumption, with import quantities reaching 92 thousand tons at the end of the period.

Table 9. Export and import with higher income growth (thousand tons)

Source: Simulation results 2013

	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
Pork export	9.6	3.4	0	0	0	0	0	0	0	0	0	0	0
Pork import	0	0	0	0	0	0	0	0	4	19	38	62	92
Maize import	1748	2105	2512	2960	3459	4004	4598	5244	5932	6647	7415	8202	9098

The expansion of pig production leads to an increase in demand for maize as feed, while technological growth in maize remains constant. Thus, Vietnam has to import more maize for the animal feed industry. The annual growth rate of imported maize is 14.2% in this scenario (6.1 percentage points higher than in the base scenario). By 2025, Vietnam imports 9.1 million tons of maize, about 2 times higher than in the base scenario.

Price growth depends much on the relationship between domestic and international markets. With regard to the average price level of the period 2014-2025, the consumer price for traditional pork rises 48.3% compared to the base scenario, while the producer price increases by 52.2% compared to that in the base scenario. Production price of pork increases around 9.9% per year, while the maize price only increases by 3.2% per year.

Table 10. National average prices with higher income growth (VND/kg)

Source: Simulation results 2013

Year	Demand price			Supply Price		
	Traditional Pig	Modern Pig	Maize	Traditional Pig	Modern Pig	Maize
2013	76575	74018	9120	34744	33563	6823
2014	83462	76250	9352	38186	34677	7032
2015	91060	82630	9581	41984	37866	7238
2016	99469	93591	9846	46188	43345	7506
2017	108668	106015	10089	50787	49557	7724
2018	118760	120151	10339	55832	56624	7949
2019	129830	136233	10596	61366	64664	8181
2020	141973	154529	10861	67437	73812	8419
2021	155242	170925	11133	74071	82009	8664
2022	169671	179455	11414	81285	86326	8916
2023	185472	187106	11702	89185	90151	9176
2024	202922	195106	12290	97910	94151	9685
2025	221899	203470	12595	107398	98333	9959

This scenario demonstrates an optimistic picture of modern pig production and a less favorable one for traditional pig producers. In this scenario, demand for modern pork rockets while demand for traditional pork climbs slowly, resulting in an increase in the market share for modern pork products. More maize is required to meet the higher demand for pig production. As the demand for modern pork exceeds the capacity of domestic production, after 2022 Vietnam begins to import pork. The amount of imported maize is also much higher than in the base scenario.

3. No productivity growth in the traditional pig sector

Scenario 3 is also a pessimistic option for traditional pig production where it is assumed there is no improvement in production technology. The reason for this assumption is that traditional pig producers are fragmented and technologically backward. Moreover, most traditional pig farmers feed their pigs with leftovers and from scavenging food. Applying new technologies in the traditional sector has many more constraints than in the modern pig sector.

Such technological stagnancy induces a reduction in the supply of traditional pork in 2025 by 350.5 thousand tons compared to the base scenario. In corresponding with the constrained supply, the demand for traditional pork grows at only around 3.4% over the whole period of 2014-2025. The supply and demand of maize is almost unchanged compared to the base scenario.

Table 11. National supply and demand without productivity growth in the traditional pig sector (thousand tons)

Source: Simulation results 2013

Year	Demand				Supply		
	Traditional Pig	Modern Pig	Maize food	Maize feed	Traditional Pig	Modern Pig	Maize
2013	1591	49	200	5873	1591	59	4325
2014	1646	54	203	6092	1646	62	4419
2015	1703	58	207	6325	1703	66	4514
2016	1761	63	210	6566	1761	70	4612
2017	1821	68	214	6817	1821	75	4712
2018	1883	73	218	7076	1883	80	4813
2019	1947	79	222	7345	1947	85	4917
2020	2013	85	225	7624	2013	91	5024
2021	2081	92	229	7913	2081	97	5132
2022	2152	100	233	8204	2152	103	5245
2023	2225	108	237	8515	2225	110	5358
2024	2300	116	241	8838	2300	117	5474
2025	2377	125	245	9178	2377	125	5592
Share 2013	97.0	3.0	3.3	96.7	96.4	3.6	
Share 2025	95.0	5.0	2.6	97.4	95.0	5.0	

Exports of pork decrease steadily during the period of 2014-2024. From 2025 onwards, Vietnam does not export any pork. Sluggish development of the pig sector was the reason for the lower growth rate of imported maize. In the base scenario, maize imports increase at 8.1% per year but in this scenario, they grow at only 6.7% per year.

Table 12. Export and import without productivity growth in the traditional pig sector (thousand tons)

Source: Simulation results 2013

	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
Pork export	9.6	8.3	8.0	7.7	7.3	6.8	6.1	5.3	4.3	3.1	1.8	0.2	0.0
Maize import	1748	1876	2017	2165	2319	2480	2649	2826	3010	3192	3394	3605	3831

Compared to the base scenario, changes in the demand and supply price of modern pork and maize are not significant, but there are considerable changes in supply and demand price of traditional pork. The lack of technological improvement in traditional pig production leads to a faster increase in consumer and producer prices of 7.5 and 8.0% per year, respectively (4.0 and 4.2 percentage points higher than in the base scenario, respectively). In 2025, consumers will have to pay 181,810 VND for a kilogram of traditional pig meat, 58.2% higher than in the base scenario.

Table 13. National average prices without productivity growth in the traditional pig sector (VND/kg)

Source: Simulation results 2013

Year	Demand price			Supply Price		
	Traditional Pig	Modern Pig	Maize	Traditional Pig	Modern Pig	Maize
2013	76575	74018	9120	34744	33563	6823
2014	82176	76250	9352	37543	34677	7032
2015	88224	79891	9581	40567	36497	7238
2016	94745	83706	9818	43826	38404	7451
2017	101773	87705	10061	47340	40403	7670
2018	109349	91896	10311	51127	42498	7895
2019	117516	96288	10568	55210	44693	8126
2020	126319	100890	10833	59611	46994	8364
2021	135807	105714	11105	64355	49406	8609
2022	146067	110769	11414	69484	51933	8916
2023	157093	116067	11702	74996	54582	9176
2024	168977	121620	11999	80938	57358	9443
2025	181810	128735	12304	87355	60915	9718

In brief, this scenario gives a somber picture of the traditional pig market, where both supply and demand decrease as compared to what they would be in the baseline. Exports of pork and import of maize are a bit lower than in the base scenario. There are also slight changes in the demand and supply of modern pork and maize; however, the price of traditional pork soars.

4. Higher productivity growth in the traditional pig sector

In the previous simulation, we assumed that there was no technological change in the traditional pig sector. However, in this scenario, we considered the impact of a much higher rate of technological change. More specifically, we examined the effects of assuming that productivity growth in the traditional pig sector rises at 10% per year instead of 3% in the base scenario.

Table 14 shows the national demand and supply of pig and maize products. The demand for traditional pig products rises from 1,591 thousand tons in 2013 to 3,525 thousand tons in 2025. The annual growth in demand for traditional pig products is 6.8% per year, higher than the 4.6% annual growth in the base simulation (2.2% point higher). In this simulation, the demand for modern pig products has an annual growth rate of 5.8% per year (1.4% point less than base simulation) and less than the demand of traditional pig products. Thus, the share of traditional pig in total pork demand has increased slightly instead of decreased as in base scenario.

Table 14: National supply and demand with higher productivity growth in the traditional pig sector (thousand tons)

Source: Simulation results 2013

	Demand				Supply		
Years	Traditional pig	Modern pig	Maize as food	Maize as feed	Traditional pig	Modern pig	Maize
2013	1591	49	200	5873	1591	59	4325
2014	1706	52	203	6207	1706	62	4419
2015	1830	55	206	6566	1830	66	4514
2016	1962	58	210	6945	1962	70	4612
2017	2103	62	213	7345	2103	75	4712
2018	2254	65	216	7758	2254	80	4816
2019	2417	69	220	8203	2417	85	4920
2020	2590	73	223	8673	2590	90	5026
2021	2777	77	227	9170	2777	96	5134
2022	2976	81	231	9694	2976	103	5245
2023	3189	85	234	10247	3189	109	5358
2024	3369	91	238	11162	3506	116	5474
2025	3525	98	242	12402	3919	124	5592
Share 2013	97.0	3.0	3.3	75.4	96.4	3.6	
Share 2025	97.3	2.7	1.9	76.5	96.9	3.1	

Looking at the supply side, the annual growth in the traditional pig sector is at 7.8%, 3.25 percentage points higher than the 4.6% in the base simulation. Annual growth in the modern pig sector is 6.5%, and basically similar to the base simulation. Consequently, the share of the traditional pig sector in total national pig production increases from 96.4% to 96.9% in volume terms (table 14). Results in Table 14 also show that the annual growth in the demand of traditional pig products is higher than the demand of modern pig products. This is presumably because some consumers switch from modern pork products, whose price remains increasing (annual growth at 4.72%), to traditional pork products, whose price falls significantly (annual growth at -3.57%) during the 2013-2025 period (see also table 16 below).

