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by

Francesco Goletti[1], Karl Rich[2], and Chris Wheatley[3]

Executive Summary

The past few years have witnessed the arrival of several large-scale foreign owned and joint-ventures with significant potential to develop and modernize the starch industry in Viet Nam. Small-scale production of starch, however, is still the predominant mode of production. Currently, over 90 percent of the starch processors in Viet Nam have a production capacity of less than 10 tons per day. The key question analyzed in the paper is to what extent small-scale production of starch in Viet Nam can be efficient. In an environment characterized by high transaction costs, with low levels of infrastructure development and market integration, and poor productivity of the raw materials needed for production, there may be advantages in having an industry structure that includes both small and large enterprises.

Based on a survey of the starch industry sector including processing enterprises, traders, and end-user enterprises, the paper presents the main characteristics and constraints of the sector. The analysis finds an industry with excess capacity, decreasing returns to scale, increasingly oriented to high-value uses of starch (fermentation, textile, and pharmaceutical products) and exports. Among the most serious constraints of the industry is a serious credit constraint, particularly for small-scale enterprises.

Using a sector model of the industry, the analysis presents the effects of two alternative policy simulations, both considering a credit increase leading to an expansion of production equipment in the industry. The first option distributes credit equally among the participants of the industry (both small and large). The second option targets the small enterprises. The analysis finds larger benefits for the industry when credit is targeted to the small. Because of more flexibility in dealing with transaction costs arising from poor infrastructure, underdeveloped marketing channels, and labor management, the small enterprises are in a better position of utilizing the additional credit. In the long-run, the industry average size will increase, consolidation will occur, and the external environment will improve so that economies of scale could develop. In the short-medium term, however, small-scale enterprises might well be positioned to take advantage of the high transaction costs facing their larger and capital-intensive rivals.

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Introduction

Despite a decade of remarkable growth in the agricultural sector, rural areas in Viet Nam are lagging behind urban areas (Nguyen Van Bich et al. 1998). The gap between rural and urban incomes has increased and the prospects for strong and sustainable growth of non-farm rural income are weak, given the limited growth prospects in rice cultivation. With 80 percent of population living in rural areas, these trends, if they continue, risk raising social tensions. In response to these trends and the recent crisis in Asia, the Government of Viet Nam has recognized the key role of agriculture and the rural economy in promoting industrialization and modernization, and contributing to increased employment and income of the rural population (see Phan Van Khai, 1998).

This suggests the need to further pursue a strategy of rural diversification and industrialization. Such a strategy would aim at achieving higher and more stable rural incomes, reducing the incentives for rural-urban migration, promoting farming systems that are more economically and environmentally sustainable, and alleviating rural poverty, especially among ethnic groups in the mountainous and hilly areas of Viet Nam.

An example of rural income diversification and industrialization concerns the starch industry in Viet Nam. In 1988, starch production utilized roughly ten percent of the cassava production. Starch production at that time typically served local markets for noodles and maltose. As a result of the economic liberalization over the past ten years and subsequent higher income growth, the demand for starch-based products has increased, spurring the development of the domestic starch industry. Newer and larger participants have become engaged in the production of specialty varieties of starch for industrial, food, and export purposes. In particular, the past few years have witnessed the arrival of several large-scale foreign joint-ventures with significant potential to develop and modernize the starch industry in Viet Nam. Small-scale production of starch is still the predominant mode of production, however. Currently, over 90 percent of the starch processors in Viet Nam have a production capacity of less than 10 tons per day.

Nevertheless, as the starch industry develops and modernizes, there will be an increasing emphasis on developing a large-scale, capital-intensive starch industry, following a pattern already pursued by more developed countries. This threatens to crowd out a large portion of the small-scale and labor-intensive producers, who do not have the capital resources to compete with larger, modern, capital-intensive firms. While this may be a desirable situation in the long run, it is conceivable that a large-scale capital-intensive industry may not be the most efficient situation in either the short or medium term. In an environment characterized by high transaction costs, with low levels of infrastructure development and market integration, and poor productivity of the raw materials needed for production, there may be advantages in having an industry structure that includes both small and large enterprises.

In this paper, we examine the starch industry of Viet Nam using field-level data from a survey undertaken during 1998 by the International Food Policy Research Institute (IFPRI) in collaboration with the Tropical Agricultural International Center (CIAT) and the Postharvest Technology Research Institute in Hanoi (PTRI) (see IFPRI 1998). We first provide a profile of the Vietnamese starch industry, highlighting the growth experienced in the industry, the structure of firms and end-users, and the constraints facing the industry. Then, with the help of a simulation model, we study the effects of alternative options to remove the credit constraints in the sector. We conclude by summarizing the results and drawing some policy implications.

Overview of Starch Uses

Starch[4] uses are varied, and are diversifying further with continued global economic development. Starch is locally produced from grain or root crops that are in abundance in the domestic market. In general, starch is fairly substitutable, in the sense that starch derived from maize can be used in place of starch derived from cassava, for instance. However, there are specialized applications for starches derived from particular raw materials. In Viet Nam, root crops, especially cassava, have been the traditional sources of starch for use in food products.

Starches can be classified into two types – unmodified and modified. Unmodified, or native, starches are produced through the separation of naturally occurring starch from either grain or root crops. In the case of cassava starch, cassava is grated and then soaked in a sedimentation tank with a sieve in order to separate the starch from the cassava. This type of unmodified starch, also called wet starch, can be used directly in certain food uses such as noodles. Wet starch can also be further processed through drying and purifying to produce dry starch. Dry starch is used in more value-added products such as textiles, paper, and MSG. Given the capital requirements needed to produce dry starch, it is usually manufactured by larger producers. Wet starch, by contrast, can be produced by small household operations, with little required in the way of capital equipment. Modified starches involve the addition of chemicals (depending on the final use) to dry starch and are significantly higher-value than unmodified starches.

