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Is Contract Farming Really Pro-poor? Empirical Evidence from Northern Vietnam

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Abstract

Maintaining smallholder competitiveness in the changing market for pigs and pig meat remains an important development challenge, particularly in the context of pro-poor public policymaking. With the ongoing rapid changes in market organizations to respond to changing consumer demand and market requirements, there are viable institutional options and market organizations for smallholders to remain active participants in the pig industry where they are substantially contributing in terms of total output. Results from this study suggest that there is limited scope for smallholder pig producers to participate in formal contracts; however, smallholders were found to participate in informal contracts with cooperatives and with input/output traders that facilitated their access to pig markets. But what drives these smallholders to participate in these types of contractual arrangements for pig and piglet production? A multinomial logit model is applied to reveal the determinants influencing the choice of contractual arrangements by smallholder pig producers in four provinces in Northern Vietnam. Results suggest that the significant determinants of smallholders' participation in contractual arrangements are age, proportion of time spent in pig-raising, location, distance to veterinary shops, and access to animal health services.

Keywords: Northern Vietnam, multinomial logit model, contractual arrangements, pig production and marketing

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Introduction

Vietnam experienced very rapid overall economic growth in the 1990's, profiting from the considerable growth potentials unleashed by *doi moi* reforms in 1986, achieving around 5.7% annual per capita income growth, outpacing that of many developing countries (Klump, 2007). The rapid rate of income growth accompanied the increase in demand for meat, particularly pig meat, with around 98% of households consuming the commodity, and has an income elasticity of demand estimated at around 1.04 (Tung et al., 2005). The growth in demand for pig meat has likewise induced a rapid growth in the production side. Smallholders (holding 1 to 3 sows or less than 10 fatteners) account for the bulk of pig production in Vietnam (80%), with most of these households working on small farms in the rural areas; they also depend heavily on pig production for their income and livelihood (Lapar et al., 2003; Tung et al., 2005). The continued growth in the pig sector of Vietnam presents an opportunity for income growth among rural households, where poverty still remains more prevalent. Poverty incidence in rural areas is 27.5% as estimated by the VHLSS 2004, in contrast to 10.8% among urban households (Klump, 2007).

Current government policy is to encourage the development of capacity in producing high quality meat (high lean meat content) for domestic as well as export markets, through the development of modern, large-scale, commercial vertically integrated farms/companies. Further, the government is promoting commercial farms, which at present comprise 20% of total pig production in Vietnam, by having support programs such as reduced land rents, increased

artificial insemination, and grants preferential tax rates for commercial farms, large-scale slaughter facilities and livestock processing factories (Huong, 2006).

In the presence of these government policies that seem to support large and commercial pig production and processing operations, as well as open importation of breeding animals, what will happen to smallholders who supply 80% of total pig production in Vietnam? As markets demand for increased uniformity of product, which in turn requires the use of improved genetics, feeds, and animal health inputs, smallholders would find it difficult to access these markets because of the higher investments required; they also generally have limited access to good quality input supplies and services. In addition, the poor state of basic rural transport infrastructure not only raises the costs of marketing of livestock products significantly, but also raises the cost of individual market-entry investments in cooling and preserving infrastructure.

A relative lack of access to market information on the part of smallholders further weakens the negotiating position of small production units. Furthermore, economies of scale in marketing and processing livestock products tend to favour integrated producers over independent ones. Finally, even if some smallholders would be able to produce objectively high-quality and reliable livestock products, they find it hard to gain access to market premia for quality and reliability because of infrequent and small amounts sold and the difficulty of differentiating their output from the mass of smallholder producers. In other words, there are high transaction costs that smallholders have difficulty in overcoming, thus inhibiting their participation or entry into competitive markets.

In many cases in Southeast Asia, contract farming has been shown to help smallholders overcome these high transaction costs in a changing and more remunerative domestic and export markets (Tiongco and Delgado, 2007). Yet the history of contract farming is mixed, and

characterized by a variety of institutional arrangements, largely dictated by local conditions, some of which are much more pro-poor than others. This paper therefore investigates the validity of these findings in the Vietnam context, and seeks to make a significant contribution to policy and institutional change for the facilitation of profitable market-oriented livestock farming partnerships. To assess the performance of contract farming of pigs in terms of how it enables market participation by smallholder pig producers in the changing market for pigs and pig meat in Vietnam, this paper looked at three key areas, which included the identification of barriers to participation by smallholders in various forms of contract arrangements in pig production, the estimation of the costs and benefits of contract arrangements in terms of quantitative and qualitative indicators, and assessing the efficiency and effectiveness of contract arrangements by evaluating producers' profitability performance.