The faster growth of the large traditional pig sector more than offsets the lower growth in the small modern sector, so that the demand for maize for feed grows more quickly in this simulation (6.5%) as compared to the base simulation (4.4%).

Table 15 shows data for the export and import of pork and maize. During 2013-2025, the supply of traditional pig sector increases. The amount of exported pork in Vietnam increases slightly from 2013 to 2024 (9.6 thousand tons to 23.8 thousand tons), while in 2024 and 2025, this amount jumps to 162.3 thousand tons and 419.4 thousand tons, respectively. The development of the pig sector also leads to an increase in the quantity of imported maize from 1.75 million tons in 2013 to 7.05 million tons in 2025. Thus, the annual growth of maize imports is at 12.2%, higher than in the base simulation (8.1%).

Table 15. Export and import with higher productivity growth in the traditional pig sector (thousand tons)

Source: Simulation results 2013

	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
Pork export	9.6	9.5	10.7	12	13.3	14.6	16	17.7	19.6	21.6	23.8	162.3	419.4
Maize import	1748	1991	2258	2543	2846	3159	3504	3871	4263	4679	5122	5926	7052

Development in technology helps increase production as well as decrease the cost of production, so that producer prices of traditional pig meat decrease during 2013-2025 period from 34.7 thousand VND to 20.9 thousand VND (4.0% per year) while producer prices of modern pig meat increase by 5.1% per year.

Table 16. National average prices with higher productivity growth in the traditional pig sector

Source: Simulation results 2013

Years	Demand price (VND/kg)			Supply Price (VND /kg)		
	Traditional pig	Modern pig	Maize	Traditional pig	Modern pig	Maize
2013	76575	74018	9120	34744	33563	6823
2014	72898	76226	9352	32905	34667	7032
2015	69418	79867	9581	31166	36487	7238
2016	66117	83682	9818	29516	38394	7451
2017	62981	87554	10061	27949	40340	7670

2018	60019	91550	10339	26468	42354	7949
2019	57194	95729	10596	25057	44463	8181
2020	54515	100173	10861	23717	46700	8419
2021	51973	104980	11133	22447	49105	8664
2022	49562	109998	11414	21242	51617	8916
2023	47273	115250	11702	20099	54248	9176
2024	47301	120780	11999	20116	57015	9443
2025	48858	126623	12304	20895	59934	9718

In conclusion, this is a positive scenario for traditional pork production where the technology index grows by 10% per year. We argue that this is more likely to happen than scenario 3 because of the government's extension programs and farmer awareness of new technology. In this scenario, production prices and demand prices for traditional pork decrease due to significant increases in the supply of traditional pork. As a result, demand and supply of modern pork also slightly decreases compared to the baseline. Export volumes of pork increase sharply since 2014 when the supply of pork is in excess of its demand.

5. Higher productivity growth in the modern sector

The Vietnamese government has put many efforts into promoting the expansion of large-scale pig production. Thus, in this simulation we assume that productivity growth in the modern pig sector rises at 10% per year instead of 4% in the base scenario.

Looking at the results in Table 17, we can see that the demand for traditional and modern pig products and maize as feed increase during 2013-2025 period. The annual growth in demand for traditional pig meat and modern pig meat products are almost the same as in the base simulation, i.e. 4.6% and 7.2% per year respectively. The supply of pig and maize sector continues to increase in responding to domestic demand and export.

Table 17. National supply and demand with higher productivity growth in the modern pig sector (thousand tons)

Source: Simulation results 2013

Year	Demand				Supply		
	Traditional pig	Modern pig	Maize food	Maize feed	Traditional pig	Modern pig	Maize
2013	1591	49	200	5873	1591	59	4325
2014	1664	54	203	6151	1664	65	4419
2015	1741	58	207	6450	1741	74	4514
2016	1821	62	210	6767	1821	83	4612
2017	1905	66	214	7104	1905	93	4712
2018	1992	71	217	7451	1992	105	4816
2019	2084	76	221	7828	2084	119	4920

2020	2179	82	225	8228	2179	134	5026
2021	2279	88	228	8653	2279	151	5134
2022	2384	94	232	9104	2384	170	5245
2023	2494	101	236	9585	2494	191	5358
2024	2608	108	240	10096	2608	215	5474
2025	2727	116	244	10642	2727	243	5592
Share 2013	97.0	3.0	3.3	96.7	96.4	3.6	
Share 2025	95.9	4.1	2.2	97.8	91.8	8.2	

The annual growth of the production of modern sector is 12.6%, 6.1 percentage points higher than in the base simulation. This means that the modern sector increases its share of national pig production, from 3.6% in 2013 to 8.2% in 2025. The demand of maize as feed also grows by 5.1% each year and the supply of maize grows 2.2%, similar to the base scenario.

As the production of modern pork increases much faster than demand, the amount of exported pork increases steadily every year. In 2013, Vietnam only exports 9.6 thousand tons of pork but in 2025, this number rises massively to 127.2 thousand tons, about 5 times higher with an annual growth rate of 23.99%..

Table 18. Export and import with higher productivity growth in the modern pig sector (thousand tons)

Source: Simulation results 2013

	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
Export Pork	9.6	11.9	16.0	21.0	27.1	34.2	42.5	52.1	63.2	76.0	90.7	107.7	127.2
Import Maize	1748	1935	2142	2365	2606	2853	3130	3427	3747	4092	4463	4862	5294

The modern pig sector uses a large amount of maize for animal feed production. As the modern pig sector develops faster and maize production does not increase, Vietnam will have to import increasingly more maize. In 2025, Vietnam imports 5,294 thousand tonnes of maize, 3,096 thousand tonnes higher than 2013 and 791 thousand tonnes higher than in the base scenario.

The demand and supply price of the pig and maize sector are displayed in Table 19. The production price of traditional pork grows at 3.7% per year, while the modern pork price grows at 5.1% per year. These growth rates are similar to the baseline. The supply price of pork and maize also remain unchanged compared to the base scenario, while the demand price of modern pork grows annually at 12.6% (6.1 percentage points higher than in the base scenario).

Table 19. National average prices with higher productivity growth in the modern pig sector

Source: Simulation results 2013

Years	Demand price (VND/kg)			Supply Price (VND/kg)		
	Traditional pig	Modern pig	Maize	Traditional pig	Modern pig	Maize
2013	76575	74018	9120	34744	33563	6823
2014	79163	75918	9352	36037	34537	7032
2015	81852	79079	9581	37381	36163	7238
2016	84641	82732	9818	38775	38009	7451
2017	87542	86730	10061	40225	40008	7670
2018	90570	90920	10339	41739	42103	7949
2019	93685	95312	10596	43296	44298	8181
2020	96914	99914	10861	44910	46599	8419
2021	100259	104737	11133	46583	49011	8664
2022	103726	109792	11414	48316	51538	8916
2023	107318	115090	11702	50111	54187	9176
2024	111040	120642	11999	51972	56963	9443
2025	114898	126461	12304	53901	59872	9718

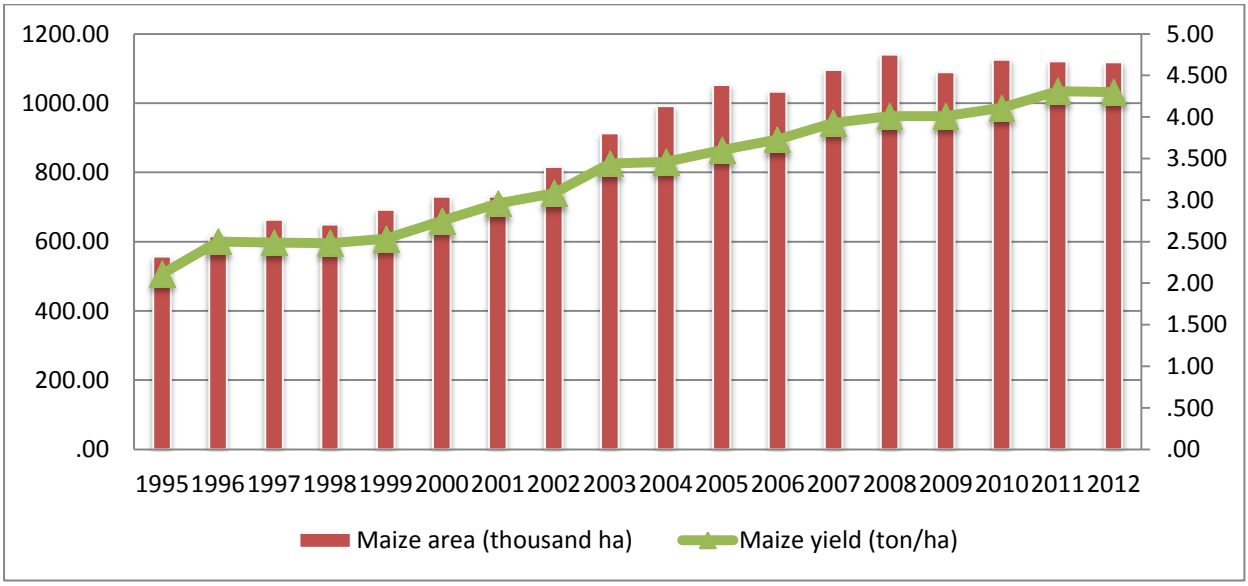
In conclusion, this scenario assumes higher productivity growth in the modern pig sector. This is successful in expanding production in the modern sector and doubling export quantities. However, its effect in generating foreign currency is significantly undercut because of the larger maize imports needed to sustain the growth in pig production.