Cassava starch is processed into a range of foods, including noodles, crackers, and cakes. Cassava starch is also the main raw material for maltose production in northern Vietnam, which, in turn, is used by the confectionery industry. All of these traditional uses are found mainly in household enterprises.

Non-food industrial uses of cassava are associated with larger scale (often state run) enterprises in Viet Nam. The textile industry, for example, uses cassava starch for sizing, while the paper industry uses starch for coating high quality types of paper. As these industrial sectors develop, demand for starch is likely to increase. In Viet Nam, the recent arrival of several large-scale starch-producing firms interested in the production of high-value products has resulted in a much more diverse product offering than was found only a few years ago. The production of fermentation products (MSG and lysine) has started, for example. There is a potential for the Vietnamese industry to develop along the lines of the more developed Thai starch industry, which has placed substantial effort and resources towards the production of higher valued modified starches from cassava. Cassava starch is considered the logical raw material for modified starch (which are used in the production of sweeteners, for instance) in SE Asia, much in the same way maize starch is used in North America and potato starch is used in Europe. As starch-using industries develop in SE Asia, the range of starch-derived intermediate and end-products manufactured from cassava will also expand.

Profile of the Starch Industry of Viet Nam

The following section presents some of the major highlights of the industry and some of the constraints within the industry that affect its competitiveness and efficiency. The empirical results are based on a survey of starch processing enterprises, starch traders, and starch using enterprises that was undertaken by IFPRI-CIAT-PTRI in 1998 (see IFPRI 1998). The survey included 339 starch processors, 115 traders, and 235 end-users across the country. While the survey sampled all starch producing regions and nearly all medium and large enterprises, it likely under-sampled the micro and small enterprises[5].

Increasing utilization of cassava production, but excess capacity in the starch industry

Starch production utilized roughly ten percent of cassava production in 1988. Since then, the number of participants involved in starch production has increased, including both rural households and large enterprises. Field survey results show that at least 24 percent of total cassava production is currently utilized for starch (see table 1).

This figure is somewhat higher than results obtained in a survey reported in Ha, Tru, and Henry (1992), which found that starch production utilized 20 percent of cassava use in 1991. Given that the 1998 survey under-sampled small producers as well as some districts in the North East South of Viet Nam, a more plausible estimate of starch production would be equal to 30 percent of cassava production (personal communication from PTRI). Total starch production in the survey was found to be 131,000 tons, corresponding to more than 477,000 tons of cassava The greatest share of starch production in Viet Nam is for dry starch production (18.7 percent of the total).

Despite increased utilization of cassava production by the starch industry, one of the major constraints faced by many starch processors is an inability to procure enough cassava to run operations at full capacity. In particular, there is a sizable gap between potential capacity and capacity utilized, a relationship that becomes stronger as the scale of a firm increases. Capacity utilization for micro enterprises is 66 percent, for small enterprises it is 41 percent, for medium enterprises is 36 percent, and for large enterprises is 25 percent.

High cassava costs contribute to lowering the competitiveness of the industry, particularly of the larger enterprises. Survey results show that large enterprises pay the highest prices for raw materials procured by farmers (Dong 319 per kg) while micro enterprises pay the lowest prices (Dong 285 per kg). Moreover, small and medium enterprises travel shorter distances to procure cassava than large processors. High costs are also related to the low productivity of cassava in Viet Nam. Current yields only average 7.9 tons/ha in Viet Nam, while in neighboring China and Thailand, yields are nearly double those in Viet Nam. (table 2).

Increasing size of new entrants, but decreasing returns to scale

Starch production in Viet Nam is undertaken by enterprises of varying sizes, including very small firms and a number of large ones. In our survey, we find an industry that is heavily skewed towards smaller enterprises. Micro enterprises (with a production capacity of less than one ton per day) comprise almost 50 percent of the sample, with small enterprises (production capacity between 1 and 5 tons per day) making up about 26 percent, medium enterprises (production capacity between 5 and 10 tons per day) about 24 percent, and large enterprises (production capacity over 10 tons per day) only 10 percent of the sample. The largest enterprise, VEDAN, has a capacity of 800 tons per day. Moreover, the average processing capacity of new entrants into the starch industry increased during 1988-98. The average processing capacity of new entrants increased from less than 10 tons per day before 1994 to almost 60 and 80 tons per day in 1995 and 1997, respectively. The regional distribution of enterprises indicates a predominance of small firms in the north and large firms in the south. This reflects higher incomes in the south, corresponding to stronger demand for more diversified, starch-based products. It is also the result of a more mature industrial structure and business-oriented environment in the south. Combined, these factors explain the presence of wet-starch processing units in the north (mainly oriented to noodles and maltose) that also happen to require less capital than dry starch units.

In general, smaller enterprises in Viet Nam are labor-intensive, with the substitution of capital in place of labor occurring as the scale of the enterprise increases. This is shown in figure 1, where firm capacity is plotted against the ratio of capital over labor for micro, small, and medium enterprises. With a few exceptions, nearly all of the firms in the figure are labor-intensive, with the quantity of capital used increasing only after an enterprise has reached a scale of at least 30 quintals (3 tons) per day.

