

Globalization, Trade Liberalization and Poverty Alleviation in Southeast Asia: the Case of the Livestock Sector in Vietnam

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Abstract

A number of developing countries consider their livestock production sectors to be particularly vulnerable to global trade liberalization, especially because of the dominance of smallholder systems. The argument goes that agricultural trade liberalization will give undue advantage to large-scale commercial livestock systems at the expense of smallholder production systems, and that this in turn will add to the adjustment pressures on smallholder producers for whom income from livestock production is vital in helping them avoid poverty. We use a micro-macro approach that combines the GTAP general equilibrium model with a simple micro model to measure expected impacts of trade liberalization on a representative sample of Vietnam's livestock producers. Our results show that the impact of trade liberalization on Vietnam's livestock production tends to be small but in general a more open Vietnamese economy would result in a deterioration of the trade balance of livestock products. In spite of this, trade liberalization would benefit poor livestock producers by increasing livestock prices relative to production costs, in particular feed costs, and by increasing non-agricultural income.

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Introduction

Over the next 20 years, the livestock production systems in many Asian developing countries are likely to face significant adjustment pressures from economic growth and globalization of their economies. The globalization process will bring trade liberalization and further integration to the world economy, increasingly stringent food safety and quality standards, and increasing liberalization of capital flows in agri-food industries. Other events that shape the globalization process like urbanization and rising incomes, rapid strengthening of domestic demand for livestock products and technological change among others, are also expected to dramatically affect agriculture production and agri-industries. These events are likely to lead to profound changes in the structure and performance of livestock industries in these countries, providing both opportunities and threats.

Trade liberalization is one of the key drivers of the globalization process, affecting supply and consumer prices and triggering second-round effects through income, investment, factor prices and employment. A number of developing countries consider their livestock production sectors to be particularly vulnerable to global trade liberalization, especially because of the dominance of smallholder systems (Narayanan and Gulati, 2002). Smallholder production is constrained by poor access to markets, a very low scale of operations, poor access to improved genetics and to high-quality forage and concentrates, and poor animal husbandry and animal nutrition. In contrast, commercial livestock production systems are seen as having significant advantages in all these areas and in access to capital and new technologies. Hence, smallholder production is considered to be less internationally competitive than large-scale operations. This is why a widely held view in developing countries contends that agricultural trade liberalization will

alter the incentives in livestock production systems toward large-scale commercial operations relative to smallholder systems. The argument goes that agricultural trade liberalization will give undue advantage to large-scale commercial livestock systems at the expense of smallholder production systems, and that this in turn will add to the adjustment pressures on smallholder producers for whom income from livestock production is vital in helping them avoid poverty.

The economic mechanisms that might validate this view of the links between global agricultural trade liberalization and the performance of smallholder livestock producers are not well understood. Global trade liberalization can be expected to accelerate global income growth, implying potentially higher incomes in both industrial and developing countries. This will translate into higher demand for and consumption of livestock products in developing countries than in the industrial countries where, due to saturation levels, per capita meat consumption no longer increases significantly as per capita income grows.

Livestock producers in the world, therefore, are likely to benefit from trade liberalization. But how the increased production to supply this additional demand will be shared between commercial and smallholder producers in developing countries and producers in industrial exporting countries is less clear. The way in which livestock industries are expected to be affected by trade liberalization is likely to be determined by the interplay of many factors, including their reliance on feed grains in production, existing barriers to trade, the capacity of each system to respond to changes in the price-cost situation, the impact of second round effects through income effects, factor prices, investment and demand linkages and the scope and nature of the liberalization process.

The goal of this paper is to evaluate the impact of trade liberalization on Vietnam's smallholder livestock producers and the potential contribution of the livestock sector to poverty alleviation in anticipation of Vietnam's accession to the WTO. It specifically investigates how effects of trade policy changes trickle down to the livestock sector and what their consequent effects are on welfare. It also discusses what the opportunities and threats from trade

liberalization are for smallholder livestock producers, analyzing the effects of pull and push factors attracting or expelling smallholders away from farming. The results will contribute to the identification and evaluation of potential policy options that will help mitigate the negative consequences of various trade policy reforms and lessen the burden on the poor smallholders.

The paper is organized as follows. In the next two sections we consider the patterns of production, trade and protection of Vietnam's economy and the main characteristics of its livestock sector. The subsequent section describes the methodology employed. We then turn to the results and the analysis of the impact of trade liberalization on Vietnam's economy, followed by our estimates of the impact of trade liberalization on smallholder livestock producers and poverty.

Vietnam and the global economy: patterns of production, trade and protection

In the last decades of the twentieth century, Vietnam progressed from a nation of chronic food shortages to one of the world's leading exporters of agricultural products that include rice, coffee, rubber, and tea. This economic growth, marked by a doubling of gross domestic product between 1991 and 2000, was largely made possible by the *doi moi* reforms of the 1980s. *Doi moi* consisted of two successive reforms: the allocation of the means of production (especially land) to individual households, followed by economic liberalization and the opening to external markets (Castella and Dang 2002).

The remarkable economic growth that resulted from the reforms was based largely on the rural household, which had become the new unit of agricultural production. The technical, economic, and social changes that accompanied the transition transformed agricultural production, resource management, land use, and the institutions that defined resource access and distribution. However, the impact of the changes varied widely across different regions. In particular, agricultural growth in the past decade has benefited the delta regions far more than the

more-remote mountainous areas (Kerkvliet and Porter 1995; Poverty Task Force 1999; Minot and Baulch 2002). Of interest as well are the differential impacts of these changes across sectors and within sectors in the economy. For the latter, a comprehensive study was undertaken on the rice sector that analyzes the policy issues and impacts of the reforms, specifically the liberalization of the rice markets (Minot and Goletti, 2000). The study indicated that it is fairly clear that market reforms have had a positive effect on economic growth, agricultural production, and the rice sector. Furthermore, survey data reveal rural incomes appear to have risen with the reforms. About 93 to 95 percent of the poor live in rural areas in Vietnam. In spite of these gains, poverty rates are still high, and the benefits of liberalization have probably not been distributed equally among regions and between urban and rural areas. These are potential areas for further empirical investigation. Similar studies focusing on the other sectors, likewise, would be worthwhile contributions to the existing literature

The analysis of Vietnam's output structure shows that almost 60 percent of Vietnam's total output comes from services (table 1). Manufactures contribute more than 30 percent of output while agriculture's contribution is less than 10 percent with livestock representing less than 2 percent of total output. The most relevant manufacturing sectors are light manufactures, processed food, electronics and wearing apparel. Within agriculture, rice, other crops (coffee, tea, rubber) and non-ruminant livestock comprise 80 percent of total agricultural output value.

The disposition of output (table 1) and trade data from figure 1 shows the importance of the manufacture sector in Vietnam's international trade. More than 40 percent of total output in manufactures is exported. The share of manufactures in total exports reached 72 percent in 1997. The sectors that contribute the most to exports are mainly light manufactures (26 percent of total exports), processed food (16 percent) and wearing apparel (15 percent). The most significant contribution to exports from the agricultural sector comes from other crops (10 percent of total exports). Livestock products have historically had a relatively low participation in total exports with a peak in 1982 (3 percent of total exports) but decreasing ever since (0.6 percent in 1998).

The domestic market largely absorbs much of livestock production in Vietnam (Vu 2002).

Vietnam imports manufactures, mainly electronics, chemicals, heavy manufactures, and textiles (figure 1). This group of commodities comprises more than 75 percent of the value of total imports. Vietnam is self sufficient in agricultural products and processed foods are the most significant food imports.

Average import tariffs for Vietnam are shown in figure 2, together with tariffs faced by Vietnam in third markets. Tariffs for manufactured products are high even for export commodities such as wearing apparel (47 percent) and processed food (39 percent). Transport equipment and textiles also have tariffs above the 30 percent level. Electronics, chemicals and heavy manufactures have relatively low tariffs (less than 10 percent). Protection of agriculture is low compared with tariff levels in manufacture, with low tariffs for livestock and cereals and higher protection for industrial crops.

Tariffs faced by Vietnam for its most significant exports are between 10 and 20 percent in most cases, except for processed food for which Vietnam faces tariffs of 30 percent on average. Tariffs for Vietnam's non-ruminant meat exports are within the 10-20 percent range and below 5 percent for non-ruminant live animals.

We conclude that despite the recent market reforms and liberalization process, Vietnam's economy is still highly protected. With the prospect of future accession to WTO and the continued reforms toward market liberalization in the years to come, reduction of tariffs and protection will likely result in significant changes in Vietnam's patterns of trade and production.

The livestock sector in Vietnam

The work by IFPRI (2001) presents information from an extensive survey of producers in Vietnam. Based on IFPRI's report, we describe below some of the characteristics of Vietnam's livestock sector relevant for our analysis.

Livestock production in Vietnam is primarily undertaken on household farms where crops and other agricultural products are also produced. More than 92 percent of producers utilize only household labor in livestock (62 percent in general agriculture); they cultivate 0.77 hectares of land on average. In terms of livestock sales, 60 percent of their sales are pigs, 23 percent are poultry and only 8 percent are cattle (see table 2). More than 99 percent of producers who kept pigs or chickens were involved in pigs and chickens sales, while less than 69 percent of producers with cattle were involved in selling cattle.