6. No productivity growth in the maize sector

Maize is a very important crop in Vietnam. Maize area, production, and yields have been increasing dramatically in recent years. However, maize production and yields in 2012 are slightly lower than 2011. In the future, due to the negative impact of pollution and climate change, maize productivity might not increase. In this scenario, we assume that growth in maize productivity is 0% instead of 2.0% to examine the impact of zero growth in maize productivity on the pig sector.

Figure 10: Maize area and yield in Vietnam

Source: GSO, 2013



In this scenario, demand for pork and maize remain the same. However, the supply and price of maize changes (table 20). Maize supply is almost flat during 2013-2025 (4.3 million tons in 2013 and 4.4 million tons in 2025), while maize demand increases significantly (from 5.9 million tons to 9.8 million tons). As productivity growth is 0%, the increase in maize supply may come from an increase in the cultivated area, although this is just a small amount due to limited land resources. However, in practice, the cultivation area of maize depends much on government policy. If the Vietnamese government removes or reduces its policy to keep 3.8 million ha of land under rice for food security, many rice growing farmers would switch to maize because of higher profits associated with it.

Table 20. National supply and demand under without productivity growth in maize sector (thousand tons)

Source: Simulation results 2013

Year	Demand				Supply		
	Traditional pig	Modern pig	Maize food	Maize feed	Traditional Pig	Modern Pig	Maize
2013	1591	49	200	5873	1591	59	4325
2014	1665	53	203	6127	1665	62	4332
2015	1741	57	207	6399	1741	66	4339
2016	1821	61	210	6683	1821	70	4346
2017	1905	66	214	6971	1905	75	4355
2018	1992	70	217	7280	1992	80	4362
2019	2084	76	221	7602	2084	85	4368
2020	2180	81	225	7938	2180	91	4375
2021	2280	87	228	8289	2280	97	4382
2022	2384	93	232	8655	2384	103	4389
2023	2494	100	236	9036	2494	110	4396

2024	2608	107	240	9435	2608	117	4403
2025	2728	115	244	9851	2728	124	4409
Share 2013	97.0	3.0	3.3	96.7	96.4	3.6	
Share 2025	96.0	4.0	2.4	97.6	95.6	4.4	

If maize were a non-tradable commodity or if the Vietnamese maize market were closed, the maize price would increase rapidly due to rising demand. However, Vietnam has been annually importing a large amount of maize, with its domestic price affected by the international market. Therefore, in this scenario, demand price and supply price do not change, but the amount of imported maize surges from 1750 thousand tons to 5444 thousand tons, 27.8% higher than in the base scenario (see Table 21).

Table 21. Export and import without productivity growth in the maize sector (thousand tons)

Source: Simulation result 2013

	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
Pork export	9.6	8.7	8.9	9.1	9.2	9.4	9.5	9.6	9.7	9.7	9.6	9.5	9.3
Maize import	1748	1998	2267	2547	2830	3135	3454	3787	4135	4498	4877	5273	5685

Our assumption is that the Vietnamese maize price is equal to the international maize price. Thus, the shortage of maize in the market will be sufficient by importing without affecting maize price. Therefore, demand and supply price of all there sector remains the same as base scenario.

Table 22. National average prices without productivity growth in the maize sector (VND/kg)

Source: Simulation results 2013

Year	Demand price			Supply price		
	Traditional pig	Modern pig	Maize	Traditional pig	Modern pig	Maize
2013	79170.6	71312.5	10389.6	35964.4	32338.5	7816.5
2014	81418.8	73689.7	10654.6	37088.2	33492.3	8054.8
2015	83744.6	77240.4	10918.4	38250.9	35285.8	8292.2
2016	86141.5	80993.3	11189.8	39449.1	37174.9	8536.4
2017	88630.3	84974.0	11495.3	40693.2	39168.7	8839.2
2018	91177.1	89164.3	11784.4	41966.4	41263.7	9101.1
2019	93800.0	93555.8	12080.1	43277.6	43459.3	9367.2
2020	96502.6	98158.2	12384.4	44628.7	45760.4	9641.0
2021	99287.1	102981.6	12697.6	46020.8	48172.0	9922.8
2022	102156.2	108036.6	13019.8	47455.1	50699.4	10212.7
2023	105112.2	113334.4	13351.3	48932.9	53348.2	10511.0
2024	108157.5	118851.7	13692.5	50455.4	56114.3	10818.0
2025	111295.1	124624.6	14043.6	52023.9	59010.7	11133.9

To conclude, this scenario gives a pessimistic picture of maize production in Vietnam. However, this is not likely to happen because Vietnam currently has quite low maize productivity compared to other countries in the world. In the future, with the development of gene-modified maize, new cultivation methods, and crop management systems, maize productivity in Vietnam might increase sharply. Even with low productivity growth, Vietnam can still satisfy its national demand by importing. However, this will worsen Vietnamese trade balance.

7. Higher income elasticity of modern pork products

In all of the above scenarios, we assumed the income elasticity for traditional pork was 0.9 and modern pork was 1.8, similar to figures in the previous version of VPM 2010 whereby the income elasticity for modern pork products was double the income elasticity for traditional pork products. However, despite the doubling of the income elasticity, simulations results reveal that modern pork still accounts for a minor share of the pork market, even in 2025. This is because the majority of Vietnamese population still live in rural areas where only traditional fresh pork is available, and most urban residents still buy their pork in small daily markets instead of supermarkets. In this scenario, we assume that the consumption habit change more rapidly, with more people switching to modern pork when they have higher income. Here, we thus assume that the income elasticity of modern pork is 2.7, three times higher than the income elasticity for traditional pork products and 1.5 times higher than in the base scenario.

With the higher income elasticity, demand for modern pork increases much faster than in the base scenario, with the annual growth rate of modern pig demand at 9.4% (this number is 7.2% in the base scenario). In 2025, demand for modern pork is 149 thousand tons, 38 thousand tons higher than in the base scenario. It accounts for 5.2% of the total pork market, a relatively small number but still higher than in the base scenario (4.0%).

Higher income elasticities of modern pork demand also cause changes in maize demand. Demand for maize as food increases slightly from 200 tons to 244 tons, while annual growth in the demand for maize as food is only 1.7%, similar to the baseline. The demand for maize feed increases slightly compared to the baseline (10,058 thousand tons in this scenario vs. 9,851 thousand tons in the base scenario).

Table 23. National supply and demand with higher income elasticity for modern pork products (thousand tons)

Source: Simulation results 2013

Year	Demand				Supply		
	Traditional pig	Modern pig	Maize food	Maize feed	Traditional pig	Modern pig	Maize
2013	1591	49	200	5873	1591	59	4325
2014	1665	56	203	6127	1665	62	4419
2015	1741	62	207	6399	1741	66	4514
2016	1821	70	210	6683	1821	70	4612
2017	1905	76	214	6991	1905	76	4712
2018	1993	83	217	7316	1993	83	4813
2019	2086	90	221	7656	2086	90	4917

2020	2182	98	225	8004	2182	98	5026
2021	2282	107	228	8377	2282	107	5134
2022	2388	116	232	8768	2388	116	5245
2023	2498	126	236	9178	2498	126	5358
2024	2613	137	240	9607	2613	137	5474
2025	2734	149	244	10058	2734	149	5592
Share 2013	97.0	3.0	3.3	96.7	94.9	5.1	
Share 2025	93.1	6.9	2.9	97.1	91.5	8.5	

In this scenario, the supply of modern pork is 149 thousand tons, 25 thousand tons higher than in the base scenario. The annual growth of modern pork supply is 8.3%, 1.8 percentage points higher than the baseline. Compared to the base scenario, the supply of traditional pork and maize are basically the same.