Data used and methodological approach

The respondents for the household survey were randomly sampled from four provinces in Northern Vietnam, namely Bac Giang, Ha Tay, Thai Binh, and Thanh Hoa. Selection of study areas were based on four criteria: high density of pig population, high rural poverty incidence, presence of market outlets, and incidence of any form of contractual arrangement for pig production.[1] A total of 400 pig producers were interviewed from the four provinces selected, of which 200 are independent producers, 166 are informal contract producers, and 34 formal contract producers. Formal contract growers are concentrated in only two provinces: Ha Tay and

[1] These contractual arrangements include cooperatives with satellite farms as voluntary members, with or without written contracts, engaged in either "direct inputs providing" production contracts or pig-purchase agreements, and vertically and horizontally integrated farms with foreign feed companies such as CP and Cargill.

Bac Giang, which are both relatively close to Hanoi and Hai Phong, the main urban markets for pigs and pig meat.

The emerging typologies of contractual arrangements found in northern Vietnam are summarized in Appendix 1, which includes groups that are motivated to contract due to market uncertainty, direct "income" impacts, farm-level impacts, and a combination of these drivers to contracting (Costales et al., 2006; ILRI-HAU-IFPRI-FAO, 2007) .

In this paper, we use the random utility model for contract choice to explain an individual pig producer's choice over substitute contract arrangements in pig production in northern Vietnam. The utility from engaging in a contract arrangement is specified as a function of the "quality" of the contract as measured by the characteristic of the choices and the individual making the choices. These functions are estimated using a multinomial logit model, which allows for multiple choices, with the underlying assumption that each choice is independent of the other choices. This is consistent with field observations that a farmer's choice to engage in one contract arrangement does not depend on other contract arrangements.

The choice of contractual arrangement is modelled as the probability that a pig producer will choose one of the four alternatives:formal contract, informal contract with cooperative, informal contract with traders or no contract/being independent, and is depicted as a binary dummy variable that takes the value 1 under each alternative and 0 otherwise.

Coefficients are estimated for any choice where one of the choices is treated as a base category where the corresponding coefficient is constrained to zero. A pig producer's decision to engage in a particular form of contractual arrangement (among the available alternatives) for pig production is hypothesized to be affected by socio-demographic factors, asset holdings, access to inputs and services, location, and proxy variables for transaction costs in searching for or

accessing the various alternatives presented. The changes in probability given a unit change in the independent variable (or the marginal effects) are also estimated.

Results and Discussion

Table 1 summarizes the descriptive statistics of survey respondents by type of contract. Contractual types have been classified into formal contracts, informal contracts with cooperatives, and informal contracts with traders (e.g. feed and pig traders). Descriptive statistics on the demographics of respondents revealed that participants in formal contracts are relatively older (hence likely to be more experienced), have more years of schooling, own more land and spend more their time in pig-raising activities compared to pig producers who are engaged in informal contracts or who operate independently. Variables related to transaction cost – in terms of distance to formal credit sources, input supply and services – were prominent distinguishing factors between farmers engaged in informal contracts with cooperatives and those who had contracts with traders of inputs or/and of outputs.. Specifically, farmers who were situated farther away from formal sources of credit (such as the Vietnam Bank for Agriculture and Rural Development (VBARD)), input supply and veterinary services tended to enter into informal contracts with cooperatives rather than traders. This may be because cooperatives always attempt to provide their members with access to inputs and services if unable to deliver them.

(Insert Table 1 here)

The incidence of receipt of a government loan was highest among farmers with informal contract arrangements with cooperatives followed by independent farmers. Only about 40% of formal contract growers had received a government loan, which may be because formal contract growers are less dependent on government loans and may have access to other sources of credit like private banks or their own integrator companies (e.g., for major inputs provided on credit).

In terms of distance variables, farmers who are linked with traders are those farthest away from VBARD, which may be one reason for the relatively lower incidence of government loan recipients in this group. Independent farmers are the second nearest to VBARD which may account for the relatively higher incidence of government loans received farmers in this group. Formal contract growers are nearest to VBARD as many of them live in urban or peri-urban areas where VBARD's offices are located. Independent farmers and farmers with trader links were situated nearest to market centres. Both groups of farmers were also situated nearest to veterinary shops; this may account for the relatively higher incidence of veterinary visits among independent farmers.