While starch enterprises are getting larger, regression analysis of the production function shows the starch industry is subject to decreasing returns to scale. The following relationship was modeled to understand the returns to scale that are present in the Vietnamese starch industry:

$$ln(q) = a + b\ ln(K) + c\ ln(L)$$

where q represents total volume of production (wet starch and dry starch), K is the value of total capital equipment, and L is the total number of man-months worked by employees in a given starch factory. Regression results showed for the full sample, $b = 0.3$ (t=5.86), $c = 0.417$ (t=2.94), and r-squared = 0.56 which implies decreasing returns to scale since $b+c < 1$ for a Cobb-Douglas production equation. Decreasing returns to scale suggest there could be problems in the procurement of raw materials that prevent firms from expanding to optimal capacity, a fact discussed previously. An alternative reason could be attributed to problems with labor management and supervision among larger enterprises, which typically are state-owned entities and likely have an excess supply of labor to begin with. Separate regression results were also obtained for micro-small-medium enterprises (in aggregate) and large enterprises. Sub-sample results show decreasing returns to scale for both groups, but are much more pronounced for larger enterprises. For micro-small-medium enterprises, b=0.26 (t=4.8), c=0.403 (t=2.09), and r-square = 0.35, while for large enterprises, b=0.246 (t=2.62), c=0.144 (t=0.68), and r-square = 0.60.

Specialization of starch production by size

The survey also points to the specialization of starch production by firm size. Micro, small, and medium enterprises produce about 87 percent of the wet starch in our sample, but only produce 13 percent of the dry starch (table 3), highlighting that smaller enterprises specialize in wet starch production and large enterprises specialize in dry starch production. This is to be expected, since dry starch is more capital intensive than the production of wet starch. Different-sized operations also target different markets. Smaller, household starch enterprises mainly produce starch for the noodle industry, while only the most advanced household processors produce starch for Viet Nam's maltose industry. By contrast, larger enterprises target their starch production toward a broader range of food and non-food uses, including the paper industry, MSG, pharmaceuticals, and textiles.

Interestingly, small enterprises have maintained their network of sales despite competition from large enterprises in traditional wet starch markets (i.e. noodles, maltose). This can be partially attributed to the nature of the markets serviced by smaller enterprises, which are generally more localized than those serviced by larger enterprises. Smaller enterprises maintain their markets by servicing a local clientele that is removed from where larger operations exist. High transaction costs, in terms of poor infrastructure, impediments in moving raw materials, and the difficulty of entering marketing channels established by small enterprises, are likely to hamper the ability of large enterprises to move into market segments served by smaller enterprises.

Increased demand for starch in Viet Nam and export markets

Increased demand for cassava starch in the local food industry and other non-food areas has induced a dramatic increase of investment by small and large enterprises, with an average annual growth rate of 78 percent over the period 1988 to 1997 (see IFPRI 1998). Starch in Viet Nam is also an exportable commodity. During 1998, more than 21,000 tons were exported to countries such as Singapore, Taiwan, Philippines, Indonesia, and Malaysia. This is significantly higher than the export levels (1,000 tons) reported by a previous survey just seven years earlier (Ha, Tru, and Henry (1992)). The export prices of starch are much higher than domestic prices, partly reflecting the better quality of exported starch. On average, export prices were almost $300 per ton, compared with less than $200 per ton for domestic starch. This provides further incentives for investment among starch producers to take advantage of opportunities outside the domestic market.

Greater capital availability by large processors relative to small processors

The level and value of the capital equipment used by starch processors varies significantly by the size of the starch operation. Survey results showed that the average value of equipment for micro and small enterprises was $ 70 and $117, respectively, while for large enterprises the average value for equipment was about $411,278 (using an exchange rate at the time of US$1 = Dong 11,500; see table 4). Small enterprises, however, make more efficient use of capital equipment, given their output-capital ratio of 9.3 tons of starch per million Dong of capital equipment (compared to 0.6 tons of starch per million Dong for large enterprises)

Differing cost structures for different firm sizes also partly explain the greater efficiency of smaller enterprises. For micro enterprises, for example, rental equipment comprises 35 percent of costs (excluding raw materials), while this is negligible for large enterprises[6]. More than 68 percent of the costs of large enterprises (excluding raw materials) are for electricity and labor, while for medium enterprises these items comprise 47 percent of costs (excluding raw materials). A regression of average cost over firm size confirms the hypothesis of greater efficiency at smaller scale.

$$\ln(\text{average cost}) = 4.14 + 0.21*\ln(\text{capacity}) \qquad \text{r-square} = 0.13$$

In the above regression, the coefficient on capacity is significant at the 1 percent level (t= 5.58).

Two capital constraints nonetheless affect the Vietnamese starch industry. First, while small enterprises utilize capacity more efficiently (given its relative scarcity), the quality of the equipment used is not comparable to the equipment used by larger enterprises. Most small processors manufacture starch with a bare minimum of equipment, using only graters and pumps in their operations. By contrast, large enterprises have access to sedimentation tanks, dryers, and complete starch systems. Second, the majority of participants (both small and large) in the starch industry use locally manufactured equipment, or equipment from Russia and China, which is often of low quality and inappropriate for producing high quality starch.

These constraints illustrate the need for a significant increase in capital in order to modernize equipment and operations. At the same time, however, the survey highlights that access to credit is limited for both small and large enterprises (table 5). The survey revealed a higher incidence of borrowing by medium and large processors (68 and 76 percent, respectively) than micro and small processors (44 and 22 percent, respectively). While large firms have better access to bank credit, the survey reports a larger gap between obtained credit and credit requirements for these firms (the requirement-obtained credit ratio is almost 7). Problems with securing sufficient collateral and difficulties with banks were mentioned as the predominant reasons by firms in the sample for not being able to obtain additional credit.

Greater environmental concerns related to starch production

Finally, there are concerns that starch production, particularly household production, is polluting the environment, causing serious problems in water quality at the community level. In the absence of sewage systems and water purification systems, starch processors are often forced to dump the residues and the polluted water from starch production into village streets and/or inadequate village sewage systems. Both households and community leaders indicated that this was one of the most serious problems facing the industry (see IFPRI 1998).