In Table 24, we can see the projection of export quantities of modern pork. Given higher income elasticities of modern pork demand, Vietnamese demand for modern pork increases more than domestic modern pig production. Therefore, exports of modern pork are lower than in the baseline, and by 2017, Vietnam does not have a pork surplus for export in this scenario.

Table 24. Net exports with higher income elasticity for modern pork products (thousand tons)

Source: Simulation results 2013

	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
Pork export	9,6	6,3	3,6	0,5	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Maize import	1748	1912	2092	2281	2493	2720	2960	3202	3471	3755	4055	4373	4710

Higher pig production will lead to increased demand for maize, especially maize for feed. While domestic maize production remains the same, the amount of imported maize increases significantly.. In this scenario, maize imports rise at a rate of 8.5% per year and will reach 4710 thousand tons in 2025, slightly more than in the baseline.

Demand for modern pork increase leads to increase in price of modern pork. In this scenario, both supply price and demand price of modern pork increases about 40% comparing to base scenario ((86,983 VND vs. 60,267 VND with producer price, and 180,874 VND vs. 127,438 VND with consumer price).

Table 25. National average prices with higher income elasticity for modern pork products (VND/kg)

Source: Simulation results 2013

Year	Demand price			Supply price		
	Traditional pig	Modern pig	Maize	Traditional pig	Modern pig	Maize
2013	76575	74018	9120	34744	33563	6823
2014	79171	76250	9352	36041	34677	7032
2015	81872	79891	9581	37391	36497	7238
2016	84671	83706	9818	38791	38404	7451
2017	87609	90694	10061	40259	41897	7670
2018	90660	98792	10311	41784	45945	7895
2019	93824	107639	10568	43366	50368	8126
2020	97128	117354	10861	45017	55225	8419
2021	100530	127916	11133	46718	60506	8664
2022	104057	139454	11414	48482	66275	8916
2023	107715	152060	11702	50310	72577	9176
2024	111507	165830	11999	52206	79462	9443
2025	115440	180874	12304	54172	86983	9718

In conclusion, if the income elasticity of modern pork demand increases, the demand for both modern pork and traditional pork will increase. However, demand for modern pork grows at a higher rate. Compared to baseline, traditional pork supply and demand growth is almost the same, while the supply and demand of modern pork will increase at slightly higher rate (about 2 percentage points higher than the baseline). The same pattern of growth could be seen for domestic pork prices. However, in this scenario, exports of modern pork reduce sharply, with exports ceasing after 2016.

8. Higher income elasticity and higher productivity growth in the modern pig sector

In the above-mentioned scenario 7, we found that the demand for modern pork increases significantly under higher income elasticities. However, we also assumed that productivity growth in the modern pig sector remained unchanged. In practice, pig producers could respond very quickly to these market signals. As demand increases, many investors including foreigners will invest in pig farms, especially in the context of further trade liberalization. These investors will bring new management and production technologies resulting in higher productivity growth. We thus test in this scenario the combined impact of a higher income elasticity in the modern pork sector and annual growth in the production technology in the modern pig sector of 10% (it is 4% in the base scenario).

Such a combined scenario will lead to an annual increase in the supply of modern pork of 12.6% (6.1 percentage points higher than in the base scenario). In 2025, Vietnam will produce 243 thousand tons of modern pork, which is more than four times higher than in 2013, and two times higher than in the scenario with only modern pork productivity growth (scenario 5) (see Table 26). The supply of traditional pork does not change compared to the baseline.

Table 26. National supply and demand with higher income elasticity and higher productivity growth in the modern pig sector (thousand tons)

Source: Simulation results 2013

Year	Demand				Supply		
	Traditional pig	Modern pig	Maize food	Maize feed	Traditional pig	Modern pig	Maize
2013	1591	49	200	5873	1591	59	4325
2014	1665	56	203	6152	1665	66	4419
2015	1741	62	207	6454	1741	74	4514
2016	1821	70	210	6772	1821	83	4612
2017	1905	78	214	7109	1905	94	4712
2018	1992	88	217	7456	1992	106	4816
2019	2084	98	221	7834	2084	119	4920
2020	2180	110	225	8234	2180	134	5026
2021	2280	124	228	8658	2280	151	5134
2022	2384	139	232	9109	2384	170	5245
2023	2494	155	236	9589	2494	192	5358
2024	2608	174	240	10099	2608	216	5474
2025	2728	195	244	10644	2728	243	5592
Share 2013	97,0	3,0	3,3	96,7	96,4	3,6	
Share 2025	93,3	6,7	2,2	97,8	91,8	8,2	

In base scenario, the amount of exported modern pork varied from 8-10 thousand tonnes. In the previous scenario (scenario 7), the amount of exported pork decreases sharply to fulfil national demand. In this scenario, the modern pork sector develops significantly, with the amount of exported modern pork rising rapidly during the 2013 – 2025 period. The annual growth rate is 14.70%, with net volumes of exported modern pork in 2025 reaching 47.5 thousand tonnes, some 38.1 thousand tonnes higher than in the base scenario.

Table 27. Net exports with higher income elasticity and higher productivity growth in the modern pig sector (thousand tons)

Source: Simulation results 2013

	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
Pork export	9.6	9.8	11.5	13.3	15.5	17.9	20.8	23.9	27.5	31.6	36.2	41.4	47.5
Maize Import	1748	1936	2146	2370	2611	2858	3135	3433	3752	4096	4466	4865	5296

Not surprisingly, the expansion of the pig sector also results in higher maize imports. In 2025, Vietnam has to import 5,296 thousand tons of maize (793 thousand tons higher than in the baseline scenario) and the annual growth rate of maize import was found to be 9.6%.

The trend in prices for traditional pork and modern pork are very close to what was observed in the base scenario. The consumer price of modern pork in 2025 is 126,720 VND/kg (annual growth rate is 4.7%) and the producer price of modern pork is 59,973 VND/kg (annual growth rate is 5.1%).

Table 28. National average prices with higher income elasticity and higher productivity growth in the modern pig sector (VND/kg)

Source: Simulation results 2013

Year	Demand price			Supply price		
	Traditional pig	Modern pig	Maize	Traditional pig	Modern pig	Maize
2013	76575	74018	9120	34744	33563	6823
2014	79171	76237	9352	36041	34671	7032
2015	81871	79867	9581	37391	36487	7238
2016	84670	83682	9818	38790	38394	7451
2017	87571	87681	10061	40240	40393	7670
2018	90599	91872	10339	41754	42488	7949
2019	93714	96263	10596	43311	44683	8181
2020	96941	100811	10861	44924	46961	8419
2021	100283	105522	11133	46595	49326	8664
2022	103747	110455	11414	48326	51803	8916
2023	107336	115619	11702	50121	54397	9176
2024	111056	121026	11999	51980	57114	9443
2025	114910	126720	12304	53907	59973	9718

To summarize, in the scenario with high-income elasticity and high technology growth of modern pork, both demand and supply of modern pork increase significantly compared to the baseline. However, the increase in the supply of modern pork is higher than the increase in its demand, leading to sharp growth in pork exports. Prices of traditional and modern pork increase at almost the same rate as in the base scenario.

9. Worst-case scenario for traditional pig sector

In this scenario, we come up with assumptions that would be most favourable for the modern pig sector and least favourable for the traditional pig sector, including:

- Per capita income growth is 10% rather than 5%;
- Income elasticity of traditional pork is 0.5 rather than 0.9;
- Income elasticity of modern pork is 2.7 rather than 1.8;
- Productivity growth in the traditional pig sector is 0% instead of 3%;
- Productivity growth in the modern pig sector is 10% instead of 4%;

As a result, modern pork consumption rises massively with demand for modern pork increasing from 49 thousand tons to 683 thousand tons (about 14 times higher). In the case of traditional pork products, both the growth rates of demand and supply decelerate to 3.7% per year (0.9 percentage points less than in the base scenario). However, traditional pork is still dominant in the domestic market as modern pork in this worst-case scenario accounts for 21.8% of total pork consumption..

Demand for maize as food rises gradually with annual growth of 2.9%. The development of the modern pig sector leads to an increase in demand for maize as feed. In this scenario, total demand for maize as feed in 2025 is 10.851 thousand tons. This is almost 1 million tons higher than the base scenario.