In terms of geographical spread, formal contract growers are concentrated only in Ha Tay and Bac Giang. Both these provinces are relatively close to Hanoi and Hai Phong, the main urban markets for pigs and pig meat. Farmers with other types of contract arrangements are evenly distributed across the survey sites, except for farmers with informal links with traders who are mostly concentrated in Bac Giang.

Formal contracts tend to favour short duration production cycles that have the potential to be made more intensive with appropriate coordination of production activities. On the other hand, informal contracts are largely driven by the scale of the pig herd. Informal arrangements for input supply and/or output purchases tend to be dictated by scale; input and output traders preferred to enter into contract agreements and trade with farmers who can generate large volumes of feed input requirements or can deliver significant volumes of piglets and/or pigs. This scale bias is potentially neutralized when traders deal with pig producer cooperatives. Cooperatives are generally intended to organize small and medium-scale producers to achieve

some common production and marketing objective for each member. A much appreciated benefit that cooperatives provide to their members is protection from market and price risks.

Determinants of participation in contracts

The results of the multinomial logit analysis aimed at unravelling the specific factors that influence farmers' decisions to engage or not to engage in a contractual arrangement in pig production are shown in Table 2, where the base category is "independent or no contract".

(Insert Table 2 here)

A farmer's decision to engage in a formal contract was found to be driven by age, proportion of time spent in pig-raising, level of resource ownership and location, which likely captures the effects of the policy environment conducive to pig-raising including infrastructure and market conditions. A farmer's choice to engage in informal contracts with cooperatives was also influenced by similar demographic characteristics though land was not a significant driver and variables related to transaction cost were more important. Engagement in informal contracts with cooperatives was significantly related to the distance to veterinary shops, a proxy for access to animal health services, an important inputs in pig production. In the case of participation in informal contracts with input/output traders, variables related to transaction cost also appear to be significant drivers of farmers' decisions, while demographics and resource-related variables do not appear to be important. Specifically, distance to VBARD (a proxy for access to formal credit) significantly influenced farmers' decisions to engage in informal contracts with traders; this suggests that pig producers with limited access to formal sources of credit may ease this constraint by partnering with input/output traders who can provide credit in kind to sustain their pig production activities.

Assets ownership was significant only in the choice to enter into formal contracts; farmers with more land are more likely to engage in formal contracts relative to operating independently. This is consistent with observations from descriptive statistics where formal contract growers generally have large land holdings compared to farmers with informal contracts or independent operators. This may also signal the potential for land as an entry barrier to formal contract participation by smallholders who, in the context of northern Vietnam, may only have an average of 0.3 to 0.5 ha of land.

Location variables were also significant drivers of farmers' decisions to engage in informal contracts either with a cooperative or an input/output trader. The significance of the Ha Tay coefficient suggests that farmers located in Ha Tay are less likely than farmers in Bac Giang (the reference variable) to engage in formal contracts or informal contracts with traders relative to being independent. Currently, formal contracting (in pigs and other commodities) is highly concentrated in Ha Tay province, while the incidence of formal contracting in Bac Giang is still relatively low at present, suggesting more potential for expansion of formal contracting in this province relative to Ha Tay. Informal contracting with traders may also be potentially attractive to farmers in Bac Giang, as can be inferred from other results on the Ha Tay location dummy. Further investigations may be useful to assess the potential for these indicators of likely interest in formal and informal trader contracts by farmers in Bac Giang. The statistical significance of the coefficient of the Thai Binh location dummy variable means that farmers in Thai Binh are less likely than farmers in Bac Giang to enter into an informal contract with a trader relative to being independent farmers.

The estimated marginal effects as shown in Table 3 suggest that the impact of independent variables on farmer's choice to engage in formal contracts is not statistically significant.

Education appears to have a higher impact on the probability of engaging in informal contracts with cooperatives compared to the potential impact of age (i.e. a unit increase in age and education will increase the probability of engaging in this type of contract by 1.4% and 8.1%, respectively). Moreover, the estimates suggest that there is a 19% increase in the likelihood of farmers engaging in informal contracts with cooperatives when pig-raising is the main occupation.

(Insert Table 3 here)

From the point of view of independent farmers, the estimated marginal effects of age and education suggest that a one-year increase in age and education of the farmer will reduce the probability that a farmer will remain an independent farmer by 1.25% and 8%, respectively. Hence, as a farmer gets more experience through added years in age and schooling, there appears to be more potential to engage in some form of contract farming. Also, the likelihood of remaining an independent operator declines by about 19% if pig-raising is the farmer's main occupation.

