Governance Strategies and Welfare Effects: Vertical Integration and Contracts in the Catfish Sector in Vietnam

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Abstract
Using an original dataset from the Vietnamese catfish sector, we study the impact of vertical coordination options on household welfare and the implications of different stages of vertical coordination for the success of the whole sector. The welfare gain from contract farming and employment on processor-owned estate farms is estimated using a maximum simulated likelihood estimator. Our results show positive welfare effects from participating in contract farming, but not from employment on processor-owned estate farms. The results imply that contract farming presents opportunities for economic growth, but additional effort is required to make the contracts more accessible to smallholders.
Key words: vertical coordination, catfish, maximum simulated likelihood, agri-food transformation, Vietnam

1. Introduction

Farmers from developing countries are connected to consumers in global markets through a series of arrangements that range from spot market transactions over contracts to full vertical integration of ownership of all transaction stages. The effects of these different arrangements – or modes of vertical coordination – on the participants of the modern agro-food sector are highly debated. While one group of studies points to severe consequences of the exclusion of smallholders from global markets (Reardon, Barrett, Berdegué, & Swinnen, 2009) raising income inequality with the proliferation of contract farming schemes (Little & Watts, 1994), another group of studies argues that rural areas can benefit from participation in global trade because of (i) positive effects of participation in export on farmers' productivity (Minten, Randrianarison, & Swinnen, 2009), (ii) employment opportunities (Maertens & Swinnen, 2009) and (iii) access to technology, inputs and investment (Gow & Swinnen, 1998). Many of these benefits are, however, available mainly to vertically integrated farms (Dries & Swinnen, 2004).

Taking the case of striped catfish[1] farmers in Vietnam, this paper investigates welfare effects of different vertical coordination options, namely contract farming and full vertical integration of catfish farms by processing companies. Catfish is a farmed freshwater fish that is marketed under several other names: pangasius, swai, basa, river cobbler or iridescent shark. The catfish export chain is a relevant case for a study of vertical coordination outcomes for several reasons. With substantial markets in more than 100 countries worldwide, total production of over 1 million metric tons and an export turnover of more than USD 1 billion, the Vietnamese catfish has become a major global industry over the past decade (Phuong & Oanh, 2010). The increase in export volumes was followed by changes in sector organisation and governance structure. Bosma et al. (2011) report a growing trend for vertical integration of farms by processing companies in the sector. It is not known how these changes affect participants, as the sector has scarcely been studied until recently, when several studies investigated the

[1] Termed catfish in the rest of the paper.

broader political-economic setting in which the industry has developed (Belton, Little, & Sinh, 2011; Loc, Bush, Sinh, & Khiem, 2010).

This paper assesses the welfare effects of different vertical coordination options in the catfish sector. In particular, it compares the outcomes from farming catfish as either non-integrated, contract or estate farmer. The aim is to answer several questions: Who benefits from vertical coordination in the sector? What is the best governance option for the average farmer? What is the best governance option for the whole sector? Understanding the incentives and outcomes of participation in different institutional arrangements may lead to better arrangements for production of high-value export commodities and improved smallholder welfare in developing countries.

The analysis is based on an original dataset from the Vietnamese catfish sector and qualitative interviews with key actors from the sector. The paper contributes in three ways to the literature on the consequences of transformation of agri-food sectors, where contract farming and vertical integration are recurrent themes.