Table 29. Long-term national supply and demand under the worst-case scenario for the traditional pig sector (thousand tons)

Source: Simulation results 2013

Year	Demand				Supply		
	Traditional pig	Modern pig	Maize food	Maize feed	Traditional pig	Modern pig	Maize
2013	1591	49	200	5873	1591	59	4325
2014	1650	64	206	6134	1650	66	4419
2015	1711	77	212	6442	1711	77	4514
2016	1775	92	218	6783	1775	92	4612
2017	1841	109	224	7142	1841	109	4714
2018	1909	129	231	7542	1909	129	4816
2019	1980	153	238	7979	1980	153	4920
2020	2052	194	244	8394	2052	174	5026
2021	2127	250	252	8823	2127	196	5134
2022	2204	321	259	9279	2204	220	5245

2023	2283	413	267	9767	2283	247	5358
2024	2365	531	274	10290	2365	277	5474
2025	2451	683	282	10851	2451	311	5592
Share 2013	97,0	3,0	3,3	96,7	96,4	3,6	
Share 2025	78,2	21,8	2,5	97,5	88,7	11,3	

The supply of modern pork in 2025 grows approximately by 15.2% per year (this number was 6.5% in the base scenario). During the period of 2015-2019, we found the highest annual growth rate ranging from 17-19%. In other years, growth rate is only 12-13%. In 2025, the supply of modern pork reaches 311 thousand tons, i.e. 186.8 thousand tons higher than in the base scenario. As productivity growth of maize is unchanged relative to the baseline, maize supply in this scenario is identical to the base scenario.

Looking at import and export performance (Table 30), Vietnam has a small amount of pork exports in 2013 and much less in 2014. From 2015 to 2019, Vietnam produces just enough pork for domestic consumption. From 2020 and beyond, domestic demand for pork is higher than domestic production and Vietnam begins to import pork. By 2025, the volume of imported pork increases to 372 thousand tons.

Table 30. Long-term net exports under the worst-case scenario for the traditional pig sector (thousand tons)

Source: Simulation results 2013

	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
Pork export	9,6	1,9	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Pork import	0,0	0,0	0,0	0,0	0,0	0,0	0,0	20,0	53,9	101,3	166,2	254,1	372,0
Maize import	1748	1920	2140	2389	2653	2958	3297	3613	3940	4293	4676	5091	5542

Demand for maize as feed increases while the supply of maize is similar to the baseline. As a result, maize imports rise rapidly at an annual rate of 10.1% (2 percentage points higher than in the base scenario) and reach 5.5 million tons by 2025.

The demand price of traditional pork increases gradually at 8.1%/year (compared to 3.4% in the base scenario) and reaches 194,002 VND/kg in 2025, nearly 70% higher than in the base scenario. The demand price for modern pork is closely related to demand, supply, and import. In the period from 2015 to 2019, the demand price of modern pork increases by 13-15% per year. From 2020-2025, the supply of modern pork exceeds demand, with price growth rates slowing to 4-6% per year (see

Table 31).

Table 31. National average prices in worst-case scenario (VND/kg)

Source: Simulation results 2013

Year	Demand price			Supply price		
	Traditional pig	Modern pig	Maize	Traditional pig	Modern pig	Maize
2013	76575	74018	9120	34744	33563	6823
2014	82569	76250	9352	37740	34677	7032
2015	89159	86201	9581	41034	39651	7238
2016	96334	99703	9818	44621	46401	7451
2017	104145	115455	10089	48525	54276	7724
2018	112592	133714	10339	52748	63405	7949
2019	121756	154944	10596	57330	74019	8181
2020	131551	164953	10861	62227	79063	8419
2021	142131	172138	11133	67516	82667	8664
2022	153591	179455	11414	73246	86326	8916
2023	166006	187106	11702	79453	90151	9176
2024	179454	195106	11999	86176	94151	9443
2025	194022	203470	12304	93460	98333	9718

This simulation uses a set of five extreme assumptions designed to suppress the traditional pig sector and boost the modern sector. As a result, demand and supply of modern pork increases faster than in other scenarios. The market share of modern pork also reaches 21.8% in 2025 while in the base scenario, modern pork only accounts for 4.0% of the market. In this scenario, the development of the pig sector can be divided into two small periods: First, from 2013 to 2019, Vietnamese pork production is higher or equal to demand, and Vietnam still exports pork at the very beginning of the period. However, the price of modern pork increases significantly such that from 2020 to 2025, demand for modern pork is much higher than supply, Vietnam starts to import pork and import quantities increase significantly, with the price growth of modern pork slowing down to 4-6%.

10.No tariff for pig products between ASEAN Plus & TPP countries

According to Trans-Pacific Strategic Economic Partnership Agreement (TPP) and ASEAN plus three, Vietnam and other member countries will have to reduce import and export tax of certain commodities, including pig products. New tax rates and tariff reduction schedules depend on specific country and agreement, in this scenario, we assume Vietnam's import tax for pork products from TPP and ASEAN countries is equal to 0 since 2013. Using another model called GTAP, we get the result that reducing tax in TPP and ASEAN plus countries will reduce world price of pork by 1%. And we will

use this result in GEMPACK model to see the impact of free trade agreements on Vietnamese pig sector.

Looking at Table 32, Table 33 and Table 34, we can barely see any different comparing to base scenario. A possible explanation for this is imported pork is mostly chilled or frozen, while most Vietnamese people consume fresh meat, therefore, reducing import tax doesn't affect much Vietnamese pork market.

However, this result based on an assumption that Vietnam only import processed pig products, but in fact, some producers might find some solution to import live pig (Vietnam currently import live cow from Australia). Thus, Vietnamese government will still have to keep a small gap between Vietnamese production price and international price.

Table 32. Long-term national supply and demand under the worst-case scenario for the traditional pig sector (thousand tons)

Source: Simulation result 2013

Year	Demand				Supply		
	Traditional pig	Modern pig	Maize as food	Maize as feed	Modern pig	Traditional pig	Maize
2013	1591	49	200	5871	1591	58	4325
2014	1664	54	203	6124	1664	62	4419
2015	1741	58	207	6396	1741	66	4514
2016	1821	62	210	6680	1821	70	4612
2017	1905	66	214	6975	1905	75	4712
2018	1992	71	217	7284	1992	79	4813
2019	2084	76	221	7606	2084	85	4917
2020	2180	82	225	7934	2180	90	5026
2021	2280	88	228	8284	2280	96	5134
2022	2384	94	232	8650	2384	102	5245
2023	2494	101	236	9031	2494	109	5358
2024	2608	108	240	9430	2608	116	5474
2025	2728	116	244	9845	2728	124	5592
Share 2013	97.0	3.0	3.3	96.7	96.5	3.5	
Share 2025	95.9	4.1	2.4	97.6	95.7	4.3	

Table 33. Long-term net exports under the worst-case scenario for the traditional pig sector (thousand tons)

Source: Simulation result 2013

	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
Pork export	8.9	7.9	8.1	8.2	8.4	8.5	8.5	8.5	8.5	8.4	8.3	8.1	7.8
Maize import	1745	1909	2088	2278	2478	2688	2910	3133	3378	3637	3909	4196	4497

Table 34. National average prices in worst-case scenario (VND/kg)

Source: Simulation result 2013

Year	Demand price			Supply price		
	Traditional pig	Modern pig	Maize	Traditional pig	Modern pig	Maize
2013	76565	73284	9120	34739	33196	6823
2014	79161	75492	9352	36036	34298	7032
2015	81862	79096	9581	37386	36100	7238
2016	84661	82874	9818	38785	37988	7451
2017	87561	86832	10061	40235	39967	7670
2018	90567	90981	10311	41738	42041	7895
2019	93681	95329	10568	43294	44214	8126
2020	96931	99885	10861	44919	46492	8419
2021	100275	104661	11133	46591	48880	8664
2022	103741	109666	11414	48323	51382	8916
2023	107333	114911	11702	50119	54004	9176
2024	111054	120408	11999	51979	56752	9443
2025	114911	126169	12304	53908	59632	9718

Summary and conclusions

Summary

The 2010 report written by Nicholas Minot et al. on the transformation of pig market in Vietnam was an attempt to design a dynamic partial equilibrium model to investigate the structural changes in the pig market in Vietnam over the next decades under different scenario options. In this report, we reviewed the current situation of Vietnamese livestock production, focusing on the pig sector and current government policies on livestock production up to 2013. Our key contributions to the development of the Vietnam Pig-Sector Model (VPM) were in updating and calibrating with newer data, making some minor changes in the model structure where needed, and adding some different macro-indicator assumptions to re-check the research question raised in the former report but under a new context i.e., when the WTO commitment on tariff reduction has been fully satisfied and when Vietnam is further integrated into regional/world markets. However we maintained the model specification of Minot's research team, and largely kept the same scenarios.