Discussion

The previous sections indicate the potential of the starch industry for rural industrialization in Viet Nam, whereby low-value agricultural commodities such as cassava are processed into high-value commodities such as starch that can be used in a variety of industries. There is evidence of growth in the starch industry, in terms of the quantity of cassava utilized by the industry; but there is also evidence of procurement bottlenecks among larger enterprises. This may explain why the starch industry faces decreasing returns to scale, particularly with respect to capital. Given that new entrants to the starch industry are larger and more capital-intensive, this constrains the development of the industry in the short to medium-term. At the same time, however, it points to the role that can be played by smaller and medium sized starch enterprises in Viet Nam. These firms produce at much higher levels of capacity with fewer constraints in terms of raw material supplies or market access. Yet these firms tend to operate at lower levels of technology and capital and have more problems with credit access. By providing greater levels of capital and technology to small and medium enterprises, there could be efficiency gains in the entire industry given the high transactions costs that beset the starch industry. This will be examined more carefully in the next section.

Policy options: The optimal allocation of credit to starch enterprises

In spite of rapid growth in the starch industry over the past 10 years, future prospects are limited by several constraints including low cassava productivity, supply bottlenecks due to poor infrastructure and an agrarian structure dominated by small farmers, low quality of final products, environmental pollution related to water contamination, and limited access to credit. While most of these constraints can be reduced through investments (such as transport infrastructure, research, extension) and institution building (such as inspection agencies), these constraints require long-term commitments. On the other hand the credit constraint is more tractable in the short-term and its analysis offers interesting insights as a policy option that could be pursued more quickly.

This section focuses on alternative policy options that reduce capital constraints among small and large enterprises. As identified in the previous section, one of the major impediments to the starch sector is limited access to credit. Both large and small enterprises face difficulties in obtaining credit to finance their procurement activities and new capital equipment. It is unclear, however, how a credit injection to the starch sector should be targeted; i.e. should credit be directed towards small or larger enterprises? To answer this question, we have developed a model of the starch industry in Viet Nam. We then use the model to study the most efficient allocation of capital to the sector.

Starch Industry Model of Viet Nam

In order to evaluate the effects of alternative policies on prices, production, income, and trade, we have built a sector model of the starch industry in Viet Nam. The model includes four commodities (food, feed, wet starch, and dry starch) and five types of agents (farmers, feed producers, wet starch processors, dry starch processors, and end users). It is an aggregate model (i.e. does not allow for regional variation and trade) and incorporates international trade in feed and dry starch. A detailed description of the model is available in the Appendix.

The first block of equations describes the supply-demand relationships in the cassava market. Since cassava is used as an input for food, feed, and starch, we model each market separately, with demand for cassava as feed, wet starch, and dry starch converted to root equivalents. Since a proportion of wet starch is used as an intermediate input in the production of dry starch, we must subtract intermediate uses in order to obtain net demand. The second block of equations models the feed market. Feed demand is a function of retail feed prices and exogenous changes in meat demand. Feed supply depends on input prices (i.e. the retail price of cassava) and output prices (i.e. the producer price for feed). The third and fourth block of equations summarize the supply-demand relationships for wet and dry starch. Supply and demand for wet and dry starch are differentiated by the size of the processing unit (small or large, where small in this case refers to micro, small, and medium-sized processors), due to differing initial endowments of capital and starch. Demand for wet and dry starch depends on the various demands by different users of wet and dry starch.

The last two blocks summarize the trade, price, and income relationships within the cassava, feed, and starch markets. Cassava and wet starch are assumed to be non-tradable, so that total supply equals total demand. Since there are exports of feed and dry starch, we model these markets such that supply equals demand plus net exports. Income for farmers, feed processors, and starch producers is defined as the value of product at producer prices multiplied by the profit share for each group. Profit shares are currently set at 0.53 for farmers and 0.15 for feed processors. Small and large processors are assumed to have different profit share (0.15 for small processors, 0.24 for large processors).

The results obtained from the model depend on assumed demand and supply elasticities. Of course, further study should evaluate these parameters more closely and conduct a rigorous sensitive analysis of those parameters. The conclusions presented here are only suggestive of the likely direction of the effects of various policy options. As such, they should be treated with caution and tested through further research.

Policy Simulations

To examine the impact of an injection of credit into the starch sector, we conduct two simulations. In both cases, we consider a 10 percent increase in the total value of capital equipment as a proxy for the credit injection. We note that the total value of capital equipment in the starch sector (with the exception of VEDAN) is roughly $21 million, so that a 10 percent increase in capital equipment implies an injection of about $2.1 million to the capital available in the sector. It should be noted that this expansion of credit should not be considered a subsidy. Rather, we consider this investment as a type of loan that could generate enough income to be repaid at market interest rates. In the case of small enterprises, we assume the credit injection will translate partly in an increase in the average capital of each processing unit and partly in an expansion of the size and/or number of small enterprises.

If the increase in capital translates into an increase of the scale of starch enterprises, then in principle it is possible that 'small' enterprises might become 'large'. However, this is not likely to occur within the context of this model, where there is a large difference (of the order of 1 to 100) in the average size of 'small' enterprise relative to 'large' enterprises. Therefore, the injection of capital envisaged in these simulations will not move one class of enterprises into the larger-scale class. This may be conceivable in the very long run after a series of increases in capital and improvements in infrastructure and raw material productivity, but this is outside the framework of this model, since such a scenario would imply that the overall industry structure will have changed.

The simulations differ in terms of how capital is distributed among enterprises. In the first scenario, we examine the effects of a 10 percent increase in the value of industry capital equipment to the entire sector, or to small enterprises and large enterprises alike. The second simulation takes the same amount of capital and allocates it only to small enterprises. In essence, this is akin to increasing the size of small enterprises and transforming them into "larger" small enterprises. The goal of this exercise is to see whether the income benefits from targeted credit injections into the starch subsector are more beneficial when aimed differentially (i.e. towards small enterprises) or when the enterprises in the sector are treated equally.