Livestock products are predominately sold to assemblers and wholesalers at the farm gate, or (in the case of pigs) direct to small slaughterhouses. Direct sales of products to consumers are uncommon due to the relatively remote locations of many livestock firms. A lack of an organized livestock marketplace infrastructure means that farmers usually deal with buyers on an individual basis. Only around 2 percent of producers had ever been involved in livestock supply contracts.

There are differences between producers at different income levels. Table 2 also presents information for the first four percentiles of the income distribution and a fifth group including producers in the 5th to 10th percentile. The first two percentiles cluster producers mostly below the poverty line of 1,789,871 Vietnamese dong (VND)¹ per capita, as defined by the General Statistics Office of Vietnam using the Vietnam's living standards survey in 1998 prices (CIE, 2002). Poor producers are more diversified than larger producers and tend to have smaller shares of pigs and poultry sales and larger shares of cattle sales.

Livestock raising costs are dominated by feed costs, which account for an average of over 75 percent of total costs. Feed costs are still the dominant cost component even when household labor is valued at full cost. Poor producers use mainly grazing systems while larger households use more roughage and complete feed systems.

¹ Exchange rate is US\$1=15,000 VND

Crossbred pigs are the dominant type of pig, with the proportion of crossbred and exotic pigs increasing with farm size. Local pigs are predominantly fed using only roughage; crossbred pigs are mostly fed on roughage and concentrates while for exotic pigs a diet of complete feed is used. Exotic chickens dominate chicken inventories and are fed on complete feed. For local chickens grazing and roughage are used. In cattle production, the low level of commercialization of the industry means that quality feed is rarely fed.

Producers were stratified into 8 regional groups dependent on the location of the farming operation. The regional groups are consistent with the 8 agro-ecological zones in Vietnam². The largest proportion of surveyed households came from the Red River Delta region and the smallest from the North West region. Pig farming is the dominant farming system in all regions, accounting for more than 70 percent of surveyed producers. The level of specialization in pig farming in the North East South and Mekong River Delta regions is the highest, at over 75 percent of farms. Poultry farming is most popular in the Red River Delta and Mekong River Delta regions. Bovine farms are most common in the Central Highlands region. The highest concentration of large-scale commercial pig and poultry farms are located in the North East South region in southern Vietnam where there are a number of large pig farms that have been developed to serve the Ho Chi Minh city market.

IFPRI (2001) finds diseconomies of scale in livestock production, with profits increasing at a slower rate as inventories and revenues increase. This implies that the efficiency levels on smaller farms, based on raising local animals with low cost feedstuffs are higher than those on larger farms employing intensive high quality feed production techniques.

There are several reasons why Vietnam and the livestock sector presents a good case study for looking at the impacts of globalization on poverty alleviation. As a country in transition from central planning to a market-oriented economy, Vietnam has been going through a rapid

² Central Highlands, Mekong River Delta, North Central Coast, North East, North East South, North West, Red River Delta and South Central Coast

process of liberalization. Moreover, it has exhibited a fairly strong growth during the last decade of reforms, growing at an average annual rate of 4.4 percent per year and accelerating in the second half of the 1990s. The livestock sector together with aquaculture has increased its contribution to at least one-third of total increases in agricultural revenues (Vietnam Development Report 2001). Livestock is an important source of income for the majority of Vietnamese farmers, particularly those in upland areas where poverty rates are highest, so that its development carries important implications for poverty reduction and income distribution.

The main explanation behind the rapid growth of the sector has been investment by the private sector in feed industry, breeding, and slaughtering/processing stimulated by strong domestic demand (IFPRI 2001). This rapid increase in demand for meat (at about 6 percent per year) was induced by rising income, particularly in urban areas. There has not been a comprehensive assessment of the impacts of such expansion on poverty in Vietnam, however.

In a scenario of increasing globalization, the livestock sector is faced with both opportunities and threats that could have implications on its poverty-reducing capacity. There is a growing trend toward the development of large commercial livestock production systems for pigs intended for the export market. This is supported by policies that provide investment incentives, as well as open importation of breeding animals and veterinary inputs. On the other hand, it is the case that a large proportion of livestock production still comes from smallholder production systems. Thus, there is a potentially critical inconsistency of current policies with the ultimate objective of reducing poverty. This will require empirical investigation in order to validate these concerns, and also to inform policymaking and development planning.

Methodology

In a survey of recent studies that analyze how trade policies affect the incidence of poverty in developing countries, Reimer (2002) distinguishes four broad categories of studies. The first category includes cross-country regression analysis that test for correlations among

trade, growth, income, poverty, and inequality variables at the national level. The second category encompasses partial-equilibrium and cost-of-living approaches based on household expenditure data. A third category includes general equilibrium models based on an economy wide Social Accounting Matrix. The fourth category represents a relatively recent approach, general equilibrium simulation coupled with some form of post-simulation analysis based on household survey data, which Reimer described as micro-macro synthesis, referring to the sequential linking of a model based on micro-level data with a model based primarily on macro-level data.

The micro-macro synthesis approach appears to be especially suited to the analysis of the impact of trade liberalization on smallholder producers. This method works in two steps. A general equilibrium model is first shocked to get commodity and factor price changes. These are then used in a post-simulation model that calculates the effect on actual or highly disaggregated representative households. Poverty measures can then be applied to assess the distributional effects of the shocks. As Reimer points out, a limitation of post-simulation analysis is that reactions of households to commodity and factor price changes in the post-simulation analysis are not transmitted back to the general equilibrium model. Applied to the analysis of smallholder producers, this method will not capture small farmer household's response to price signals in terms of substitution between commodities (in consumption and production), marketed surplus and labor allocation decisions.

There are different possible approaches to the micro-macro synthesis in the literature (see Robillard, Bourguignon and Robinson, 2001; Hertel et al., 2003; Chan and Ravallion, 2002 among other studies). In this study we use a micro-macro approach that combines the GTAP general equilibrium model with a simple micro model that allows us to measure expected impacts of trade liberalization on a representative sample of Vietnam's livestock producers. Price changes induced by trade policy changes are carried to an extensive survey of livestock producers in Vietnam (IFPRI, 2001), to analyze production, welfare and poverty alleviation implications of policy changes for smallholder livestock producers. The welfare impacts on the livestock sector

are measured using first-order approximations of a money metric of the change in utility (Chen and Ravallion, 2002), which are based on a household model incorporating own-production activities and are calibrated to the household-level data without imposing aggregation. The sample of 2213 livestock producers was drawn from 29 provinces covering all eight agro-ecological regions in Vietnam and a range of farm sizes from small subsistence farms to some of the largest commercial agricultural operations in the country. The survey provides information about household characteristics and livestock production systems that allow us to explain the heterogeneity of welfare impacts.

The impacts of policy change on livestock producers are estimated following Chen and Ravallion (2002, pp. 6-8), who define a money-metric derived from a standard indirect utility function of a household and a profit function for household enterprises. The indirect utility function of household i is given by:

$$(1) \quad v_i[p_i^d, w_i, \pi_i] = \max_{(q_i^d, L_i)} [u_i(q_i^d, L_i) / p_i^d q_i^d = w_i L_i + \pi_i]$$

and the profit function results from the following maximization problem:

$$(2) \quad \pi_i[p_i^s, p_i^d, w_i] = \max_{(z_i, L_i^o)} [p_i^s q_i^s - p_i^d z_i - w_i L_i^o / q_i^s = f_i(z_i, L_i^o)]$$

where q_i^d is the vector of commodities demanded by household i , L_i is a vector of labor supplies by activity including household's own production activity, p_i^d is the price vector for consumption, w_i is the vector of wage rates, π is the profit obtained from the household enterprise, p_i^s is the vector of supply prices, q_i^s is the vector of quantities supplied, L_i^o is the labor input to the own production activities, f_i is the household-specific production function and z_i are commodities used as production inputs. Taking differentials of equations (1) and (2) and using the envelope property where the welfare impacts in a neighborhood of an optimum can be evaluated by treating the quantity choices as given, the gain to household i is given by the money metric of the change in utility:

$$(3) \quad g_i = \frac{du_i}{v_{\pi}} = \sum_{j=1}^m \left[p_{ij}^s q_{ij}^s \frac{dp_{ij}^s}{p_{ij}^s} - p_{ij}^d (q_{ij}^d + z_{ij}) \frac{dp_{ij}^d}{p_{ij}^d} \right] + \sum_{k=1}^n \left(w_k L_{ik}^s \frac{dw_k}{w_k} \right)$$

where v_{π} is the marginal utility of income for household i and L_{ik}^s is the household's labor supply to external activities, assuming that gains from labor used in own production are exactly matched by the higher cost of this input to own-production. The gains from policy changes are then measured as the changes in consumption prices, supply prices and wages resulting from GTAP simulations, weighted by their corresponding expenditure and income shares.

Simulation and experiments

To model trade liberalization, we draw on the GTAP modelling framework (Hertel, 1997), using the latest version of the model and the most recent version of GTAP database (Dimaranan and McDougall, 2001) that incorporates updated information on trade and tariffs. Agricultural tariffs for 1998 are derived from the AMAD database and the non-agricultural tariffs are for 1997 from the WITS system of the UNCTAD and the World Bank. GTAP is a relatively standard, multi-region, applied general equilibrium model which features a relatively sophisticated Constant Difference of Elasticities (CDE) consumer demand system designed to capture differential price and income responsiveness across countries and a global bank designed to mediate between world savings and investment. Trade flows are modeled using the Armington approach by which products are differentiated by origin and are assumed to substitute imperfectly for one another forming a composite import aggregate that substitutes imperfectly for domestically produced goods. The model is solved using GEMPACK (Harrison and Pearson 1996).