The basic hypothesis of the report is that the income elasticity of modern pork demand is much higher than that of traditional pork, and as a result of industrialisation, modernisation, and urbanization, people will shift to pork supplied by modern farms and in modern forms (i.e., pork that is chilled, frozen, or processed and sold in supermarkets). Consequently, under this hypothesis, small and medium farms will be gradually squeezed out of the market. There is a huge chance that this will happen because of high per capita income growth rates in Vietnam and the importance of pork in diets. Furthermore, the market share of large-scale commercial pig farms has increased from 0.01 percent in 2001 to 17.4% in 2011. However, only a small part of these commercial large-scale pig farms could be considered as true modern farms that are directly involved in the modern supermarket system in Vietnam.

Using VPM, a dynamic partial equilibrium model, with eight regions and three sectors, we simulated the development of the Vietnamese pig sector over a 12-year time scale. The model was calibrated using data on production, consumption, trade, and prices from Vietnam, as well as behavioural parameters estimated in Vietnam and elsewhere. We come up with several plausible scenarios with different assumptions about changes in income, population, production technology, exchange rates, world prices, and income elasticities. We used VPM to examine the impact of those individual or combined changes on the pig market in Vietnam for both traditional and modern pig sectors as well as the maize sector, an important input for pig production.

Our simulation results revealed the following:

- The modern pig sector in Vietnam is small but increasing. Large-scale farms (over 100 pig heads) account for 17.4 per cent of the market, though only 13.2 per cent of meat products in Vietnam have any sort of quarantine stamp. Most pork products are sold as fresh meat in the daily market;

- In most scenarios with VPM, modern pork production increases slightly but remains relatively small as a share of consumption in the next two decades. While the traditional pig sector has a lower income elasticity and growth rate, because of its convenience and cheap prices, it is still popular in most parts of Vietnam, especially in rural areas;

- Scenario 9 was the scenario with the least favorable outlook for traditional pig production. In this scenario, the market share of modern pork rises to more than 20 percent, significantly higher than the 4 percent share in the base scenario. However, even with all the assumptions stacked against traditional pig production, traditional pork still accounts for nearly 80 percent of total pork demand in the next 12 years;

- Technology is the biggest motivation to improve the production of modern pig sector. Increasing demand without technology development will lead to import instead of developing production. Vietnam currently exports pork in relatively small quantities. In scenarios where the technology of the sector improves, the production of modern pork exceeds domestic demand and Vietnam exports more pork. In other scenarios, modern pork demand is higher than production, resulting in a decline in the amount of exported pork. In some cases, Vietnam will have to import pork;

- In all scenarios, Vietnam has to import maize for the animal feed industry. The imported amount depends on the production of pork and maize productivity. However, an increase in maize demand does not affect its domestic price given that supplies come from the international market at world prices.

Our conclusions do not support the hypothesis that small-scale pig producers will be squeezed when per capita income increases and consumption habits changes. Pork consumption per capita in Vietnam is relatively small compared to other countries in the world, while the income elasticities of both modern pork and traditional pork are still high. Therefore, in the next decade, demand for traditional pork should remain high and not necessarily squeeze small and medium-sized pig producers .

Policy implications

- Traditional pig production will still account for the majority of the pork market in Vietnam in the coming decades. Thus, the Vietnamese government will have to address food safety and pork quality issues in a broader view, taking into account both large farms and small and medium farms.

- Productivity and efficiency are two different concepts. The Vietnamese pig sector has high productivity but low efficiency due to high feed costs. In order to increase the amount of exported pork, Vietnam will have to pay more attention on increasing this efficiency of the sector through policies to reduce animal feed price (increase planned area of maize, prompt to spread GMO maize species) and applying new technology in pig production.

- It is not necessary to issue policies to protect small-scale pig farmers. Despite the slower growth rate of the traditional sector relative to the modern pig sector, the traditional pig sector is not likely to disappear for some decades.

- Technology changes in the modern pig sector will help to increase production, meeting national demand and allowing surpluses for export. Technological changes in the traditional pig sector will help to reduce prices, maintain market shares, and have pro-poor impacts. In the maize sector, improving technology help reduce the amount of imports.

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Annex

Table 35 Detailed simulation result: 1. Base scenario

	Demand				**Supply**			**Demand price**			**Supply Price**			**Export**			**Import**		
	Trad Pig	Mod Pig	MZ Food	MZ Feed	Trad Pig	Mod Pig	Maize	Trad Pig	Mod Pig	Maize	Trad Pig	Mod Pig	Maize	Trad Pig	Mod Pig	Maize	Trad Pig	Mod Pig	Maize
2013	1591	49	200	5873	1591	59	4325	76575	74018	9120	34744	33563	6823	0	9.6	0	0	0	1748
2014	1665	53	203	6127	1665	62	4419	79171	76250	9352	36041	34677	7032	0	8.7	0	0	0	1912
2015	1741	57	207	6399	1741	66	4514	81872	79891	9581	37391	36497	7238	0	8.9	0	0	0	2092
2016	1821	61	210	6683	1821	70	4612	84671	83706	9818	38791	38404	7451	0	9.1	0	0	0	2281
2017	1905	66	214	6979	1905	75	4712	87572	87705	10061	40241	40403	7670	0	9.3	0	0	0	2481
2018	1993	70	217	7288	1993	80	4813	90578	91895	10311	41743	42498	7895	0	9.4	0	0	0	2692
2019	2084	76	221	7610	2084	85	4917	93693	96287	10568	43300	44693	8126	0	9.6	0	0	0	2914
2020	2180	81	225	7938	2180	91	5026	96943	100890	10861	44925	46994	8419	0	9.6	0	0	0	3137
2021	2280	87	228	8289	2280	97	5134	100288	105714	11133	46597	49406	8664	0	9.7	0	0	0	3383
2022	2384	93	232	8655	2384	103	5245	103754	110769	11414	48330	51933	8916	0	9.7	0	0	0	3642
2023	2494	100	236	9036	2494	110	5358	107346	116067	11702	50126	54582	9176	0	9.6	0	0	0	3914
2024	2608	107	240	9435	2608	117	5474	111068	121619	11999	51987	57358	9443	0	9.5	0	0	0	4201
2025	2728	115	244	9851	2728	124	5592	114926	127438	12304	53915	60267	9718	0	9.3	0	0	0	4503

Table 36 Detailed simulation result: 2. Higher income growth

	Demand				**Supply**			**Demand price**			**Supply Price**			**Export**			**Import**		
	Trad Pig	Mod Pig	MZ Food	MZ Feed	Trad Pig	Mod Pig	Maize	Trad Pig	Mod Pig	Maize	Trad Pig	Mod Pig	Maize	Trad Pig	Mod Pig	Maize	Trad Pig	Mod Pig	Maize
2013	1591	49	200	5873	1591	59	4325	76575	74018	9120	34744	33563	6823	0	9.6	0	0	0	1748
2014	1708	59	206	6318	1708	62	4419	83462	76250	9352	38186	34677	7032	0	3.4	0	0	0	2105
2015	1834	67	212	6815	1834	67	4514	91060	82630	9581	41984	37866	7238	0	0.0	0	0	0	2512
2016	1970	75	218	7356	1970	75	4614	99469	93591	9846	46188	43345	7506	0	0.0	0	0	0	2960
2017	2115	83	224	7949	2115	83	4714	108668	106015	10089	50787	49557	7724	0	0.0	0	0	0	3459
2018	2271	92	231	8589	2271	92	4816	118760	120151	10339	55832	56624	7949	0	0.0	0	0	0	4004
2019	2438	102	238	9279	2438	102	4920	129830	136233	10596	61366	64664	8181	0	0.0	0	0	0	4598
2020	2617	114	245	10025	2617	114	5026	141973	154529	10861	67437	73812	8419	0	0.0	0	0	0	5244
2021	2809	129	252	10815	2809	124	5134	155242	170925	11133	74071	82009	8664	0	0.0	0	0	4	5932
2022	3013	151	259	11633	3013	133	5245	169671	179455	11414	81285	86326	8916	0	0.0	0	0	19	6647
2023	3232	179	267	12507	3232	141	5358	185472	187106	11702	89185	90151	9176	0	0.0	0	0	38	7415
2024	3467	212	273	13410	3467	149	5481	202922	195106	12290	97910	94151	9685	0	0.0	0	0	62	8202
2025	3718	251	281	14416	3718	159	5599	221899	203470	12595	107398	98333	9959	0	0.0	0	0	92	9098

Table 37 Detail silmulation result: 3. No productivity growth in the traditional pig sector