Among distance variables, a one-kilometre increase in distance between the farmer's premises and the location of VBARD increases the probability that a farmer will engage in informal contracts with traders.

Impacts of location dummies were observed to be significant only in the context of informal contracts with traders or among independent farmers. Specifically, the likelihood of engaging in informal contracts with traders is reduced by 5.8%, 7.4% and 5.6%, respectively, for farmers in Ha Tay, Thai Binh, and Thanh Hoa relative to farmers in Bac Giang. On the other hand, the likelihood of remaining an independent farmer is increased by 19.5% when a farmer is located in Ha Tay relative to Bac Giang.

Taking into consideration that there were no smallholders found among formal contract growers, a probit model was estimated to determine the factors influencing a farmer's decision to engage in informal contracts. The same set of independent variables is hypothesized to affect this choice plus additional variables on production system and social capital. Results show that education and pig-raising as the main occupation significantly affect farmers' decisions to engage in informal contracts (Table 4). Specifically, a one-year increase in education increases the probability that a farmer will engage in informal contracts by 7%. Pig-raising as the main occupation increases the probability that a farmer will engage in an informal contract by 21%. The type of production system also significantly affects a small farmer's choice of contract arrangement. If a farmer operates a grow-to-finish (fattening) or combination production system, the probability of engaging in informal contracts declines by 51% or 44%, respectively.

(Insert Table 4 here)

Membership in cooperatives (as proxy for social capital) increases the probability of engaging in informal contracts by 69%. Again, it is known that informal contracts with cooperatives are among the more common alternative contractual arrangements practiced by smallholder farmers in northern Vietnam. Distance to VBARD and to commercial supply also influences a farmer's choice of contract. For every one-kilometre increase in distance from VBARD and commercial supply (proxy for urban centre), the probability of engaging in informal contracts increases by 3% and 4%, respectively. This is consistent with the hypothesis that contracting will facilitate reduced transaction costs associated with obtaining inputs or accessing services.

The impact of location on choice of contract suggests that the probability of small farmers in Ha Tay, Thai Binh, and Thanh Hoa engaging in informal contracts will decrease by 42%, 47%, and

36%, respectively, relative to that of farmers in Bac Giang. Hence, farmers in Bac Giang appear to have a higher likelihood of choosing to enter into informal contracts.

Costs and benefits of contract farming

Costs and benefits of contract arrangements were assessed by estimating profitability (returns to labour) under various types of contracts and identifying qualitative indicators of benefits and costs. Comparisons were made between informal contracts and independent operators because of lack of data on production and other costs from formal contract growers. Table 5 suggests that informal contracts with either cooperatives or traders can facilitate higher returns in some specific production activities using specific technologies.

(Insert Table 5 here)

Results show that informal contracts appear to facilitate better returns in production of crossbreeds in farrow-to-weaning and grow-to-finish systems; these are both short duration systems that were also the preferred types for formal contracts by integrators. It should also be emphasized that in these two cases, the informal contracts were with cooperatives. For longer duration production cycles (farrow-to-finish), independent producers had higher returns to labour. Informal contracts with cooperatives also facilitated higher returns to labour among producers engaged in combination mode of production of crossbreeds, which could be due to the fact that in combination systems, producers can engage in two types of short-cycle production processes: farrow-to-wean and grow-to-finish.

Producers indicated the following benefits from participation in contract arrangements: access to quality inputs and services, to financing, to assured market for outputs, to information about technology and technology transfer, protection from production and market risks, reduced transaction costs in input procurement and output marketing and, more importantly, reduced

transaction costs arising from asymmetric information in product quality certification. The latter is important because it represents the lost sales that farmers may potentially incur when the market does not recognize the quality of the product they bring to the market, assuming that there is quality differentiation. Discussions with key informants revealed that informal contract arrangements with input suppliers can facilitate third-party certification of output by pig producers who are linked with reputable feed distributors.[2] These linkages occurred at the farmer and cooperative levels; in the latter case, the cooperative had input supply arrangements with a feed distributor. Farmers linked with cooperatives were also able to obtain protection from market risk as the cooperatives provided them with a 'market of last resort' for their outputs when the market was down and it was difficult to sell pigs at the spot market without incurring substantial losses. The cooperatives were able to provide this service to their members through a collective fund contribution intended to provide resources to help stabilize prices and provide a buffer to members from the effects of market fluctuations.