Results

The results of the two scenarios are summarized in table 6. In the first simulation, we consider an equal distribution of capital to small and large enterprises. Total income increases $640,000, or 1.7 percent. Wet starch income is reduced slightly, as prices fall. Dry starch income is buoyed by higher production and the prospect of export markets. Since dry starch has an export outlet, prices do not fall; rather, excess production is channeled into 4,500 tons of exports. In the cassava subsector, farmers' income rises slightly (1.4 percent), supported by higher retail prices owing from greater demand for starch. As expected, higher cassava prices reduce feed income marginally (-0.9 percent). Overall, despite the growth in export markets, it should be noted that the effects of the sector are not very large. Given the difficulty in ensuring a good recovery rate for investment loans, it is unclear whether this policy would make much of a difference.

When we examine the second simulation, a much different story emerges. Total income rises by nearly 11 percent (or $4 million). The injection of credit boosts the income of small starch processors for both wet and dry starch. Wet starch income for small processors increases by almost 9 percent, while dry starch income for this group rises tremendously, by 167 percent. The capital injection causes a substantial increase in wet starch production by small processors. This in turn causes an increase in overall wet starch production and a significant fall in prices (-33 percent). Overall wet starch income declines as a result, mainly because large processors suffer from higher input prices and low wet starch prices. In the dry starch industry, there is significant expansion, as small processors expand production into the dry starch sector. While the model does not dynamically capture a change in capacity for starch enterprises, expanding into dry starch production would necessarily imply a need to increase enterprise size, given the technology needed to enter this market. Exports rise by 137 percent to 52,000 tons. Farm income rises considerably (10 percent), as demand for cassava boosts production and prices. This in turn reduces feed income (6 percent). Given that the benefit to the sector is a rise in income of $4 million, a credit injection packaged as a $2.1 million loan (or 10 percent of the value of capital equipment), would imply easy repayment over a short period of time.

It should be noted that the model results provide a long-run outlook from such a policy. As previously noted, the model as constructed cannot capture the dynamics involved in the starch sector to realize these gains in production. In particular, a number of constraints could mitigate these results, especially in the short-term. The transition of smaller enterprises into the dry starch market requires much more than simply an infusion of capital. In particular, the development of a market for dry starch requires the close coordination of product specifications between processors and end-users. Infrastructure and location constraints, which protect the market for wet starch among small processors, may inhibit small processors from selling to dry starch users, who are typically located in urban areas. Moreover, in order to meet the demand of dry starch users, a sufficient scale of production is required as well, suggesting that an increase in capital may need to be combined with significant consolidation among small starch processors in order to reach the scale necessary to be competitive in the dry starch market.

A final note of caution relates to the distributional assumptions of the model. As noted previously, the sample distribution is likely biased against micro and small enterprises. If the true distribution were available, the quantitative results presented here would change even though the qualitative results would not change, given the enormous disparity between large and small enterprises in terms of capital equipment. The addition of under-sampled micro and small enterprises would increase the total capital that exists in the industry, but the distribution of that capital between small and large enterprises would not be altered significantly, confirming that the direction of the results provided here are valid. The growth benefit of targeted credit to small enterprises would still have a much stronger impact than the same credit targeted to the industry as a whole, but the income and production effects in such a scenario would be mitigated somewhat, relative to the results provided for in this model.

Conclusions and Policy Implications

The paper has presented the case of the starch industry in Viet Nam, an industry largely characterized by small enterprises that have been able to grow and adapt to rapid change over the past decade. The analysis of micro-efficiency and transaction costs suggests a role for small and medium enterprises in a continuum of firm sizes that includes large enterprises and multinational companies. Simulation modeling has shown that a broad-based strategy that promotes small and medium enterprises has benefits in terms of rural income generation. The broad-based growth process is important because of its implications for rural development in a country that is still mostly rural and where the income gap between urban and rural areas is growing.

REFERENCES

Dang Thanh Ha, Le Cong Tru, and Guy Henry. "Prospects for Cassava Starch in Vietnam," in *Cassava Flour and Starch: Progress in Research and Development*. Eds. D. Dufour, G.M. O'Brien, and Rupert Best (Cali, Colombia: CIAT, 1996).

IFPRI 1998. Starch industry Development as a Strategy for Agrofood based Rural Industrialization, Markets and Structural Studies Division, International Food Policy Research Institute, Washington, D.C., December 1998.

Nguyen Van Bich, Nguyen Xuan Nguyen, Chu Tam Quang, Tran Huu Quang, 1998, *Differences in economic development in urban and rural areas. Viet Nam Socioeconomic* Development, No. 13, Spring 1998

Phan Van Khai 1998. Socioeconomic Development in 1998 and major Orientation for Socioeconomic Development in 1999. Government Report presented at the 4th Session of the 10th National Assembly on October 28, 1998. The Gioi Publisher, Hanoi, Viet Nam, 1999.

Appendix: Description of the Model

The model below is a mathematical programming model designed to examine the effects of various policies and exogenous shocks on the starch subsector. The following is a list of the endogenous variables in the model. All quantities are denoted in thousand tons:

Variable	Description	Number of Variables
q_G^s	Total Supply of commodity G	4
q_G^d	Total Demand of commodity G	4
$q^d_{c,G}$	Demand for Cassava by commodity G	4
$q^s_{wet,N}$	Supply of wet starch from group N	2
$q^s_{dry,N}$	Supply of dry starch from group N	2
$q^d_{wet,W}$	Demand for wet starch by enduser W	5
$q^d_{dry,D}$	Demand for dry starch by enduser D	8
p_G^F	Farm Price for commodity G (Dong/kg)	4
p_G^R	Retail Price for commodity G (Dong/kg)	4
X^{feed}	Exports of Feed	1
X^{dry}	Exports of Dry Starch	1
M^{feed}	Imports of Feed	1
M^{dry}	Imports of Dry Starch	1
Y^{farm}	Farm Income (million USD)	1
Y^{feed}	Feed Income (million USD)	1
$Y^{wet, N}$	Wet Starch income for group N (million USD)	2
$Y^{dry, N}$	Dry Starch income for group N (million USD)	2
TOTAL		47