	Demand				**Supply**			**Demand price**			**Supply Price**			**Export**			**Import**		
	Trad Pig	Mod Pig	MZ Food	MZ Feed	Trad Pig	Mod Pig	Maize	Trad Pig	Mod Pig	Maize	Trad Pig	Mod Pig	Maize	Trad Pig	Mod Pig	Maize	Trad Pig	Mod Pig	Maize
2013	1591	49	200	5873	1591	59	4325	76575	74018	9120	34744	33563	6823	0	9.6	0	0	0	1748
2014	1646	54	203	6092	1646	62	4419	82176	76250	9352	37543	34677	7032	0	8.3	0	0	0	1876
2015	1703	58	207	6325	1703	66	4514	88224	79891	9581	40567	36497	7238	0	8.0	0	0	0	2017
2016	1761	63	210	6566	1761	70	4612	94745	83706	9818	43826	38404	7451	0	7.7	0	0	0	2165
2017	1821	68	214	6817	1821	75	4712	101773	87705	10061	47340	40403	7670	0	7.3	0	0	0	2319
2018	1883	73	218	7076	1883	80	4813	109349	91896	10311	51127	42498	7895	0	6.8	0	0	0	2480
2019	1947	79	222	7345	1947	85	4917	117516	96288	10568	55210	44693	8126	0	6.1	0	0	0	2649
2020	2013	85	225	7624	2013	91	5024	126319	100890	10833	59611	46994	8364	0	5.3	0	0	0	2826
2021	2081	92	229	7913	2081	97	5132	135807	105714	11105	64355	49406	8609	0	4.3	0	0	0	3010
2022	2152	100	233	8204	2152	103	5245	146067	110769	11414	69484	51933	8916	0	3.1	0	0	0	3192
2023	2225	108	237	8515	2225	110	5358	157093	116067	11702	74996	54582	9176	0	1.8	0	0	0	3394
2024	2300	116	241	8838	2300	117	5474	168977	121620	11999	80938	57358	9443	0	0.2	0	0	0	3605
2025	2377	125	245	9178	2377	125	5592	181810	128735	12304	87355	60915	9718	0	0.0	0	0	0	3831

Table 38 Detailed simulation result: 4. Higher productivity growth in the traditional pig sector

	Demand				**Supply**			**Demand price**			**Supply Price**			**Export**			**Import**		
	Trad Pig	Mod Pig	MZ Food	MZ Feed	Trad Pig	Mod Pig	Maize	Trad Pig	Mod Pig	Maize	Trad Pig	Mod Pig	Maize	Trad Pig	Mod Pig	Maize	Trad Pig	Mod Pig	Maize
2013	1591	49	200	5873	1591	59	4325	76575	74018	9120	34744	33563	6823	0	9.6	0	0	0	1748
2014	1706	52	203	6207	1706	62	4419	72898	76226	9352	32905	34667	7032	0	9.5	0	0	0	1991
2015	1830	55	206	6566	1830	66	4514	69418	79867	9581	31166	36487	7238	0	10.7	0	0	0	2258
2016	1962	58	210	6945	1962	70	4612	66117	83682	9818	29516	38394	7451	0	12.0	0	0	0	2543
2017	2103	62	213	7345	2103	75	4712	62981	87554	10061	27949	40340	7670	0	13.3	0	0	0	2846
2018	2254	65	216	7758	2254	80	4816	60019	91550	10339	26468	42354	7949	0	14.6	0	0	0	3159
2019	2417	69	220	8203	2417	85	4920	57194	95729	10596	25057	44463	8181	0	16.0	0	0	0	3504
2020	2590	73	223	8673	2590	90	5026	54515	100173	10861	23717	46700	8419	0	17.7	0	0	0	3871
2021	2777	77	227	9170	2777	96	5134	51973	104980	11133	22447	49105	8664	0	19.6	0	0	0	4263
2022	2976	81	231	9694	2976	103	5245	49562	109998	11414	21242	51617	8916	0	21.6	0	0	0	4679
2023	3189	85	234	10247	3189	109	5358	47273	115250	11702	20099	54248	9176	0	23.8	0	0	0	5122
2024	3369	91	238	11162	3506	116	5474	47301	120780	11999	20116	57015	9443	137	25.3	0	0	0	5926
2025	3525	98	242	12402	3919	124	5592	48858	126623	12304	20895	59934	9718	393	26.4	0	0	0	7052

Table 39 Detailed simulation result: 5. Higher productivity growth in the modern sector

	Demand				**Supply**			**Demand price**			**Supply Price**			**Export**			**Import**		
	Trad Pig	Mod Pig	MZ Food	MZ Feed	Trad Pig	Mod Pig	Maize	Trad Pig	Mod Pig	Maize	Trad Pig	Mod Pig	Maize	Trad Pig	Mod Pig	Maize	Trad Pig	Mod Pig	Maize
2013	1591	49	200	5873	1591	59	4325	76575	74018	9120	34744	33563	6823	0	9.6	0	0	0	1748
2014	1664	54	203	6151	1664	65	4419	79163	75918	9352	36037	34537	7032	0	11.9	0	0	0	1935
2015	1741	58	207	6450	1741	74	4514	81852	79079	9581	37381	36163	7238	0	16.0	0	0	0	2142
2016	1821	62	210	6767	1821	83	4612	84641	82732	9818	38775	38009	7451	0	21.0	0	0	0	2365
2017	1905	66	214	7104	1905	93	4712	87542	86730	10061	40225	40008	7670	0	27.1	0	0	0	2606
2018	1992	71	217	7451	1992	105	4816	90570	90920	10339	41739	42103	7949	0	34.2	0	0	0	2853
2019	2084	76	221	7828	2084	119	4920	93685	95312	10596	43296	44298	8181	0	42.5	0	0	0	3130
2020	2179	82	225	8228	2179	134	5026	96914	99914	10861	44910	46599	8419	0	52.1	0	0	0	3427
2021	2279	88	228	8653	2279	151	5134	100259	104737	11133	46583	49011	8664	0	63.2	0	0	0	3747
2022	2384	94	232	9104	2384	170	5245	103726	109792	11414	48316	51538	8916	0	76.0	0	0	0	4092
2023	2494	101	236	9585	2494	191	5358	107318	115090	11702	50111	54187	9176	0	90.7	0	0	0	4463
2024	2608	108	240	10096	2608	215	5474	111040	120642	11999	51972	56963	9443	0	107.7	0	0	0	4862
2025	2727	116	244	10642	2727	243	5592	114898	126461	12304	53901	59872	9718	0	127.2	0	0	0	5294

Table 40 Detailed simulation result: 6. No productivity growth in the maize sector

	Demand				**Supply**			**Demand price**			**Supply Price**			**Export**			**Import**		
	Trad Pig	Mod Pig	MZ Food	MZ Feed	Trad Pig	Mod Pig	Maize	Trad Pig	Mod Pig	Maize	Trad Pig	Mod Pig	Maize	Trad Pig	Mod Pig	Maize	Trad Pig	Mod Pig	Maize
2013	1591	49	200	5873	1591	59	4325	76575	74018	9120	34744	33563	6823	0	9.6	0	0	0	1748
2014	1665	53	203	6127	1665	62	4332	79171	76250	9352	36041	34677	7032	0	8.7	0	0	0	1998
2015	1741	57	207	6399	1741	66	4339	81872	79891	9581	37391	36497	7238	0	8.9	0	0	0	2267
2016	1821	61	210	6683	1821	70	4346	84671	83706	9818	38791	38404	7451	0	9.1	0	0	0	2547
2017	1905	66	214	6971	1905	75	4355	87594	87705	10089	40251	40403	7724	0	9.2	0	0	0	2830
2018	1992	70	217	7280	1992	80	4362	90600	91895	10339	41754	42498	7949	0	9.4	0	0	0	3135
2019	2084	76	221	7602	2084	85	4368	93715	96287	10596	43311	44693	8181	0	9.5	0	0	0	3454
2020	2180	81	225	7938	2180	91	4375	96943	100890	10861	44925	46994	8419	0	9.6	0	0	0	3787
2021	2280	87	228	8289	2280	97	4382	100288	105714	11133	46597	49406	8664	0	9.7	0	0	0	4135
2022	2384	93	232	8655	2384	103	4389	103754	110769	11414	48330	51933	8916	0	9.7	0	0	0	4498
2023	2494	100	236	9036	2494	110	4396	107346	116067	11702	50126	54582	9176	0	9.6	0	0	0	4877
2024	2608	107	240	9435	2608	117	4403	111068	121619	11999	51987	57358	9443	0	9.5	0	0	0	5273
2025	2728	115	244	9851	2728	124	4409	114926	127438	12304	53915	60267	9718	0	9.3	0	0	0	5685

Table 41 Detailed simulation result: 7. Higher income elasticity of modern pork products