The 57 commodities in the version 5.0 GTAP database have been aggregated up to 29 commodity groups, with 15 agricultural and food commodities (rice, wheat, other grains, oils, fruits and vegetables, sugarcane, other crops, beef cattle, other livestock, milk, beef, other meat,

dairy products, processed food and fish). Meat producing livestock farming is represented by two aggregates: beef cattle (i.e. ruminant livestock) and other livestock (i.e. non-ruminants). These farming sectors provide inputs to the beef processing (beef) and other meat (non-ruminant meat sectors). Manufactures and services are disaggregated into 14 sectors to capture price changes of consumption goods and inputs relevant for livestock producers. The 66 GTAP countries/regions of version 5.0 database are aggregated into 16 regions (see Annex).

We explore nine different scenarios (table 3) using the GTAP model to examine the impact of trade liberalization on Vietnam's economy.

In the first three scenarios, we analyse agricultural trade liberalization by eliminating all tariffs and export subsidies of agricultural commodities only in Vietnam (Scenario 1); in Vietnam and in all other ASEAN countries (Scenario 2); and multilateral trade liberalization for all regions including Vietnam, ASEAN countries and the rest of the world (Scenario 3). The same experiments are conducted for manufacture and services (scenarios 4 to 6) and for all sectors simultaneously (scenarios 7 to 9). We compare the results of the different scenarios in terms of welfare gains and changes in trade and production specialization in order to understand the impact of liberalization on Vietnam's economy, the contribution of agriculture and manufacture to those results and the effect of enhanced market access on Vietnam's trade and production.

Figure 3 presents the welfare and efficiency gains for Vietnam and tables 4 and 5 compare the change in trade balance and total output of different sectors of Vietnam's economy as the result of simulations in the nine different experiments.

The best results for Vietnam occur when tariffs and export subsidies of manufactures and services are eliminated and in particular when this occurs together with enhanced market access for Vietnam's exports (scenarios 6 and 9), showing the structural adjustment needed to allow Vietnam to better exploit its comparative advantages. The elimination of tariffs in Vietnam's manufacture sector increases exports and production of wearing apparel and light manufactures

while reducing production and exports and increasing imports of almost all agricultural products and processed food commodities with the only exception of rice.

Vietnam would achieve relatively small gains from agricultural liberalization. Unilateral liberalization (scenario 1) results in welfare losses due to negative terms of trade effects. A regional agreement in agriculture (scenario 2) has a very small impact on Vietnam's welfare, while a multilateral liberalization of agriculture (scenario 3) results in smaller gains than those from a unilateral liberalization of manufactures. Agricultural trade liberalization has very little impact on manufactures and also relatively small impact on trade of most agricultural commodities. The most significant difference between scenarios is given by the results obtained for trade of processed food (which includes the feed industry). Vietnam would expand exports of processed food only if tariffs and subsidies from other countries are eliminated (agricultural regional or multilateral liberalization in scenarios 2 and 3, respectively) and if there are no policy changes (trade liberalization) on its own manufacture sector.

In sum, Vietnam can achieve significant gains from further integration into the global economy. The structural adjustment needed to allow Vietnam to better exploit its comparative advantages would be to expand manufacture production (wearing apparel and light manufactures) and reduce the share of agriculture including the livestock sector, on trade and production. In the next section we explore the consequences of these changes on the smallholder livestock producers.

Trade liberalization and livestock smallholder producers

The gains for livestock producers measured as the change in utility (equation 3) for six of the nine macro scenarios are presented in figure 4. Total welfare gains for livestock producers are relatively small on average, less than 2% of pre-simulation income. The largest gains are obtained with liberalization of agriculture and manufactures, while the smallest gains come from liberalization of manufactures only.

What is the impact of trade liberalization on the poor livestock producers? Total welfare gains for poor and non-poor livestock producers are presented in figure 5. Results show that poor livestock producers benefit in all of the alternative scenarios with the smallest increase occurring with agricultural liberalization, and the largest with liberalization of all sectors (even larger than the gains from multilateral agricultural liberalization).

In figure 6, total welfare change is decomposed into change in net farm income, change in non-farm income and change in prices of consumption goods purchased by the household. Positive values of the different components of total income change mean a positive contribution to income. So, for example, a positive value of the change in consumer prices means that consumer prices are reduced, contributing to increase in income (see equation 3). Non-farm income results from participation of household members in non-farm activities. As the survey does not specify the nature of these activities, we assume that they are employed as unskilled labor.

Decomposition of welfare gains in figure 6 shows that in all scenarios where protection of manufacture is eliminated (last four bars in the figure), changes in non-agricultural income explain a significant portion of total change in income. Without the contribution of non-farm income, the gains for the poor in those scenarios are reduced significantly. Poor livestock producers benefit from increases in non-farm income as a consequence of an increase in the price of unskilled labor, especially in those scenarios where trade of manufactures is liberalized. Liberalization increases consumer prices in all scenarios (except unilateral agricultural liberalization), with the most important increases occurring with manufacture liberalization. The decomposition of the gains from trade liberalization in non-poor livestock producers (figure 6b) is similar to that in poor producers with less importance of non-farm income and a low or negative farm income in the manufacture liberalization scenarios.

Figure 7 shows the change in utility that results from the change in the net farm income component of total utility change in poor and non-poor livestock producers. Even at the farm

level and without including changes in non-farm income, poor producers benefit more than non-poor producers in all scenarios. The results in terms of farm income for poor and non-poor producers can be explained by the change in relative price of livestock with respect to processed feed. Farm income for all producers increases in all scenarios where livestock prices increase more than processed feed costs. On average, poor producers appear to use less processed feed than larger producers, and because of this, they are less likely to be disadvantaged by the change in relative prices.

The impact of the different liberalization scenarios on poverty is shown in figure 8. The headcount ratio (figure 8a) shows that with the exception of regional agricultural liberalization, all other policies reduce or at least do not increase the number of poor livestock producers. The different regional liberalization scenarios contribute less to poverty reduction, while Vietnam's unilateral liberalization of all sectors (scenario 7) reduces the poverty headcount index from 19.4 to 13.7. Although the effect of the different policies on the poor livestock producers is positive, the negative impact of some of these policies on income of non-poor producers could be significant. The poverty gap index, showing the shortfall of the poor's expenditure from the poverty line, captures the negative impact of liberalization on the livestock sector (figure 8b). Unilateral liberalization of Vietnam's economy (scenario 7) is still the best option for the poor, contributing with the largest reduction of the poverty gap. In spite of reducing the number of poor producers, all other policies increase the poverty gap.

Explaining Gains and Losses

The gain from the price changes induced by trade reform as shown in equation (3) depends on the consumption, labor supply and production choices of the household, which depend on prices and characteristics, x_{1i} and x_{2i} affecting consumption and outputs from own production activities respectively. Following Chen and Ravallion we can write the gain as:

$$\begin{aligned}
g_i &= g(p_i^d, p_i^s, w_i, x_{1i}, x_{2i}) = \\
(4) \quad & \sum_{j=1}^m [p_{ij}^s q^s(p_i^d, p_i^s, w_i, x_{2i}) \frac{dp_{ij}^s}{p_{ij}^s} - p_{ij}^d [q^d(p_i^d, w_i, \pi_i, x_{1i}) + z_{ij}(p_i^d, p_i^s, \pi_i, x_{2i})] \frac{dp_{ij}^d}{p_{ij}^d}] + \\
& \sum_{k=1}^n w_k [L_{ik}(p_i^d, w_i, \pi_i, x_{1i}) \frac{dp_{ij}^s}{p_{ij}^s} - L_{ik}^o(p_i^d, p_i^s, w_i, x_{2i})] \frac{dw_{ij}}{w_k}
\end{aligned}$$

Assuming that wage rates are a function of prices and characteristics as

$w_i = w(p_i^d, p_i^s, x_{1i}, x_{2i})$, and that differences in prices faced can be adequately captured by a complete set of regional dummy variables, linearizing (4) and adding an error term, the gains from trade liberalization can be expressed as the following regression model:

$$(5) \quad g_i = \beta_1 x_{1i} + \beta_2 x_{2i} + \sum_k \sum_{h=1}^2 \gamma_{kh} D_{khi} + \varepsilon_i$$

where $D_{k1i} = 1$ if household i lives in region k and is poor (D_{k2i} if non-poor). Characteristics x include household size, age, education and gender of the household head, sales of different animal categories and characteristics of the production system (species, breed and type of feed used). Under the usual assumptions we estimate (5) by Ordinary Least Squares. The results are given in table 6.

Poor households in different regions tend to obtain results above the mean although in general not statistically different from the mean. The exception is the Mekong River Delta (specialized in pig and poultry production) region where gains for the poor are below the mean and the difference is significant. Non-poor households show results below the mean in North East South, the region with the highest concentration of large-scale commercial pig and poultry farms, in the Mekong River Delta, North Central and in the Red River Delta region.

Welfare gains increase with the age (up to a maximum) and education of the household head and decreases with the household size. Welfare gains are also positively related with the crop area under irrigation and negatively related with total cultivated area.