The exogenous variables used in the model are listed below:

Variable	**Description**
z	Exogenous shift parameters

γ	Conversion rate of the number of cassava roots required to generate one unit of feed or starch
p^x	Export Price (USD/ton)
p^M	Import Price (USD/ton)
MKT	Marketing Margins (Dong/kg)
TC	Transportation Costs (Dong/kg)
NER	Nominal Exchange Rate
$\pi^{G,(N)}$	Profit Share for commodity G (for starch, differs by processor size, N, as well)
θ^N	Initial Proportion of Dry Starch produced by group N

The labels used are defined as follows:

Label	***Definition***
c	Cassava
food	Cassava as food
feed	Cassava feed
wet	Wet Starch
dry	Dry Starch
G	All Commodities (cassava as food, feed, wet starch, and dry starch)
XG	Exported Commodities (feed and dry starch), a subset of G
N	Size of Processor (small or large)
W	Endusers using wet starch (intermediate uses, noodles, maltose, other food, and glucose)
D	Endusers using dry starch (noodles, maltose, other food, glucose, MSG, pharmaceuticals, textiles, and paper)

The first block of equations describes the cassava market. The supply of cassava roots (equation 1) is simply a function of the farmer price for cassava and exogenous supply shocks, such as technology.

Since cassava is used as an input for food, feed, and starch, we model each market separately (equations 2

$$\ln(q_c^s) = \alpha_c^s + \beta_{c,c}^s \ln(p_c^F) + \ln(z^c) \qquad (1)$$

through 5). Cassava demand for food (equation 2) is assumed to be a function of retail cassava prices and exogenous changes in demand. Cassava demand for feed (equation 3) and dry starch (equation 5) is assumed to be the root equivalent of the total supply of feed and starch, respectively. In the case of wet starch (equation 4), demand for cassava by wet starch is the root equivalent of the net supply of starch. Since a proportion of wet starch is used as an intermediate input in the production of dry starch, we must subtract intermediate uses in order to obtain net demand. Total demand for cassava roots (equation 6) is simply the sum of the demand for cassava from food, feed, and starch.

$$\ln(q^d_{c,food}) = \alpha^d_{c,food} + \beta^d_{c,food} \ln(p^R_c) + \ln(z_{food}\, supd) \quad (2)$$

$$q^d_{c,feed} = \gamma_{c,feed}\, q^s_{feed} \quad (3)$$

$$q^d_{c,wet} = \gamma_{c,wet}\,(q^s_{wet} - q^d_{wet,interm}) \quad (4)$$

$$q^d_{c,dry} = \gamma_{c,dry}\, q^s_{dry} \quad (5)$$

$$q^d_c = q^d_{c,food} + q^d_{c,feed} + q^d_{c,wet} + q^d_{c,dry} \quad (6)$$

The second block of equations models the feed market. Feed demand (equation 7) is a function of retail feed prices and exogenous changes in meat demand. Feed supply (equation 8) depends on input prices (i.e. the retail price of cassava) and output prices (i.e. the producer price for feed).

$$\ln(q^d_{feed}) = \alpha^d_{feed} + \beta^d_{feed,feed} \ln(p^R_{feed}) + \ln(z^{meat}) \quad (7)$$

$$\ln(q^{s}_{feed}) = \alpha^{s}_{feed} + \beta^{s}_{feed,c} \ln(p^{R}_{c}) + \delta_{feed,feed}\, sups \ln(p^{F}_{feed}) \qquad (8)$$

The third block of equations focuses on the market for wet starch. The supply of wet starch (equation 9) is differentiated by the size of the processing unit (small or large). While both groups face the same prices, they have different initial endowments of capital and starch. Total supply of wet starch (equation 10) is the sum of small

$$\ln(q^{s}_{wet,N}) = \alpha^{s}_{wet,N} + \beta^{s}_{wet,N,c} \ln(p^{R}_{c}) + \delta^{s}_{wet,N,wet} \ln(p^{F}_{wet}) + \zeta^{S}_{wet,N} \ln(K^{N}), \qquad (9)$$

processor supply and large processor supply.

$$q^{s}_{wet} = q^{s}_{wet,small} + q^{s}_{wet,large} \qquad (10)$$

Wet starch demand (equation 11) depends on the various demands by different users of wet starch (e.g. noodle factories, maltose factories). Enduser demand for wet starch is a function of the retail price of wet starch as well as the retail price for dry starch, which can be a substitute for wet starch. Wet starch demand is also affected by exogenous shifts in demand for end-use products, such as noodles or maltose. Total wet starch demand is the sum of wet starch demand by endusers (equation 12).

$$\ln(q^{d}_{wet,W}) = \alpha^{d}_{wet,W} + \beta^{d}_{wet,W,wet} \ln(p^{R}_{wet}) + \delta^{d}_{wet,W,dry} \ln(p^{R}_{dry}) + \ln(z^{W}), \qquad (11)$$

$$q^{d}_{wet} = \sum_{W} q^{d}_{wet,W} \qquad (12)$$

The fourth block of equations is for dry starch supply and demand. These are similar to the relationships in wet starch. Dry starch supply is a function of cassava retail prices and the producer price for dry starch as well as the capital endowment for small and large processors (equation 13). Total dry starch supply is the sum of supply from small and large processors (equation 14). Dry starch demand depends on the individual demand from the different endusers for dry starch (equation 15). For noodles, maltose, other food, and glucose, dry starch demand depends on the retail price of both wet and dry starch and on exogenous shocks on those end-products, since both types of starch can be used as in input. For textiles, paper, pharmaceuticals, and MSG, dry starch demand is function of only dry starch price and exogenous shifters. [1] Total dry starch demand is the sum of the individual enduser demand for dry starch (equation 16).