Conclusions and policy implications

Pig producers in northern Vietnam may engage in formal contracts with integrator companies or in informal contractual arrangements with cooperatives or with traders of inputs or/and of outputs. While smallholders may be willing to enter into formal contract arrangements, there is limited scope for them to participate because of the barrier due to scale, i.e. participation in formal contracts is not scale-neutral. This scale requirement is largely due to profit and efficiency motives of the contractor. Integrators certainly have their reasons for imposing such restrictive requirements based on valid business profitability or viability indicators. Formal contracts tend to favour short duration production cycles that have the potential to be made more

[2] Feed distributors usually assist their clients to search for market outlets for their products and negotiate prices.

intensive with appropriate coordination of production activities. . For large integrator companies, efficiency gains can be derived from reduced monitoring costs, lower risks of default and economies of scale. This is because it is easier to monitor and supervise a few large farms than numerous small farms, large farms have more resources to invest and sustain their operations than small farms, and large farms have a lower cost per unit of input and services provision to contract growers. Hence, smallholder participation in formal contracts may be limited in the long term unless alternative forms of contracts can be developed that will provide the right incentives for the private-sector investor (contractor or integrator) to engage with smallholder producers.

Meanwhile, alternative forms of informal contracts are emerging such as informal contracts with cooperatives and informal contracts with input/output traders. Between the two, contracts with cooperatives have the potential for mitigating the scale bias inherent in formal contract agreements that are currently observed in Northern Vietnam. Informal arrangements for input supply and/or output purchases also tend to be dictated by scale; input and output traders preferred to enter into contract agreements and trade with farmers who can generate large volumes of feed input requirements or can deliver significant volumes of piglets and/or pigs.

Public policy could, therefore, focus on helping small farmers to accumulate assets that will help them surmount some of the resource-related constraints (including scale-related barriers) to participation. Given the potential of cooperatives to facilitate profitable pig production by smallholders, public policy will need to consider how best to use this mechanism to help smallholder pig producers improve their productivity and competitiveness in the changing market for pigs and pig meat. With proper incentives, traders can bridge the gap in information asymmetry in output quality certification that will enable pig producers to be appropriately compensated for delivering quality pigs to the market by output buyers who will accept and pay

for the informally certified pigs. However, this is only a second-best solution in the short term to address the prevailing needs of smallholder pig producers. There is still the bigger policy issue of market power and this third-party certification may not work effectively where the market is a buyers' market. Hence, the long-term interest of the public would be best served by establishing some form of product certification or infrastructure that will make it easy for smallholders to access and have the quality of their pigs assessed and certified (particularly for disease-free status or lean meat content) according to specific grading standards. In addition, complementary policies to address the need for infrastructure in markets and services (wholesale markets, transport and communication services, and inspection and storage facilities) will also be useful intervention points from the public sector, as well as co-financing arrangements that will promote private-sector investment in infrastructure.

Meanwhile, partnerships between large farms/companies and smallholder pig producers when properly designed and implemented can generate employment especially to the unemployed sectors in rural areas. They can also demonstrate new ways to diversify income and reduce risks, and establish new market outlets that otherwise may not be accessible to smaller farmers and from which they will subsequently benefit. Since this is largely an initiative that is private-sector led, public policy can provide an enabling environment for enforcement of laws on contracts, trade and labour, among other sectors, to support private-sector investment.