Regression results also show that pig production systems are positively related while chicken and cattle production systems are negatively related with welfare gains. Within pig production, activities like fattening piglets or pigs weighting less than 50 kilograms have negative impact on welfare while fattening pigs weighting more than 50 kilograms are associated with welfare gains. In poultry production, selling eggs and breeding poultry tend to contribute positively to welfare while selling live poultry for consumption result in negative impacts on utility. Other activities like selling milk and fish are positively related with welfare gains.

Conclusions

The results from our different liberalization scenarios show that Vietnam would benefit from trade liberalization. To better exploit its comparative advantage, Vietnam needs to reduce protection of manufactures and services. Welfare gains would be maximized if this liberalization occurs together with enhanced market access for Vietnam's manufacture exports and liberalization of agriculture. Relatively small gains are to be achieved from agricultural liberalization alone.

In all scenarios, the impact of trade liberalization on livestock production tends to be small but in general a more open Vietnamese economy would result in a deterioration of the trade balance of livestock products. Trade liberalization would expand manufactures increasing competition for labor and capital with the processed food and the crop sectors, thus, increasing costs and prices of feed. However, simultaneous liberalization of manufactures and agriculture would revert the negative impact of manufacture growth on the livestock sector, reducing costs of feed (even if there is no enhanced market access for Vietnam's agricultural products) resulting in gains for the agricultural sector and especially for the poor. An alternative scenario could be one of liberalization of the agricultural sector with no enhanced market access for manufactures. This

would result in small increases in labor and capital costs (even reduction of prices in unilateral agricultural liberalization), lower prices of processed food and feed, and benefits for the livestock sector. However, these scenarios that benefit the livestock sector imply moving against Vietnam's comparative advantage and would result in low benefits for Vietnam's overall economy.

Trade liberalization in Vietnam would benefit poor livestock producers from all regions. These benefits are derived from an increase in livestock prices relative to production costs, in particular feed costs, and also from an increase in the price of unskilled labor that determines an increase of non-agricultural income. These results show that trade liberalization could open opportunities for the poor livestock producers to compete and improve their income. The number of poor producers is reduced with unilateral trade liberalization of agriculture, manufactures or both from 19 percent before policy changes to 14 percent in the most favorable result for the poor (unilateral trade liberalization of agriculture and non-agriculture). Poor producers can exploit these opportunities if appropriate productivity-enhancing technologies are available and accessible to them. The best opportunities for smallholder producers are in pig production, especially for the better-educated households, with small household size and better resources and infrastructure.

What implications do these results have for policy? We can envision that in the long run Vietnam will keep moving towards an economy increasingly specialized in the production and trade of manufactures with income growth and increasing urbanization. Higher labor costs and opportunities in the manufacture sector will act as pull factors attracting workers from agriculture including the livestock sector. However, as the past experience showed, this transition is not necessarily smooth. Rigidities in factor movements across sectors, market access for local producers, protection and discrimination in international markets, among other factors could result in some sectors being left behind, especially in agriculture. In the context of increased liberalization and integration to the global economy, our results show that there is room to develop enabling policies for the livestock sector in Vietnam that would allow smallholders to

better exploit the opportunities that globalization presents. Our analysis suggests that the availability of improved production technologies for pig production that reduce the intensive use of complete and processed feed could contribute to increase competitiveness and income of Vietnam's smallholder producers in a globalized economy. Poor producers can exploit these opportunities if appropriate productivity-enhancing technologies are available and accessible to them. Vietnam's current policy of increasing market orientation in livestock production is in the right direction. On the other hand, the seeming direction toward the development of industrial type high-input systems may prove counterproductive. The alternative option of facilitating more productive smallholder production systems through adoption of productivity-enhancing technologies may be more beneficial, equitable, and sustainable in the long run.

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Table 1. Disposition of output in Vietnam (mill.U.S.dollars 1997)

	Domestic	Expots	Total	Share (percentage)	
				Domestic	Exports
Rice	1588	33	1621	4.92	0.37
Other cereals	39	5	44	0.12	0.05
Other crops	539	752	1292	1.67	8.42
Ruminants	39	0	39	0.12	0.00
Non-ruminants	596	61	656	1.85	0.68
Milk	1	0	1	0.00	0.00
Beef	7	0	7	0.02	0.00
Other meat	66	24	90	0.20	0.27
Dairy	60	0	60	0.19	0.00
Processed food	2184	1054	3238	6.77	11.80
Textiles	313	316	629	0.97	3.53
Wearing apparel	72	1181	1253	0.22	13.22
Chemicals	711	259	969	2.20	2.90
Electronics	757	598	1355	2.35	6.69
Light manuf.	1452	1958	3411	4.50	21.92
Heavy manuf	1901	175	2076	5.89	1.96
Transport equip.	193	21	214	0.60	0.24
Services and other	21761	2496	24257	67.42	27.94
Total	32278	8933	41211	100.00	100.00

Table 2. Characterization of livestock producers in Vietnam

	Percentile					
	1	2	3	4	5+	All
Average farm sales (000' dong)	20639	24577	38519	37027	81689	60635
Area (hectares)	0.82	0.79	0.55	0.89	0.76	0.7719
Ratio family labor/total labor	0.986	0.97	0.966	0.953	0.921	0.9402
Share of farm income in total income	0.78	0.78	0.81	0.80	0.82	0.81
Share of pig sales in total sales	0.56	0.58	0.602	0.605	0.647	0.623
Share of poultry sales in total sales	0.172	0.209	0.205	0.234	0.25	0.232
Share of cattle sales in total sales	0.158	0.127	0.127	0.096	0.056	0.084

Table 3. Trade liberalization scenarios

	Unilateral trade liberalization Vietnam	Regional trade liberalization ASEAN	Multilateral trade liberalization World
- Agriculture			
Including meat processing, dairy and processed food	Scenario 1 agvietnam	Scenario 2 agasean	Scenario 3 agworld
- Manufacture and services	Scenario 4 nonagvietnam	Scenario 5 nonagasean	Scenario 6 nonagworld
- Agriculture, manufacture and services	Scenario 7 allvietnam	Scenario 8 allasean	Scenario 9 allworld

Table 4. Change in trade balance in Vietnam under different scenarios (mill.U.S.dollars 1997)

	Agvietnam	Agasean	Agworld	Nonagvietnam	Nonagasean	Nonagworld	Allvietnam	Allasean	Allworld
Rice	12	3	38	-1	-1	-2	11	3	37
Other cereals	1	-1	-4	0	0	-1	0	-1	-4
Other crops	48	-32	9	-49	-48	-92	1	-37	-62
Ruminants	0	0	0	0	0	0	0	0	-1
Non-ruminants	1	-10	-36	-15	-15	-27	-13	-10	-54
Dairy	-5	-3	-10	-2	-2	-6	-7	-2	-16
Processed food	-200	281	275	-138	-135	-324	-359	318	-144
Textiles	-14	25	33	-1722	-1674	-2209	-1773	-96	-2104
Wearing apparel	42	-80	-101	51	92	717	99	47	626
Chemicals	10	-16	-12	-149	-150	-269	-141	-46	-270
Electronics	12	-27	-33	-123	-143	-317	-112	16	-333
Light manuf.	42	-80	-101	51	92	717	99	47	626
Heavy manuf	10	-18	-20	-245	-243	-371	-235	-67	-383
Transport equip.	2	-8	-14	-86	-77	-128	-84	-119	-138
Other	63	-108	-114	-805	-798	-1424	-748	-232	-1474

Table 5. Production of different sectors in Vietnam under different scenarios (mill. U.S. dollars 1997)

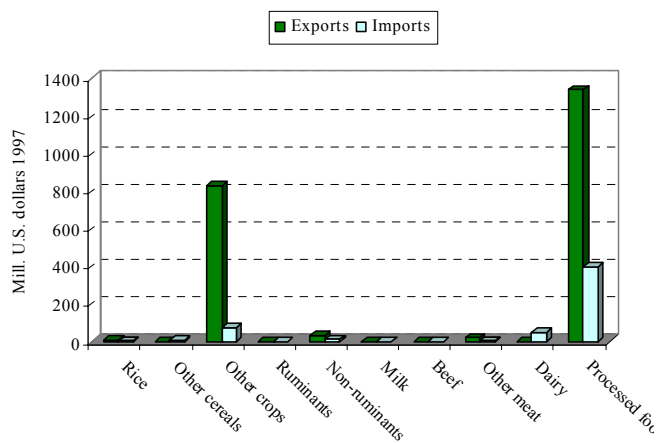
	Pre-sim.	Agvietnam	Agasean	Agworld	Nonagvietnam	Nonagasean	Nonagworld	Allvietnam,	Allasean	Allworld
Rice	1621	1543	1734	1729	1457	1462	1366	1373	1731	1436
Other cereals	44	45	43	40	41	41	40	42	42	37
Other crops	1292	1349	1254	1295	1174	1176	1117	1227	1240	1144
Ruminants	39	38	39	38	36	36	35	35	38	35
Non-ruminants	656	660	646	634	613	614	616	616	635	605
Milk	1	1	1	1	1	1	1	1	1	1
Beef	7	7	7	7	6	6	6	6	7	6
Other meat	90	89	86	72	80	81	76	79	85	65
Dairy	60	51	58	55	55	55	52	46	58	47
Processed food	3238	2998	3500	3403	2886	2896	2671	2637	3503	2745
Textiles	629	640	608	605	1009	1004	1047	1030	653	1015
Wearing apparel	1253	1278	1210	1209	4557	4455	5269	4654	1388	5138
Chemicals	969	979	955	952	876	876	824	884	963	816
Electronics	1355	1381	1313	1304	1171	1144	969	1192	1382	949
Light manuf.	3411	3478	3299	3287	3382	3432	3923	3452	3448	3832
Heavy manuf	2076	2102	2038	2038	1636	1636	1491	1655	1970	1480
Transport equip.	214	219	207	205	94	89	74	96	129	72
Services and other	31504	31603	31461	31586	29384	29455	28881	29432	31184	29035