$$\ln(q^{s}_{dry,N}) = \alpha^{s}_{dry,N} + \beta^{s}_{dry,N,c}\ln(p^{R}_{c}) + \delta_{dry,N,dry}\, sups\, \ln(p^{F}_{dry}) + \zeta^{s}_{dry,N}\ln(K^{N}), \quad (13)$$

$$q^{s}_{dry} = q^{s}_{dry,small} + q^{s}_{dry,large} \quad (14)$$

Footonote 5 In the case of MSG, pharmaceuticals, textiles, and paper, which only use dry starch, we assume that in equation 15, $\beta^{d} = 0$.

$$\ln(q^{d}_{dry,D}) = \alpha^{d}_{dry,D} + \beta^{d}_{dry,D,wet}\ln(p^{R}_{wet}) + \delta^{d}_{dry,D,dry}\ln(p^{R}_{dry}) + \ln(z^{D}), \quad (15)$$

$$q^{d}_{dry} = \sum_{D} q^{d}_{dry,D} \quad (16)$$

The fifth block summarizes the trade and price relationships within the cassava, feed, and starch markets. Cassava and wet starch are assumed to be non-tradable, so that total supply equals total demand (equations 17 and 19, respectively). Since there are exports of feed and dry starch, we model these markets such that supply equals demand plus net exports (equations 18 and 20).

$$q^{s}_{c} = q^{d}_{c} \quad (17)$$

$$q^{s}_{feed} = q^{d}_{feed} + X^{feed} - M^{feed} \quad (18)$$

$$q^{s}_{wet} = q^{d}_{wet} \quad (19)$$

$$q^{s}_{dry} = q^{d}_{dry} + X^{dry} - M^{dry} \quad (20)$$

Domestic prices (equation 21) are defined such that the difference between retail and farm prices is the marketing margin. In addition, farmer prices plus transportation costs and marketing margins must be at least the level of the export price (equation 22). Similarly, the retail price must be less than or equal to the import price plus any marketing margins and transport costs (equation 23).

$$p_G^R = p_G^F + MKT + TC \qquad (21)$$

$$p_{XG}^F + MKT + TC \geq p_{XG}^X \frac{NER}{1000} \qquad (22)$$

$$p_{XG}^R \leq \left(p_{XG}^M \frac{NER}{1000} \right) + MKT + TC \qquad (23)$$

The last block defines income for farmers, feed processors, and starch processors. Farm income (equation 24) is the value, in million US dollars, of cassava at producer prices multiplied by the profit share for cassava

$$Y^{dry,N} = [\, p^{F}_{dry} \; (q^{s}_{dry,N} - \theta^{N} X^{dry}) \pi^{dry,N} \,/\, NER \,] + p^{X}_{dry} \; X^{dry} \pi^{dry,N} \theta^{N} \,/\, 1000 \qquad (24)$$

$$Y^{farm} = p^{F}_{c} \, q^{s}_{c} \pi^{c} \,/\, NER \qquad (25)$$

farmers (currently set at 0.53). Feed income (equation 25) is the product of the profit share (0.15) for feed processors and the value of feed supply. Since a portion of feed is exported, we value domestic consumption at farmer prices and exports at the world price for feed. Wet starch income (equation 26) is defined as the value of wet starch production for small and large processors, each of whom has a different profit share (0.15 for small

$$Y^{wet,N} = p^{F}_{wet} \; q^{s}_{wet,N} \; \pi^{wet,N} \,/\, NER \qquad (26)$$

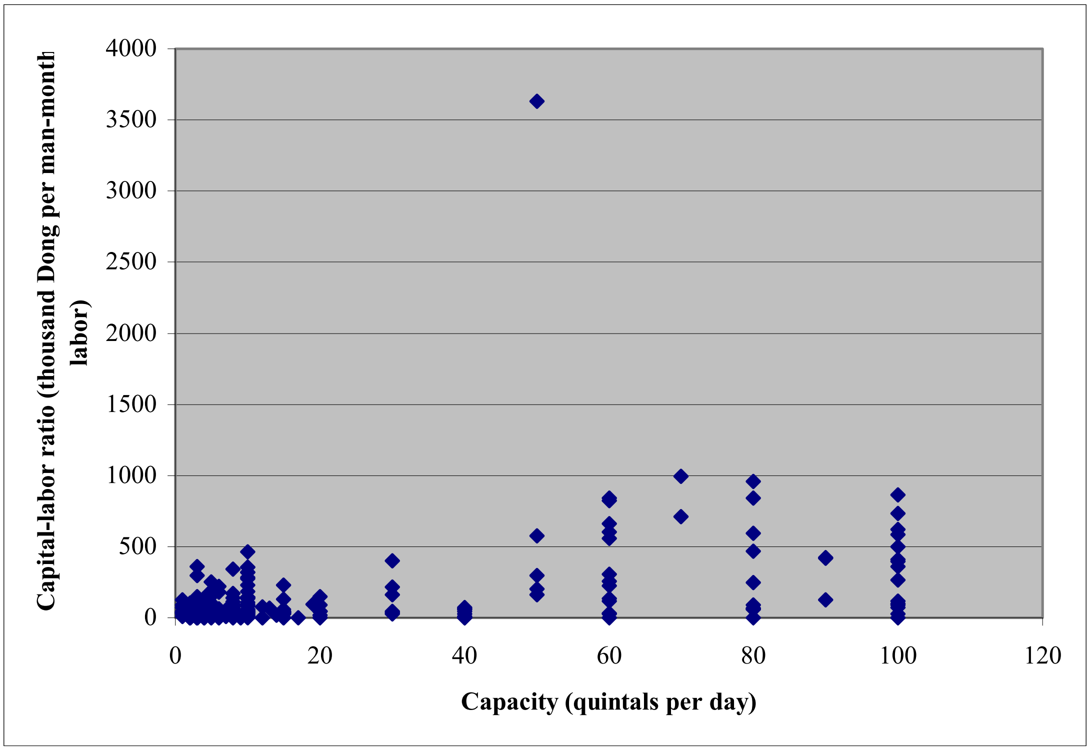
$$Y^{feed} = [\; p^{F}_{feed} (q^{s}_{feed} - X^{feed}) \; \pi^{feed} \,/\, NER] + p^{X}_{feed} \; X^{feed} \; \pi^{feed} \,/\, 1000 \qquad (27)$$

processors, 0.24 for large processors). Dry starch income (equation 27) is similar to feed income, in that exports are valued at the world price while domestic consumption is valued at the producer price. [2]