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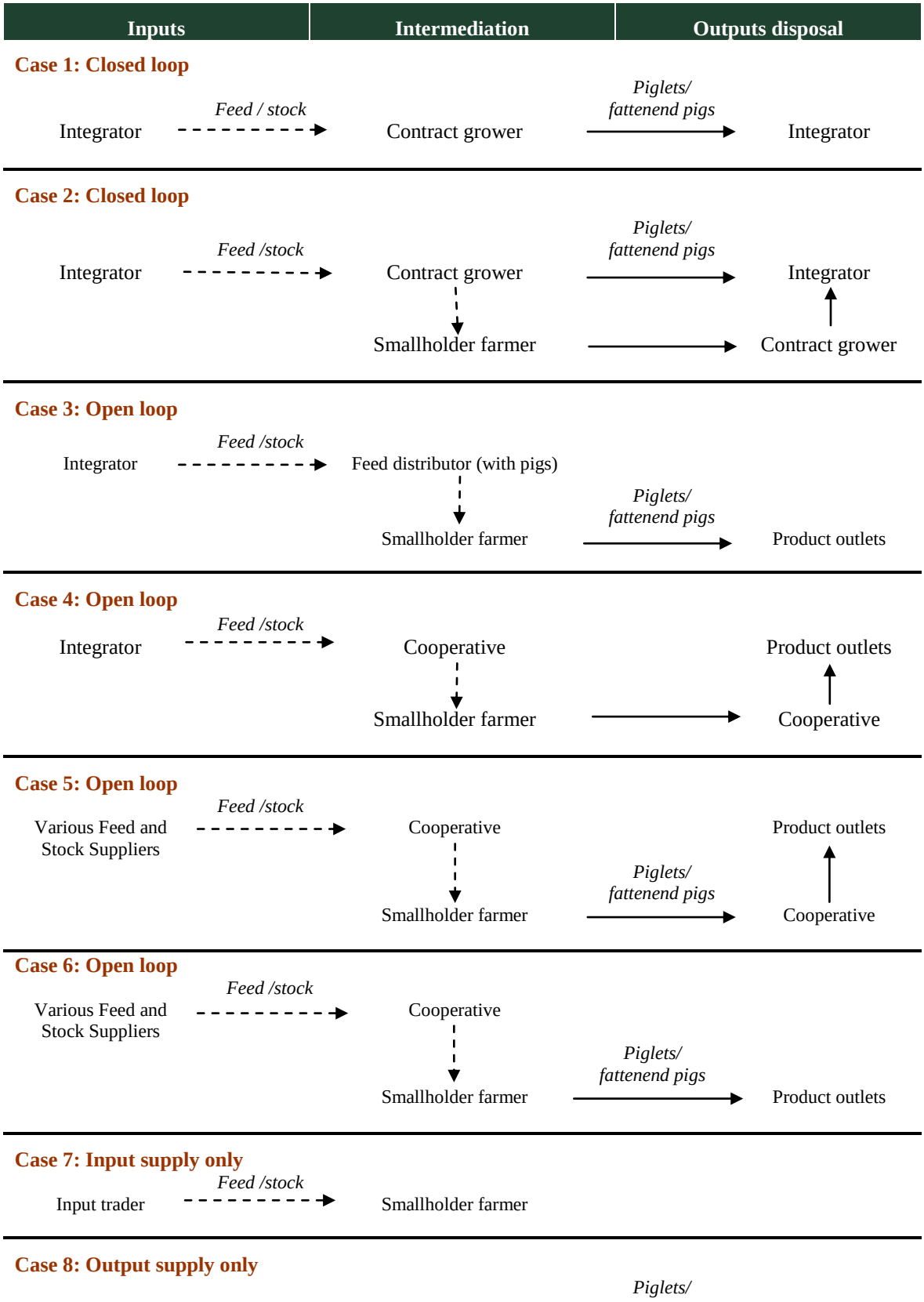
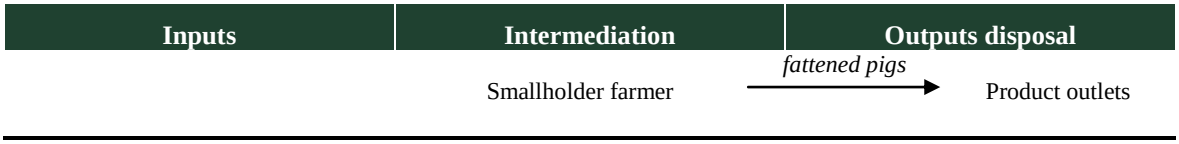
Appendix 1: Typology of contract arrangement in swine production in Northern Vietnam





Source: Costales et al 2006.

Case 1 is the typical contract growing arrangement between an integrator and a farmer (who is relatively larger than the typical farmer in North Vietnam as observed in the field visits). These cases have been observed specifically in Ha Tay and Bac Giang. Cases 2 to 6 are informal contractual arrangements that allow smallholders to overcome barriers to access to input and output markets by being linked to a contract grower (usually a farmer operating on a larger scale), a feed distributor (also a farmer with relatively larger scale operations), or a cooperative were also investigated. In these cases, there is no direct link between the smallholder farmer and the integrator, but the cooperative, contract grower or feed distributor acts as an intermediary, allowing farmers' access to inputs and product outlets. These cases can be considered as complete loops where linkage with input and output markets is facilitated by the same intermediary. Cases 7 and 8 are considered incomplete loops where smallholders are linked to either the input side only or the output side only. In these cases, the smallholders operate as independent farmers, even if they have better linkages with either side of the production/marketing loop.