Table 6. Regressions for level and percentage of gains from trade liberalization (World lib. of agriculture, and non-agriculture)

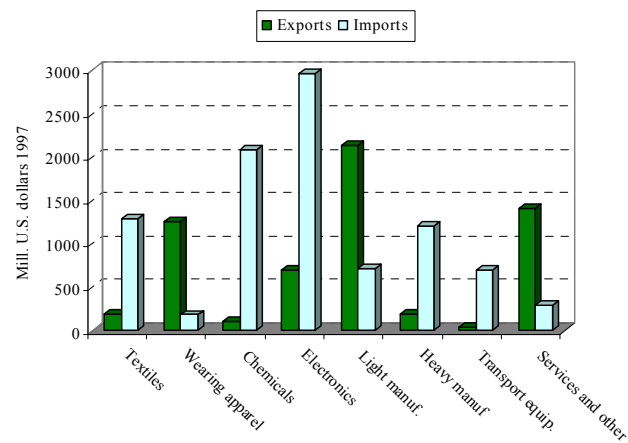
Variable	Regression for levels of gains (000' VDN) R-Square = 0.41 R-Square Adj.= 0.39			Regression for percentage gains R-Square = 0.21 R-Square Adj.= 0.18		
	Estimated Coeff.	Standard Error	t – Ratio 2051 DF	Estimated Coeff.	Standard Error	t – Ratio 2051 DF
Household Characteristics and Resources						
Age	171.6	72.9	2.4	0.0938	0.0241	3.9
Age squared	-1.4	0.8	-1.8	-0.0009	0.0003	-3.5
Education	205.4	124.5	1.7	0.0613	0.0412	1.5
Gender	141.8	299.9	0.5	0.0550	0.0992	0.6
Number of HH members	-146.8	68.7	-2.1	0.0047	0.0227	0.2
Irrigation	648.1	227.0	2.9	0.1471	0.0751	2.0
Crops total area	-608.3	244.2	-2.5	-0.1588	0.0808	-2.0
Land total area	-32.4	48.6	-0.7	-0.0079	0.0161	-0.5
Dummy Variable = 1 if poor/non-poor living in region k						
Central Highlands poor	390.0	954.4	0.4	0.0587	0.3158	0.2
Mekong River Delta poor	-1789.5	1080.0	-1.7	-0.6124	0.3572	-1.7
North Central Coast poor	453.3	663.7	0.7	0.1987	0.2196	0.9
North East poor	1148.6	787.4	1.5	0.4642	0.2605	1.8
North East South poor	541.6	1840.0	0.3	0.3480	0.6089	0.6
North West poor	1282.9	971.1	1.3	0.7452	0.3213	2.3
Red River Delta poor	957.7	718.1	1.3	0.2183	0.2376	0.9
South Central Coast poor	2243.9	734.7	3.1	1.3726	0.2431	5.6
Central Highlands non-poor	375.2	557.6	0.7	-0.2118	0.1845	-1.1
Mekong River Delta non-poor	-1680.5	482.4	-3.5	-0.7252	0.1596	-4.5
North Central Coast non-poor	-64.3	463.5	-0.1	-0.1533	0.1534	-1.0
North East non-poor	141.4	383.0	0.4	-0.1072	0.1267	-0.8
North East South non-poor	-4528.5			-1.2098		
North West non-poor	547.7	572.2	1.0	0.0607	0.1893	0.3
Red River Delta non-poor	-520.7	381.7	-1.4	-0.3670	0.1263	-2.9
South Central Coast non-poor	501.1	444.0	1.1	-0.0796	0.1469	-0.5

Table 6 (continued). Regressions for level and percentage of gains from trade liberalization (World lib. of agriculture, and non-agriculture)

Variable	Regression for levels of gains (000' VDN) R-Square = 0.41 R-Square Adj.= 0.39			Regression for percentage gains R-Square = 0.21 R-Square Adj.= 0.18		
	Estimated Coeff.	Standard Error	t – Ratio 2051 DF	Estimated Coeff.	Standard Error	t – Ratio 2051 DF
Sales specialization						
Piglets breed	0.039	0.033	1.2	0.0000	0.0000	1.3
Piglets fattening	-0.030	0.006	-5.0	0.0000	0.0000	-0.3
Pigs < 50 kgs. Fattening	-0.019	0.004	-4.2	0.0000	0.0000	-2.4
Pigs > 50 kgs. Fattening	0.021	0.001	29.9	0.0000	0.0000	7.7
Eggs	0.031	0.005	6.2	0.0000	0.0000	5.7
Poultry breed	0.035	0.008	4.2	0.0000	0.0000	3.1
Poultry live animals	-0.025	0.003	-9.5	0.0000	0.0000	-9.6
Cattle	-0.017	0.028	-0.6	0.0000	0.0000	-0.4
Other livestock	0.047	0.008	5.6	0.0000	0.0000	3.8
Characteristics of the production system = 1 if household employs particular system						
Pigs						
Local pigs – Roughage	5.0	377.1	0.1	0.0036	0.1248	0.3
Local pigs – Rough. and conc. feed	714.9	450.0	1.6	0.1544	0.1489	1.0
Crossbred pigs – Roughage	630.3	417.9	1.5	0.2964	0.1383	2.1
Crossbred pigs - Rough. and complete feed	714.5	601.2	1.2	0.4641	0.1989	2.3
Crossbred pigs - Rough. and conc. feed	363.3	356.9	1.0	0.2669	0.1181	2.3
Exotic pigs - Complete feed	3257.8	703.1	4.6	1.0216	0.2326	4.4
Chicken						
Local chicken - Grazing and roughage	-506.0	342.6	-1.5	-0.1937	0.1133	-1.7
Exotic chicken - Complete feed	-1438.4	549.3	-2.6	-0.5963	0.1817	-3.3
Cattle						
Local cattle – Grazing	-552.3	645.8	-0.9	-0.3491	0.2137	-1.6
Local cattle - Grazing and roughage	-444.7	386.8	-1.2	-0.2336	0.1280	-1.8
Buffalo - Grazing and roughage	-361.9	444.3	-0.8	-0.2571	0.1470	-1.7
Constant	-4282.7	1789.0	-2.4	-2.1937	0.5919	-3.7