First, I simultaneously compare the effect of two vertical coordination forms on farmers' welfare. The impact of contract farming on smallholders' livelihoods has received sizeable attention (see Bellemare, 2012; Miyata, Minot, & Hu, 2009; Warning & Key, 2002), but only Maertens and Swinnen (2009) compare the effect of contract farming and employment on industrial farms with non-participation. They estimate the effects of contract farming and employment, respectively, using propensity score matching, thereby assuming that conditioning on observable variables is sufficient for determining the causal effect of vertical coordination on household welfare. As processing companies may choose employees on the estate farms and contract farmers based on unobservable characteristics, such as effort or managerial abilities, I use an instrumental variable approach. Specifically, I estimate the impact of contract farming and estate employment using the maximum simulated likelihood estimator developed by Deb and Trivedi (2006). Second, unlike studies that compare producers in the export sector with producers that exclusively sell in the domestic market (for example, Maertens & Swinnen, 2009), I estimate the welfare outcomes for three groups of farmers that all participate in the catfish export sector based on the chosen governance structure. Third, I use a combination of quantitative and qualitative methods to understand and explain individual and contextual drivers of vertical coordination, and to elicit the functional relationship between farmers' welfare and vertical coordination.

The results show that the gain from participating in intensive export sectors depends on the governance structure. Although belonging to a high-value export sector is not conditioned by contracts, the results show that producing under contract has a positive effect on consumption expenditure when evaluated against the situation of non-integrated farmers. Conversely, there is no difference in welfare between estate farm employees and non-integrated farms. Thus, the results imply that traditionally vulnerable groups – such as landless wage labourers who work on estate farms – are not left behind in the process of rapid transformation of rural economies with the arrival of high-value export sectors because they can look for employment on estate farms and thereby achieve the same level of wellbeing as the non-integrated farmers.

2. Study area and data

The analysis is based on the data obtained through qualitative interviews and farmer survey. The data collection took place from April to June 2011 in Mekong River Delta, Vietnam. Qualitative interviews included 52 interviewees with specialised knowledge about the sector, while the survey

comprised 276 catfish farmers. The questions in the questionnaire referred to respondents' situation in 2010. Apart from basic household and demographic information, the survey data contains information on asset ownership, marketing choices, infrastructure, expenditure and consumption. The consumption expenditure module was aligned to the Vietnam Household Living Standard Survey (GSO, 2011), which is a Living Standard Measurement Surveys questionnaire type used for assessing poverty and wellbeing in Vietnam.

3. Estimation Strategy

The aim is to estimate the (causal) impact of vertical coordination, I_i, on household welfare, Y_i, recognising that the vertical coordination outcome is not independent of household's socio-economic status and other characteristics. I start by identifying farmer characteristics that result in different vertical coordination options. The observed alternatives are non-integration ($j = 0$), vertical integration, that is, estate farming ($j = 1$) and contract farming ($j = 2$). Non-integrated farmers sell on the spot market. Estate farmers are employees on processor-owned farms, which are considered fully vertically integrated as a company's share in ownership exceeds 50 per cent. Estate farms initially emerged as a processors' response to weak quality assurance capabilities of farmers, but after the crisis in 2009, the key incentive for the integration became reducing uncertainty through stable fish supply. Contract farmers have either outgrower or marketing contracts with some of the processing companies. The outgrower contracts imply that a processing company supplies inputs (such as fry, fingerlings, feed and medicines) to the farmer, while the farmer delivers specified quantity of the fish of exportable quality. The production process follows the prescribed hygiene rules and ensures low mortality rates of fry and fingerlings. Marketing contract only stipulates quantities and price, with the price being conditioned on the quality test performed right before the purchase. This contract type is found in 83 per cent of contract farms in the sample. The weak contract enforcement makes the ties between processors and farmers much more flexible in case of marketing contracts than in the case of outgrower schemes.

Table A1 in the Appendix gives the basic descriptive statistics of the sample that comprises 85 estate, 88 contract and 103 non-integrated farmers. These farm categories are mutually exclusive, that is, a farmer can belong to only one of three groups, because the decision to contract with a processing company or to work on estate farms reflects a commitment that is not partial. Unlike in high-value export sectors in other countries where farmers allocate only part of their land and labour to export activities while continuing to be independent smallholders (see Maertens & Swinnen, 2009), the catfish farmers dedicate all of the production area to contract farming or become full-time employees on estate farms.