Table 1: Descriptive statistics of survey respondents by type of contract

Variable	Formal	Cooperative	Trader	Independent
Demographic characteristics				
Age (years)	45.35	45.08	42.65	43.31
	(8.09)	(7.43)	(8.95)	(8.35)
Education (years)	11.65	10.31	9.19	9.27
	(2.17)	(1.79)	(1.81)	(1.71)
Proportion of time in pig-raising (%)	80.45	60.81	37.35	49.92
	(26.05)	(23.12)	(16.34)	(21.96)
Main occupation is pig-raising (dummy = 1 if yes)	82.35	84.38	44.74	59.5
Assets				
Area of land owned (m^2)	4522.77	2993.48	3121.79	2667.70
	(8607.44)	(3654.92)	(2791.97)	(1749.80)
Access to services				
Received government loan (dummy = 1 if yes) (%)	38.24	54.69	26.32	40.5
No. of visits by veterinarian	0.41	6.35	4.26	4.73
	(1.18)	(7.57)	(3.87)	(6.63)
Distance to VBARD (km)	3.38	4.46	6.02	3.72
	(2.66)	(4.09)	(3.37)	(2.79)
Distance to commercial supply (km)	3.06	4.90	2.09	1.60
	(3.01)	(10.35)	(3.75)	(2.57)
Distance to vet shops (km)	2.47	5.55	2.21	1.61
	(2.68)	(8.87)	(5.53)	(2.97)
Location				
Ha Tay (dummy = 1 if yes) (%)	73.53	16.41	10.53	25.00
Thai Binh (dummy = 1 if yes) (%)	0	34.38	15.79	25.00
Thanh Hoa (dummy = 1 if yes) (%)	0	35.16	13.16	25.00
Bac Giang (dummy = 1 if yes) (%)	26.47	14.05	60.52	25.00
Sample size	34	128	38	200

Standard deviation in parentheses
VBARD: Vietnam Bank for Agriculture and Rural Development
Source: ILRI-HAU-IFPRI-FAO survey (2006)

Table 2: Estimated coefficients of the multinomial logit model

	Formal	Cooperative	Trader
Demographic characteristics			
Age	0.133* (0.069)	0.059** (0.019)	0.0004 (0.026)
Education	1.410*** (0.480)	0.363*** (0.083)	0.126 (0.129)
Proportion of time in pig-raising	0.123*** (0.040)	0.009 (0.008)	-0.024* (0.013)
Main occupation is pig-raising	-2.484 (1.765)	0.908** (0.393)	0.169 (0.557)
Assets			
Area of land owned	0.0007** (0.0003)	-0.00005 (0.00009)	0.00002 (0.00001)
Access to services			
Received government loan (dummy = 1 if yes)	-1.220 (1.228)	0.374 (0.288)	-0.478 (0.539)
Number of visits by a veterinarian	-0.957 (0.680)	0.003 (0.019)	0.012 (0.043)
Distance to VBARD	-0.405 (0.273)	0.023 (0.050)	0.204** (0.069)
Distance to commercial supply	0.163 (0.118)	0.066 (0.044)	0.089 (0.059)
Distance to veterinary shops	0.066 (0.150)	0.077** (0.036)	-0.012 (0.082)
Location			
Ha Tay (dummy = 1 if yes)	-3.358** (1.701)	-0.749 (0.518)	-1.807** (0.782)
Thai Binh (dummy = 1 if yes)	-35.846 (1.03e+07)	-0.124 (0.468)	-2.033** (0.718)
Thanh Hoa (dummy = 1 if yes)	-36.846 (1.03e+07)	0.280 (0.482)	-1.246* (0.697)
Constant	-27.004*** (7.937)	-8.205*** (1.466)	-2.101 (1.827)

Independent status is the base outcome
Number of observations: 340
LR chi^2 (39): 229.58
Probability > chi^2: 0.0000
Log likelihood: -247.71046
Pseudo R^2: 0.3167
VBARD: Vietnam Bank for Agriculture and Rural Development