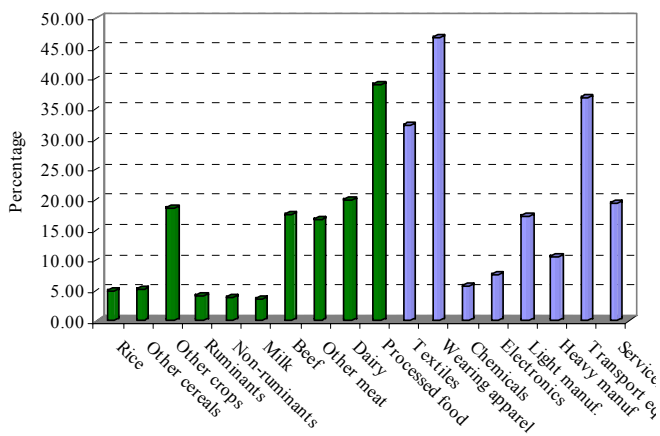
a. Agriculture and food



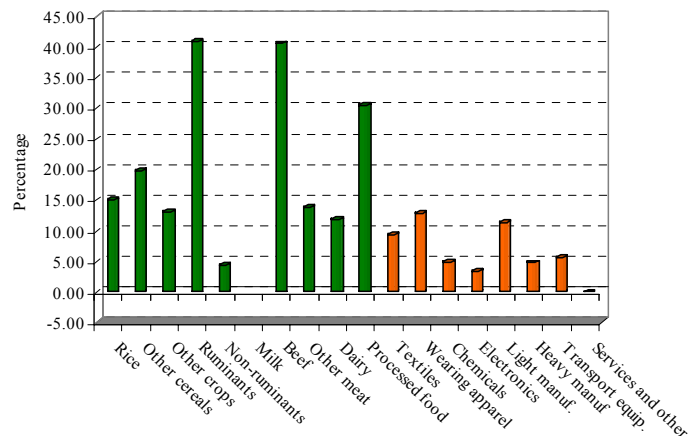
b. Manufactures

Source: GTAP

Figure 1. Vietnam: International trade. 1998



a. Average import tariffs for Vietnam



b. Average tariffs faced by Vietnam

Source: GTAP

Figure 2. Tariffs for Vietnam

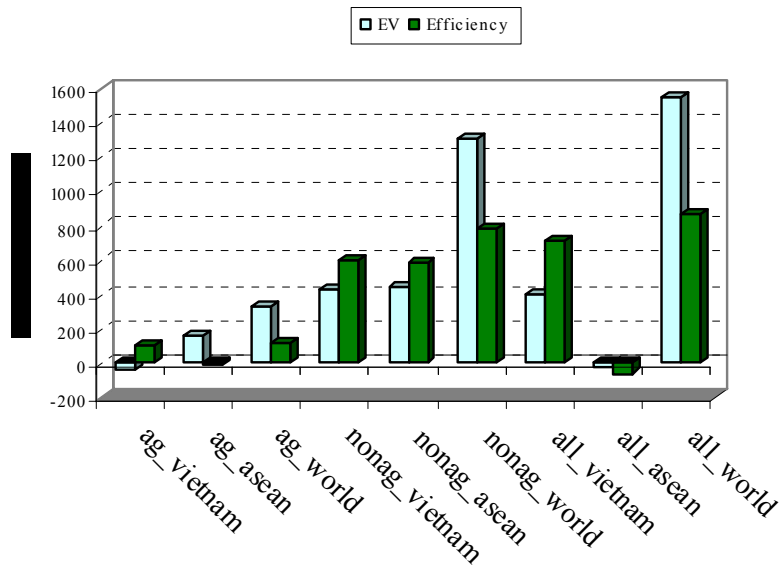


Figure 3. Welfare and efficiency gains in different liberalization scenarios

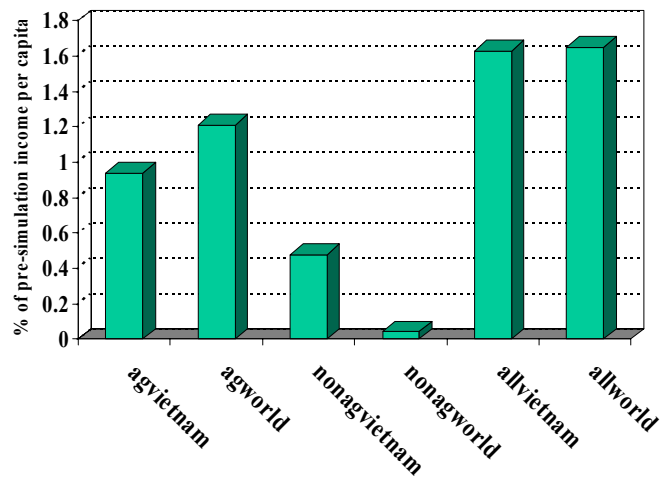


Figure 4. Welfare gains by the livestock sector under different scenarios

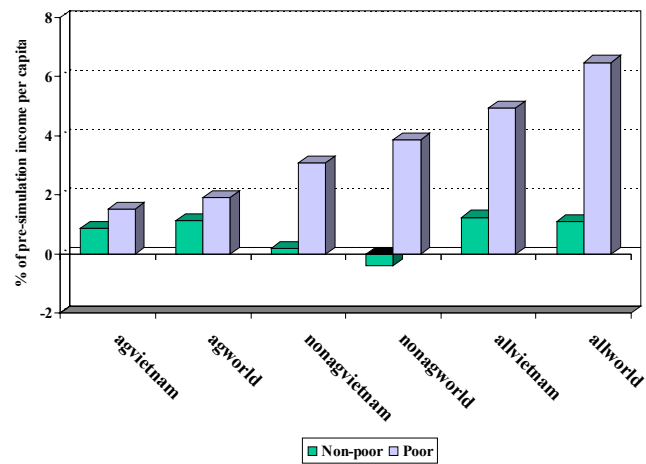
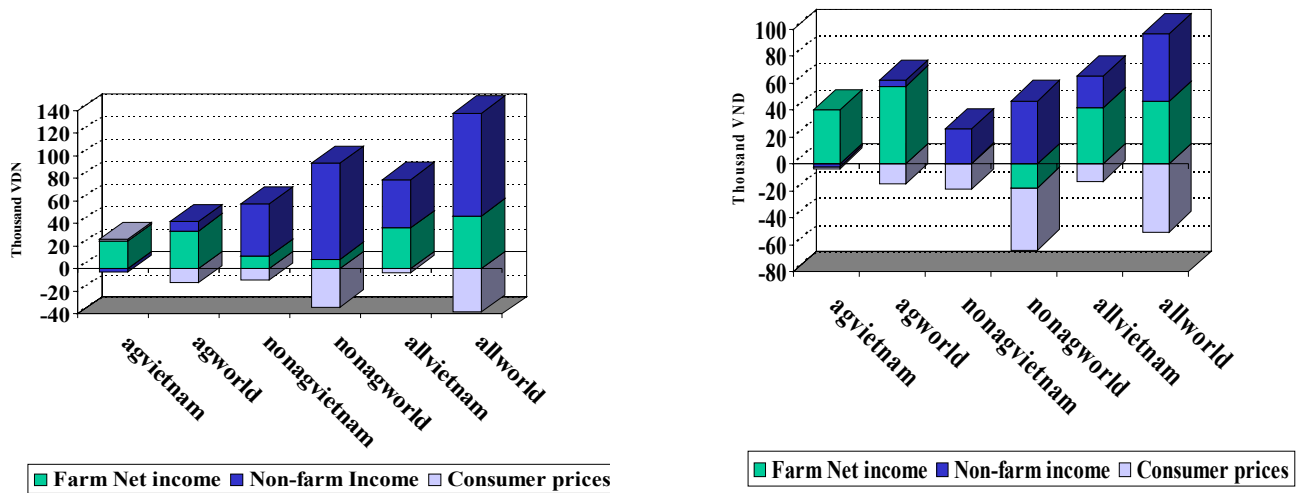


Figure 5. Welfare gains for poor and non-poor livestock producers under different scenarios



a. Poor livestock producers

b. Non-poor livestock producers

Figure 6. Decomposition of the change in utility for livestock producers in different scenarios

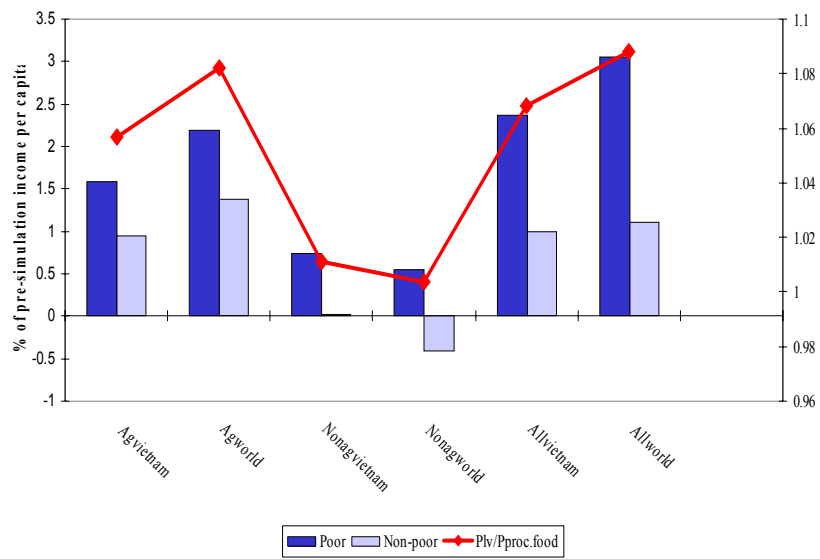


Figure 7. Farm income and relative prices

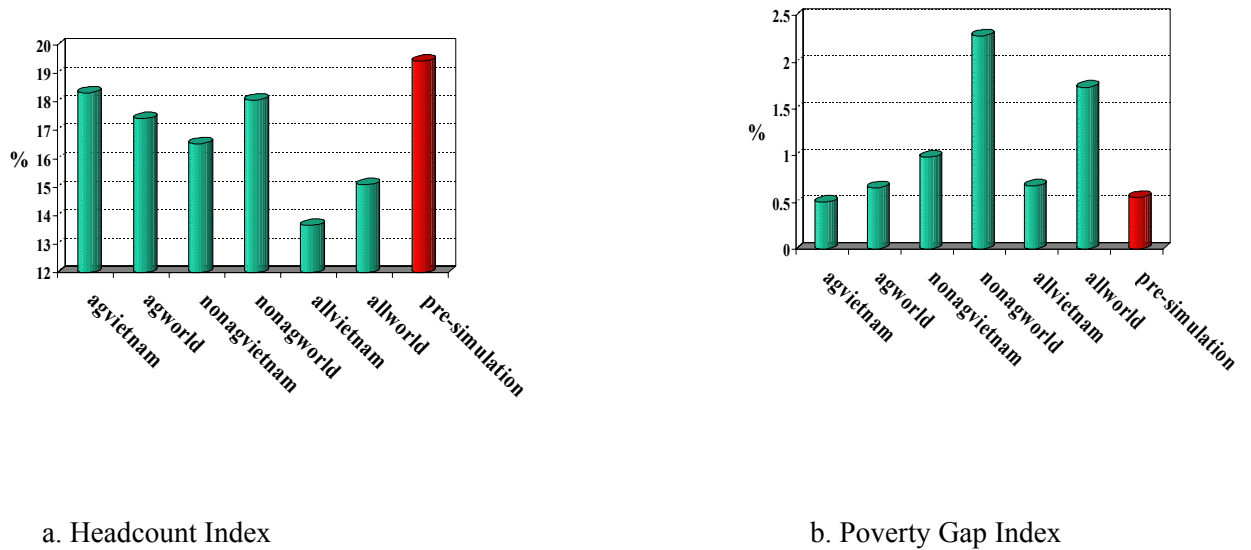


Figure 8. Poverty indices for the livestock in Vietnam under different scenarios

Annex

Table A1. Change on supply price of commodities and endowments in Vietnam under different scenarios (percentage)