The model is written in GAMS (General Algebraic Modeling System) using mixed complementarity programming (MCP). With MCP, the programmer specifies an equal number of equations and variables. In addition, each inequality of the form f(x)³0 is explicitly linked to a complementary variable, λ, such that λf(x)=0 (see Rutherford, 1995). Intuitively, when an inequality becomes binding, it effectively increases the number of equations in the system. In order to preserve the balance between the number of equations and the number of endogenous variables, a new variable must also enter the system by becoming positive. In this model, this only occurs with imports and exports. For example, when the price relationship between the export price and farm price becomes binding (i.e. farm price plus marketing costs equals the export price), an equation for exports (namely, X > 0) enters the system, thus allowing for external trade.

[2] For this discussion, we have omitted the equations for total starch income, which are simply equations 26 and 27 summed over the group, N.

Figure1: Relationship between enterprise capacity and capital-labor utilization for micro, small, and medium enterprises



Note: IFPRI/CIAT/PTRI Survey 1998

Table1: Starch Production and Cassava Equivalent

Starch Type	Starch Production ('000 tons)	Cassava Equivalent ('000 tons)	Share of Cassava Production (%)
Wet Starch	42,307	105,767	5.3
Dry Starch	89,143	371,429	18.7
TOTAL	131,450	477,196	24

Source: IFPRI/CIAT/PTRI Survey 1998

Table 2: Yield of cassava in 1999

Country	Yield (Tons per hectare)
Viet Nam	7.9
China	15.9
Thailand	15.5
Brazil	13.2

Source: FAO Agrostat

Table 3: Small and large firms contribution to starch production

	Wet Starch Production ('000 tons)	Share of Wet Starch Production	Dry Starch Production ('000 tons)	Share of Dry Starch Production
Small Enterprises	36,961	87%	11,522	13%
Large Enterprises	5,346	13%	77,621	87%
Total	42,307	100%	89,143	100%

Source: IFPRI/CIAT/PTRI Survey 1998. Note that "small" enterprises in this table denote firms with a capacity of less than 10 tons per day, and "large" enterprises denote firms with a capacity of more than 10 tons per day.

Table 4: Average value of equipment and assets (thousand Dong)

Enterprise Size	Value of Equipment	Value of All Productive Assets
Micro	808	6,760
Small	1,354	4,429
Medium	17,749	350,209
Large	4,729,007	5,979,160
Viet Nam	491,512	671,398

Source: IFPRI/CIAT/PTRI Survey 1998. The value of US$1 = Dong 11,500.

Table 5: Access to credit

Enterprise Size	Credit (Million Dong)	Share of Credit from Bank (%)	Requirement Ratio*
Micro	5.1	78	2.5
Small	14.9	89	1.1
Medium	21.4	83	3.5
Large	108	94	6.9

Source: IFPRI/CIAT/PTRI Survey 1998. Note that the requirement ratio is the ratio between the credit deemed necessary to conduct operations smoothly and the actual credit obtained.

Table 6. Effects of alternative policy options.

	Option 1: 10% increase of capital targeted to both small and large processors			**Option 2: 10% increase of capital targeted only to small processors**		
	Amount	Change	Percentage Change	Amount	Change	Percentage Change
Income						
Total income (million US$)	37.52	0.64	1.74	40.89	4.01	10.87
Farmers (million US$)	26.17	0.36	1.41	28.42	2.62	10.16
Feed (million US$)	4.21	-0.04	-0.86	3.99	-0.25	-5.91
Wet starch total (million US$)	0.69	0	-0.33	0.57	-0.13	-18.59
Wet starch small processors (million US$)	0.4	0	-0.63	0.44	0.04	8.94
Wet starch large processors (million US$)	0.29	0	-0.25	0.13	-0.17	-57.15
Dry starch total (million US$)	6.49	0.32	5.16	7.91	1.77	28.8
Dry starch small processors (million US$)	0.37	0.02	4.89	0.95	0.6	167.3
Dry starch large processors (million US$)	6.08	0.3	5.19	6.95	1.17	20.27
Producers prices						
Cassava (Dong/kg)	282.76	2.81	1	299.98	20.03	7.15
Wet starch (Dong/kg)	1086.82	-18.08	1.64	712.27	-392.63	-35.54
Dry starch (Dong/kg)	1990	0	0	1990	0	0
Export of starch (‘000 tons)	26.59	4.57	20.73	52.15	30.12	136.79

Source: computed by authors based on model simulation.

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[4] A white, granular, organic chemical that is produced by all green plants. Starch is a soft, white, tasteless powder that is insoluble in cold water, alcohol, or other solvents. The basic chemical formula of the starch molecule is $(C_6H_{10}O_5)N$.

[5] As such, the sample distribution is slightly biased towards medium and large enterprises While this does not affect the validity of the major results presented later in this paper, it may mitigate the magnitudes of the those results.

[6] The importance of rental equipment for micro and small enterprises should not be interpreted as a solution to the credit constraints for capital equipment investment. While the credit constraint for these small firms is of the order of Dong 15 million, the rental cost is of the order of less than Dong 1 million.