Table 3: Estimated marginal effects under each type of contractual arrangement

Variable	Formal	Cooperative	Trader	Independent
Demographic characteristics				
Age	6.89e-14 (0.000)	0.0136*** (0.004)	-0.001 (0.001)	-0.0125** (0.004)
Education	7.87e-13 (0.000)	0.081*** (0.019)	-0.0006 (0.006)	-0.080*** (0.019)
Proportion of time in pig-raising	7.47e-14 (0.000)	0.002 (0.002)	-0.001** (0.0006)	-0.001 (0.002)
Main occupation is pig-raising	-3.84e-12 (0.00003)	0.192** (0.076)	-0.007 (0.029)	-0.185** (0.077)
Assets				
Area of land owned	4.47e-16 (0.000)	-0.00001 (0.00002)	1.90e-06 (0.00001)	0.00001 (0.00002)
Access to services				
Received government loan (dummy = 1 if yes)	-8.25e-13 (0.000)	0.095 (0.065)	-0.031 (0.027)	-0.064 (0.066)
No. of vet visits	-5.93e-13 (0.000)	0.0006 (0.004)	0.0006 (0.002)	-0.001 (0.004)
Distance to VBARD	-2.62e-13 (0.000)	0.001 (0.011)	0.010** (0.004)	-0.011 (0.011)
Distance to commercial supply	8.32e-14 (0.000)	0.013 (0.009)	0.003 (0.003)	-0.017 (0.010)
Distance to veterinary shops	2.43e-14 (0.000)	0.018 (0.008)	-0.002 (0.004)	-0.016* (0.009)
Location				
Ha Tay (dummy = 1 if yes)	-1.15e-12 (0.00001)	-0.137 (0.102)	-0.058** (0.025)	0.195* (0.102)
Thai Binh (dummy = 1 if yes)	-6.31e-09 (0.0167)	0.00002 (0.105)	-0.074** (0.026)	0.074 (0.105)
Thanh Hoa (dummy = 1 if yes)	-1.77e-08 (0.047)	0.085 (0.112)	-0.056** (0.028)	-0.029 (0.111)

Note: VBARD stands for Vietnam Bank for Agriculture and Rural Development

Table 4: Estimated coefficients and marginal effects of the probit model

Variable	Coefficient	Marginal effect
Demographic characteristics		
Gender (dummy = 1 if male)	0.183 (0.216)	0.071 (0.083)
Age	0122 (0.011)	0.005 (0.004)
Education	0.205*** (0.054)	0.080*** (0.021)
Main occupation is pig-raising	0.561** (0.233)	0.213** (0.084)
Proportion of time spent in pig production	-0.006 (0.005)	-0.002 (0.002)
Assets		
Area of agricultural land owned	-9.23e-06 (0.00005)	-3.62e-06 (0.00002)
Production system		
Grow-to-finish (dummy = 1 if yes)	-1.910*** (0.396)	-0.511*** (0.059)
Piglet prod & fattening combined (dummy = 1 if yes)	-1.153*** (0.315)	-0.436*** (0.106)
Total weight sold	1.50e-06 (4.96e-06)	5.90e-07 (1.94e-06)
Social capital		
Member of cooperative (dummy = 1 if yes)	2.085 *** (0.254)	0.692*** (0.058)
Access to services		
Received government loan (dummy = 1 if yes)	0.2952574 (0.193)	0.116 (0.075)
No. of veterinarian visits	-0.015 (0.013)	-0.006 (0.005)
Distance to VBARD	0.084** (0.035)	0.033** (0.014)
Distance to commercial supply	0.101** (0.039)	0.040** (0.015)
Distance to vet shops	0.024 (0.026)	0.009 (0.010)
Location		
Ha Tay (dummy = 1 if yes)	-1.278*** (0.339)	-0.420*** (0.080)
Thai Binh (dummy = 1 if yes)	-1.404*** (0.320)	-0.466*** (0.078)
Thanh Hoa (dummy = 1 if yes)	-1.013*** (0.314)	-0.360*** (0.094)
Constant	-2.702*** (0.799)	

Number of observations: 319
Wald chi^2 (18): 110.38
Probability > chi^2: 0.0000
Log pseudo likelihood: -128.76929
Pseudo R^2:0.4146
Proportion correctly predicted of informal contracts: 82%
VBARD: Vietnam Bank for Agriculture and Rural Development

Table 5: Returns to labor ('000VND) per kilogram of output by production system and by contractual arrangement.

Production system	Crossbreed			Exotic breed		
	Type of contract arrangement					
	Informal-cooperative	Informal-trader	Independent producer	Informal-cooperative	Informal-trader	Independent producer
Farrow to wean	1.96	4.44	1.48	7.6		9.92
Farrow to finish	3.8	1.82	2.1	4.55	2.74	3.36
Grow to finish	3.69	0.78	-3.25	-4.48		
Combination	1.14	2.52	-1.2	3.75	4.79	-0.88