	agasean	agvietnam	agworld	allasean	allvietnam	allworld	nonagasean	nonagvietnam	nonagworld
Land	12.72	0.92	18.37	13.59	-8.79	-3.94	-8.37	-8.73	-17.25
UnSkLab	2.55	-1.18	3.16	4.27	16.65	35.32	17.94	17.93	33.1
SkLab	2.42	-1.44	2.95	3.33	14.92	34.22	16.51	16.49	32.29
Capital	2.15	-1	2.82	3.66	15.29	32.62	16.41	16.36	30.62
NatRes	-0.62	-0.4	-1.45	2.87	-19.86	-37.19	-17.97	-19.05	-36.95
Rice	6.21	-1.57	7.69	6.56	-0.42	9.58	1.61	1.5	4.32
Wheat	0.91	-7.82	-5.12	0.95	-7.16	-3.13	0.93	0.82	2.73
Othergrains	3.79		2.76	3.77	1.81	7.63	1.99	1.89	5.33
Oils	8.78	2.53	7.37	9.09	3.96	10.06	1.79	1.74	3.75
FruitsVeg	4.62	-1.23	6.17	4.99	1.55	11.33	3.31	3.19	6.94
Sugarcane	7.83	-2.11	12.1	8.75	-0.14	13.47	2.59	2.42	4.72
Othercrops	3.24	3.11	7.46	3.61	4.45	10.03	1.73	1.62	3.45
Beefcattle	5.69	-2	6.63	6.46	1.46	12.23	4	3.83	7.59
Otherlvstk	5.07	-1.08	5.63	5.5	2.44	12.54	4.06	3.91	8.35
Milk	5.39	-5.74	4.77	6.39	-2.07	9.54	3.96	3.78	6.53
Beef	4.92	-1.86	5.7	5.38	1.68	12.31	4	3.86	8.36
Othermeat	3.36	-1.11	3.68	3.02	2.95	13.65	4.39	4.3	11.06
Dairyprod	1.23	-6.28	-1.55	0.88	-3.69	5.55	2.9	2.81	8.02
Procfood	3.71	-2.14	3.68	3.49	0.72	10.89	3.19	3.11	8.82
Fish	5.23	-3.59	4.11	5.08	-1.05	10.9	3.03	2.9	8.62
Othernatres	0.23	-0.09	0.62	0.69	1.64	5.75	2.01	1.77	5.12
Textiles	0.65	-0.28	0.48	-0.9	-12.4	-8.08	-12.02	-12.1	-8.36
Wearapp	0.43	-0.21	0.12	-1.47	-15.99	-13.04	-15.69	-15.77	-13.05
Fuel	1.85	-0.93	2.29	2.19	9.96	24	10.98	10.95	22.44
Chemicals	0.84	-0.45	0.92	-0.15	-0.11	5.99	0.38	0.36	5.41
Electronics	0.84	-0.41	0.99	-0.85	-0.56	5.95	-0.13	-0.13	5.31
Lightmnfoth	0.86	-0.44	0.91	-0.36	-3.21	3.21	-2.71	-2.76	2.65
Heavymnfes	1.1	-0.54	1.42	0.45	3.14	11.96	3.76	3.7	10.99
Transpequip	0.74	-0.37	0.86	-5.43	-7.6	-2.28	-7.59	-7.25	-2.83
Electricity	1.01	-0.5	1.27	-1.14	-1.07	6.92	-0.52	-0.54	6.05
Transport	0.95	-0.53	1.19	-4.14	-7.44	0.06	-6.93	-6.88	-0.73
Communic	1.54	-0.93	1.78	1.42	7.24	19.27	8.25	8.23	18.13
Edu_Health	1.81	-1.12	2.06	1.7	8.26	22.21	9.47	9.46	20.9
SvcesOther	1.72	-0.9	2.14	1.86	8.86	22.26	9.84	9.81	20.81
CGDS	1.26	-0.65	1.53	0.25	4.03	13.82	4.7	4.71	12.79

Table A2. Change on consumer price of commodities in Vietnam under different scenarios (percentage)

	agasean	agvietnam	agworld	allasean	allvietnam	allworld	nonagasean	nonagvietnam	nonagworld
Rice	6.21	-1.58	7.67	6.56	-0.43	9.56	1.61	1.49	4.32
Wheat	-0.03	-4.9	0.51	-0.02	-4.89	0.74	0.07	0.01	0.08
Othergrains	3.18	-0.6	1.9	3.16	0.71	5.93	1.69	1.59	4.46
Oils	1	-6.72	-11.29	1.05	-6.59	-10.71	0.28	0.21	0.83
FruitsVeg	4.06	-4.19	2.05	4.39	-1.89	6.51	2.96	2.84	6.32
Sugarcane	7.83	-2.11	12.09	8.75	-0.14	13.47	2.59	2.42	4.72
Othercrops	-2.37	-5.64	-6.01	-2.29	-5.63	-5.11	0.19	0.01	0.81
Beefcattle	5.67	-2	6.6	6.44	1.44	12.18	3.98	3.81	7.56
Otherlvstk	4.91	-1.16	5.15	5.32	2.25	11.83	3.94	3.79	8.14
Milk	4.4	-5.38	2.96	5.21	-2.32	6.88	3.3	3.13	5.49
Beef	4.73	-2.41	5.04	5.17	0.96	11.32	3.86	3.71	8.04
Othermeat	2.71	-2.35	1.99	2.43	1.29	10.91	4.06	3.96	10.2
Dairyprod	-0.39	-12.17	-6.08	-0.48	-11.15	-2.99	1.37	1.28	3.71
Procfood	0.74	-10.97	-8.63	0.69	-9.22	-4.08	2.51	2.4	6.98
Fish	5.19	-3.56	4.07	5.02	-1.13	10.68	2.91	2.78	8.44
Othernatres	0.22	-0.09	0.6	0.65	1.39	5.33	1.76	1.51	4.73
Textiles	0.1	-0.04	-0.45	-2.01	-22.97	-22.5	-22.83	-22.93	-22.11
Wearapp	0.08	-0.04	-0.15	-4.76	-30.45	-31.36	-30.33	-30.44	-31.16
Fuel	0.01	0	0.18	-9.5	-25.62	-24.9	-25.51	-25.61	-25.04
Chemicals	0.27	-0.11	0.12	-1.11	-4.21	-2.38	-4.16	-4.11	-2.39
Electronics	0.18	-0.08	0.12	-2.6	-5.89	-4.32	-5.86	-5.82	-4.36
Lightmnfoth	0.48	-0.24	0.39	-1.76	-8.88	-5.4	-8.55	-8.67	-5.53
Heavymnfc	0.84	-0.41	1.07	-0.51	-0.38	5.9	0.04	0	5.27
transpequip	0.04	-0.01	-0.09	-19.91	-29.59	-29.55	-30.83	-29.59	-29.57
Electricity	1.01	-0.5	1.27	-1.14	-1.07	6.92	-0.52	-0.54	6.05
Transport	0.77	-0.43	0.98	-3.37	-6.09	0.2	-5.65	-5.63	-0.46
Communic	1.32	-0.8	1.55	1.22	6.18	16.35	7.05	7.02	15.39
Edu_Health	1.75	-1.08	2	1.64	7.97	21.38	9.14	9.13	20.13
SvcesOther	1.68	-0.88	2.09	1.82	8.64	21.65	9.59	9.56	20.24

Table A3. Changes on input and endowment prices paid by non-ruminant producers in Vietnam under different scenarios (percentage)