	Demand				**Supply**			**Demand price**			**Supply Price**			**Export**			**Import**		
	Trad Pig	Mod Pig	MZ Food	MZ Feed	Trad Pig	Mod Pig	Maize	Trad Pig	Mod Pig	Maize	Trad Pig	Mod Pig	Maize	Trad Pig	Mod Pig	Maize	Trad Pig	Mod Pig	Maize
2013	1591	49	200	5873	1591	59	4325	76575	74018	9120	34744	33563	6823	0	9.6	0	0	0	1748
2014	1665	56	203	6127	1665	62	4419	79171	76250	9352	36041	34677	7032	0	6.3	0	0	0	1912
2015	1741	62	207	6399	1741	66	4514	81872	79891	9581	37391	36497	7238	0	3.6	0	0	0	2092
2016	1821	70	210	6683	1821	70	4612	84671	83706	9818	38791	38404	7451	0	0.5	0	0	0	2281
2017	1905	76	214	6991	1905	76	4712	87609	90694	10061	40259	41897	7670	0	0.0	0	0	0	2493
2018	1993	83	217	7316	1993	83	4813	90660	98792	10311	41784	45945	7895	0	0.0	0	0	0	2720
2019	2086	90	221	7656	2086	90	4917	93824	107639	10568	43366	50368	8126	0	0.0	0	0	0	2960
2020	2182	98	225	8004	2182	98	5026	97128	117354	10861	45017	55225	8419	0	0.0	0	0	0	3202
2021	2282	107	228	8377	2282	107	5134	100530	127916	11133	46718	60506	8664	0	0.0	0	0	0	3471
2022	2388	116	232	8768	2388	116	5245	104057	139454	11414	48482	66275	8916	0	0.0	0	0	0	3755
2023	2498	126	236	9178	2498	126	5358	107715	152060	11702	50310	72577	9176	0	0.0	0	0	0	4055
2024	2613	137	240	9607	2613	137	5474	111507	165830	11999	52206	79462	9443	0	0.0	0	0	0	4373
2025	2734	149	244	10058	2734	149	5592	115440	180874	12304	54172	86983	9718	0	0.0	0	0	0	4710

Table 42 Detailed simulation result: 8. Higher income elasticity and higher productivity growth in the modern pig sector

	Demand				**Supply**			**Demand price**			**Supply Price**			**Export**			**Import**		
	Trad Pig	Mod Pig	MZ Food	MZ Feed	Trad Pig	Mod Pig	Maize	Trad Pig	Mod Pig	Maize	Trad Pig	Mod Pig	Maize	Trad Pig	Mod Pig	Maize	Trad Pig	Mod Pig	Maize
2013	1591	49	200	5873	1591	59	4325	76575	74018	9120	34744	33563	6823	0	9.6	0	0	0	1748
2014	1665	56	203	6152	1665	66	4419	79171	76237	9352	36041	34671	7032	0	9.8	0	0	0	1936
2015	1741	62	207	6454	1741	74	4514	81871	79867	9581	37391	36487	7238	0	11.5	0	0	0	2146
2016	1821	70	210	6772	1821	83	4612	84670	83682	9818	38790	38394	7451	0	13.3	0	0	0	2370
2017	1905	78	214	7109	1905	94	4712	87571	87681	10061	40240	40393	7670	0	15.5	0	0	0	2611
2018	1992	88	217	7456	1992	106	4816	90599	91872	10339	41754	42488	7949	0	17.9	0	0	0	2858
2019	2084	98	221	7834	2084	119	4920	93714	96263	10596	43311	44683	8181	0	20.8	0	0	0	3135
2020	2180	110	225	8234	2180	134	5026	96941	100811	10861	44924	46961	8419	0	23.9	0	0	0	3433
2021	2280	124	228	8658	2280	151	5134	100283	105522	11133	46595	49326	8664	0	27.5	0	0	0	3752
2022	2384	139	232	9109	2384	170	5245	103747	110455	11414	48326	51803	8916	0	31.6	0	0	0	4096
2023	2494	155	236	9589	2494	192	5358	107336	115619	11702	50121	54397	9176	0	36.2	0	0	0	4466
2024	2608	174	240	10099	2608	216	5474	111056	121026	11999	51980	57114	9443	0	41.4	0	0	0	4865
2025	2728	195	244	10644	2728	243	5592	114910	126720	12304	53907	59973	9718	0	47.5	0	0	0	5296

Table 43 Detailed simulation result: 9. Worst-case scenario for traditional pig sector

	Demand				**Supply**			**Demand price**			**Supply Price**			**Export**			**Import**		
	Trad Pig	Mod Pig	MZ Food	MZ Feed	Trad Pig	Mod Pig	Maize	Trad Pig	Mod Pig	Maize	Trad Pig	Mod Pig	Maize	Trad Pig	Mod Pig	Maize	Trad Pig	Mod Pig	Maize
2013	1591	49	200	5873	1591	59	4325	76575	74018	9120	34744	33563	6823	0	9.6	0	0	0	1748
2014	1650	64	206	6134	1650	66	4419	82569	76250	9352	37740	34677	7032	0	1.9	0	0	0	1920
2015	1711	77	212	6442	1711	77	4514	89159	86201	9581	41034	39651	7238	0	0.0	0	0	0	2140
2016	1775	92	218	6783	1775	92	4612	96334	99703	9818	44621	46401	7451	0	0.0	0	0	0	2389
2017	1841	109	224	7142	1841	109	4714	104145	115455	10089	48525	54276	7724	0	0.0	0	0	0	2653
2018	1909	129	231	7542	1909	129	4816	112592	133714	10339	52748	63405	7949	0	0.0	0	0	0	2958
2019	1980	153	238	7979	1980	153	4920	121756	154944	10596	57330	74019	8181	0	0.0	0	0	0	3297
2020	2052	194	244	8394	2052	174	5026	131551	164953	10861	62227	79063	8419	0	0.0	0	0	20	3613
2021	2127	250	252	8823	2127	196	5134	142131	172138	11133	67516	82667	8664	0	0.0	0	0	54	3940
2022	2204	321	259	9279	2204	220	5245	153591	179455	11414	73246	86326	8916	0	0.0	0	0	101	4293
2023	2283	413	267	9767	2283	247	5358	166006	187106	11702	79453	90151	9176	0	0.0	0	0	166	4676
2024	2365	531	274	10290	2365	277	5474	179454	195106	11999	86176	94151	9443	0	0.0	0	0	254	5091
2025	2451	683	282	10851	2451	311	5592	194022	203470	12304	93460	98333	9718	0	0.0	0	0	372	5542

Table 44 Detailed simulation result: 10. No tariff for pig products between ASEAN Plus & TPP countries

	Demand				**Supply**			**Demand price**			**Supply Price**			**Export**			**Import**		
	Trad Pig	Mod Pig	MZ Food	MZ Feed	Trad Pig	Mod Pig	Maize	Trad Pig	Mod Pig	Maize	Trad Pig	Mod Pig	Maize	Trad Pig	Mod Pig	Maize	Trad Pig	Mod Pig	Maize
2013	1591	49	200	5871	1591	58	4325	76565	73284	9120	34739	33196	6823	0	8.9	0	0	0	1745
2014	1664	54	203	6124	1664	62	4419	79161	75492	9352	36036	34298	7032	0	7.9	0	0	0	1909
2015	1741	58	207	6396	1741	66	4514	81862	79096	9581	37386	36100	7238	0	8.1	0	0	0	2088
2016	1821	62	210	6680	1821	70	4612	84661	82874	9818	38785	37988	7451	0	8.2	0	0	0	2278
2017	1905	66	214	6975	1905	75	4712	87561	86832	10061	40235	39967	7670	0	8.4	0	0	0	2478
2018	1992	71	217	7284	1992	79	4813	90567	90981	10311	41738	42041	7895	0	8.5	0	0	0	2688
2019	2084	76	221	7606	2084	85	4917	93681	95329	10568	43294	44214	8126	0	8.5	0	0	0	2910
2020	2180	82	225	7934	2180	90	5026	96931	99885	10861	44919	46492	8419	0	8.5	0	0	0	3133
2021	2280	88	228	8284	2280	96	5134	100275	104661	11133	46591	48880	8664	0	8.5	0	0	0	3378
2022	2384	94	232	8650	2384	102	5245	103741	109666	11414	48323	51382	8916	0	8.4	0	0	0	3637
2023	2494	101	236	9031	2494	109	5358	107333	114911	11702	50119	54004	9176	0	8.3	0	0	0	3909
2024	2608	108	240	9430	2608	116	5474	111054	120408	11999	51979	56752	9443	0	8.1	0	0	0	4196
2025	2728	116	244	9845	2728	124	5592	114911	126169	12304	53908	59632	9718	0	7.8	0	0	0	4497