	agvietnam	Agasean	agworld	nonagasean	nonagvietnam	nonagworld	allvietnam	allasean	allworld
Land	1.01	10.02	12.76	-6.19	-6.54	-11.53	-6.35	9.95	-1.02
UnSkLab	-1.18	2.55	3.16	17.94	17.93	33.10	16.65	4.27	35.32
SkLab	-1.44	2.42	2.95	16.51	16.49	32.29	14.92	3.33	34.22
Capital	-1.00	2.15	2.82	16.41	16.36	30.62	15.29	3.66	32.62
NatRes	1.36	-0.67	-8.11	3.54	3.17	16.97	4.54	-4.16	11.99
Rice	-1.58	6.21	7.67	1.61	1.49	4.32	-0.43	6.56	9.56
Wheat	-4.92	-0.02	0.48	0.08	0.02	0.09	-4.90	-0.01	0.72
Othergrains	0.00	3.63	2.53	1.91	1.81	5.10	1.52	3.61	7.18
Oils	-7.63	0.22	-12.91	0.11	0.05	0.52	-7.60	0.24	-12.48
FruitsVeg	-11.48	2.55	-7.70	2.01	1.87	4.67	-10.21	2.76	-4.74
Sugarcane	-2.11	7.83	12.10	2.59	2.42	4.72	-0.14	8.75	13.47
Othercrops	2.12	2.63	5.88	1.57	1.45	3.17	3.30	2.96	8.23
Beefcattle	-2.00	5.69	6.63	4.00	3.83	7.59	1.46	6.46	12.23
Otherlvstk	-1.08	5.07	5.62	4.06	3.90	8.35	2.44	5.49	12.53
Milk	-5.73	5.39	4.76	3.96	3.78	6.53	-2.07	6.39	9.54
Beef	-4.28	4.05	2.78	3.36	3.22	6.93	-1.48	4.43	7.95
Othermeat	-2.46	2.66	1.85	4.03	3.93	10.12	1.14	2.37	10.67
Dairyprod	-12.17	-0.39	-6.08	1.37	1.28	3.71	-11.15	-0.48	-2.99
Procfood	-6.42	2.34	-2.40	2.88	2.79	7.97	-4.12	2.19	3.41
Fish	-3.56	5.19	4.07	2.91	2.78	8.45	-1.12	5.02	10.69
Othernatres	-0.09	0.23	0.61	1.97	1.73	5.06	1.60	0.68	5.67
Textiles	-0.04	0.10	-0.45	-22.82	-22.93	-22.10	-22.96	-2.01	-22.49
Wearapp	-0.04	0.08	-0.15	-30.32	-30.43	-31.15	-30.44	-4.76	-31.35
Fuel	0.00	0.01	0.18	-25.51	-25.61	-25.04	-25.62	-9.50	-24.90
Chemicals	-0.11	0.27	0.12	-4.15	-4.10	-2.38	-4.21	-1.11	-2.37
Electronics	-0.07	0.16	0.08	-6.10	-6.05	-4.73	-6.11	-2.68	-4.71
Lightmnfoth	-0.39	0.76	0.77	-4.35	-4.43	0.30	-4.81	-0.74	0.72
Heavymnfcs	-0.42	0.85	1.09	0.22	0.18	5.53	-0.22	-0.46	6.19
Transpequip	-0.06	0.12	0.03	-29.30	-28.08	-27.93	-28.09	-18.67	-27.89
Electricity	-0.50	1.01	1.27	-0.52	-0.54	6.05	-1.07	-1.14	6.92
Transport	-0.43	0.77	0.98	-5.65	-5.63	-0.46	-6.10	-3.37	0.20
Communic	-0.80	1.32	1.55	7.06	7.02	15.40	6.19	1.22	16.36
Edu_Health	-1.08	1.75	2.00	9.14	9.13	20.13	7.98	1.64	21.38
SvcesOther	-0.86	1.65	2.05	9.39	9.36	19.80	8.46	1.78	21.16

Table A4. Mapping from GTAP's (version 5.0) sectors into the sectors used in this analysis

GTAP	Description	Sector in this study
pdr	Paddy rice	& Rice
wht	Wheat	& Wheat
gro	Cereal grains nec	& Othergrains
v_f	Vegetables, fruit, nuts	& FruitsVeg
osd	Oil seeds	& Oils
c_b	Sugar cane, sugar beet	& Sugarcane
pfb	Plant-based fibers	& Othercrops
ocr	Crops nec	& Othercrops
ctl	Cattle,sheep,goats,horses	& Beefcattle
oap	Animal products nec	& Otherlvstk
rmk	Raw milk	& Milk
wol	Wool, silk-worm cocoons	& Othernatres
for	Forestry	& Othernatres
fsh	Fishing	& Fish
col	Coal	& Othernatres
oil	Oil	& Othernatres
gas	Gas	& Othernatres
omn	Minerals nec	& Othernatres
cmt	Meat: cattle,sheep,goats,horse	& Beef
omt	Meat products nec	& Othermeat
vol	Vegetable oils and fats	& Procfood
mil	Dairy products	& Dairyprod
per	Processed rice	& Procfood
sgr	Sugar	& Procfood
ofd	Food products nec	& Procfood
b_t	Beverages and tobacco products	& Procfood
tex	Textiles	& Textiles
wap	Wearing apparel	& Wearapp
lea	Leather products	& Lightmnfoth
lum	Wood products	& Lightmnfoth
ppp	Paper products, publishing	& Lightmnfoth
p_c	Petroleum, coal products	& Fuel
crp	Chemical,rubber,plastic prods	& Chemicals
nmn	Mineral products nec	& Heavymnfcs
i_s	Ferrous metals	& Heavymnfcs
nfm	Metals nec	& Heavymnfcs
fmp	Metal products	& Heavymnfcs
mvh	Motor vehicles and parts	& transpequip
otn	Transport equipment nec	& transpequip
ele	Electronic equipment	& electronics
ome	Machinery and equipment nec	& electronics
omf	Manufactures nec	& Lightmnfoth
ely	Electricity	& Electricity
gdt	Gas manufacture, distribution	& SvcesOther
wtr	Water	& SvcesOther
cns	Construction	& SvcesOther
trd	Trade	& SvcesOther

otp	Transport nec	& Transport
wtp	Sea transport	& SvcesOther
atp	Air transport	& SvcesOther
cmn	Communication	& Communic
ofi	Financial services nec	& SvcesOther
isr	Insurance	& SvcesOther
obs	Business services nec	& SvcesOther
ros	Recreation and other services	& SvcesOther
osg	PubAdmin/Defence/Health/Educat &	Edu_Health
dwe	Dwellings	& SvcesOther

Table A5. Mapping from GTAP's (version 5.0) regions into the regions used in this analysis

GTAP	Description	Region in this study
aus	Australia	& AusNZ
nzl	New Zealand	& AusNZ
chn	China	& China
hkg	Hong Kong	& EastAsia
jpn	Japan	& EastAsia
kor	Korea	& EastAsia
twm	Taiwan	& EastAsia
idn	Indonesia	& Indonesia
mys	Malaysia	& RestSEA
phl	Philippines	& Philippines
sgp	Singapore	& RestSEA
tha	Thailand	& Thailand
vnm	Vietnam	& Vietnam
bgd	Bangladesh	& RestSasia
ind	India	& India
lka	Sri Lanka	& RestSasia
xsa	Rest of South Asia	& RestSasia
can	Canada	& NAM
usa	United States	& NAM
mex	Mexico	& NAM
xcm	Central America, Caribbean	& Latinamerica
col	Colombia	& Latinamerica
per	Peru	& Latinamerica
ven	Venezuela	& Latinamerica
xap	Rest of Andean Pact	& Latinamerica
arg	Argentina	& Latinamerica
bra	Brazil	& Latinamerica
chl	Chile	& Latinamerica
ury	Uruguay	& Latinamerica
xsm	Rest of South America	& Latinamerica
aut	Austria	& EU
bel	Belgium	& EU
dnk	Denmark	& EU

fin	Finland	& EU
fra	France	& EU
deu	Germany	& EU
gbr	United Kingdom	& EU
grc	Greece	& EU
irl	Ireland	& EU
ita	Italy	& EU
lux	Luxembourg	& EU
nld	Netherlands	& EU
prt	Portugal	& EU
esp	Spain	& EU
swe	Sweden	& EU
che	Switzerland	& ROW
xef	Rest of EFTA	& ROW
hun	Hungary	& ROW
pol	Poland	& ROW
xce	Rest of Central European Assoc	& ROW
xsu	Former Soviet Union	& ROW
tur	Turkey	& NAWA
xme	Rest of Middle East	& NAWA
mar	Morocco	& NAWA
xfn	Rest of North Africa	& NAWA
bwa	Botswana	& SSafrica
xsc	Rest of SACU (Namibia,RSA)	& SSafrica
mwj	Malawi	& SSafrica
moz	Mozambique	& SSafrica
tza	Tanzania	& SSafrica
zmb	Zambia	& SSafrica
zwe	Zimbabwe	& SSafrica
xfj	Other Southern Africa(Ang,Maur	& SSafrica
uga	Uganda	& SSafrica
xss	Rest of Sub-Saharan Africa	& SSafrica
xrw	Rest of World	& ROW

Table A6. GTAP sectors in this study and their concordance with Vietnam's livestock survey

1. Livestock sales and purchases	
pigs	(otherlvstk)
poultry	(otherlvstk)
cattle	(beefcattle)
milk	(Milk)
fish	(fish)
other	(otherlvstk)
2. Crops	
Paddy	(Rice)
Maize	(Othergrains)
Cassava	(Othercrops)
Sweet potato	(Othercrops)
Potato	(Othercrops)
Groundnut	(Othercrops)
Soy beans	(Oils)
Sugarcane	(Othercrops)
3. Inputs	
Chemicals	(Chemicals)
Irrigation	(Natural Resources)
4. Feed	
Fodder	(land in livestock)
Othercrops	(Othercrops)
Othergrain	(Othergrains)
Procfeed	(Procfood)
Rice	(Rice)
Wheat	(Wheat)
5. Animal Health	
Drugs	(Chemicals)
Veterinary	(Skilled labor)
6. Labor	(Unskilled labor)
7. Land	(land in livestock)
8. Non-agricultural income	(unskilled labor)
9. Expenditure non-food	
clothing	(wearing apparel)
education health electricity telephone social repairs other	(Edu_Health)
fuel woodcoal	(fuel)
furniture and appliances	(electronics)

10. Expenditure food

"Rice"	(rice)
"Cassava"	(othercrops)
"Sweet potato"	(othercrops)
"Maize"	(othergrains)
"Fruits"	(othercrops)
"Vegetables"	(othercrops)
"Pork"	(othermeat)
"Poultry meat"	(othermeat)
"Beef"	(beef)
"Carabeef"	(beef)
"Milk"	(milk)
"Aquaculture"	(fish)
"Other food"	(procfood)