The selection of the vertical coordination form and the resulting outcomes for the farmers are driven by transaction costs, perceptions of the alternatives and, in the context of weak contract-enforcing environment, by trustworthiness, reliability or reputation. These are typically unobserved by the researcher, while processors are more likely to possess such information, or some specific indicator of it. To achieve an unbiased estimate, I use the maximum simulated likelihood (MSL) estimator proposed by Deb and Trivedi (2006).

I compare the outcome for contract and estate farms with the outcome for non-integrated farmers, which I believe, constitute a good comparison group. As almost total catfish production is exported, all three groups of farmers sell in the same marketing channel but under different conditions. In this way, I obviate the problem of confounding the effect of vertical coordination with the effect of participation in two different marketing channels: selling in domestic market or for export.

The following model is estimated:

$$Y_i = \boldsymbol{\beta x}_i + \rho_1 I_{i1} + \rho_2 I_{i2} + \lambda_0 t_{i0} + \lambda_1 t_{i1} + \lambda_2 t_{i2} + \varepsilon_i, \qquad (1)$$

where Y_i is the per capita consumption expenditure for household *i* in the year 2010. The controls $\boldsymbol{x_i}$ include a range of household and farm characteristics as well as the variables for proximity to markets and services (described in Table A1 in the Appendix). Individual farmer and household characteristics (for example age, education, household size and composition) and ownership of assets (production and household assets) may affect the probability of vertical coordination. In the context of this study, it is expected that younger and better-educated farmers have greater chances of benefiting from contracts and employment on the estate farms, as found in previous studies (Barrett et al., 2012). While the experience with fish farming may be important for contracts, it is not crucial for the employment on the estate farms where processors look for specialised skills and higher education. Household characteristics, such as household size and composition are important determinants of the effects of vertical coordination. They measure the household labour endowment so the expected relationship with consumption is positive. The relationship can, however, be negative depending on the structure of expenditures (Deaton & Grosh, 1998). Farm resource endowments are potentially positively related with consumption expenditure and vertical coordination. Larger farms are probably more attractive to processors as they enable benefiting from economies of scale (Maertens and Swinnen, 2009). I control for the effects of household endowments through an asset index, which represents a stable measure of household welfare (Carter & Barrett, 2006). Farmers must have access to information about best farming practices, which they are likely to obtain from other farmers during local community meetings. Therefore, the expected relationship between consumption and attendance of community meetings is positive. Renting land for catfish production deters vertical coordination. As religious groups may be inclined to collaborate more closely (Bandiera & Rasul, 2006), I expect a positive relationship.

Processors may prefer to contract or establish farms in convenient locations, so I consider the possibility of a location bias. Thus, I look at the prevalence of vertical coordination at the village level where 23 per cent of the villages have only non-integrated farms; 26 per cent of the villages have at least one contract farm; 36 per cent of the villages have at least one estate farm and 15 per cent of the villages have both contract and estate farms. The location of farms with respect to the buyer may be decisive for vertical coordination as it is assumed that processors would prefer working with farms positioned closer to the processing facilities. To control for the influence of location, I use three variables: distance between the farm and the buyer, distance to the nearest health centre and average farmgate price at the village level. These variables enter the model exogenously as they primarily capture the potential exposure to information about different vertical coordination options. While living in a specific location may determine farmer's exposure to the information about vertical coordination, it may not affect how much the farmer will profit from it. I expect to find a negative relationship between consumption and distances from buyers and health centres, which would indicate overall remoteness from major markets, services and sources of information. I expect a positive relationship between the average price of catfish in the village and consumption as higher prices would positively translate into higher revenue and income available for consumption.

The coefficients ρ_1 and ρ_2 are the average effects of vertical coordination on per capita consumption. As the decision about vertical coordination is made with future welfare in mind, the decision to integrate is not exogenous. Assuming I_1 and I_2 are exogenous would result in inconsistent

estimates of ρ_1 and ρ_2. In equation (1), I denote the unobserved characteristics that influence both the coordination decision and welfare as t_{ij} and coefficients associated with unobservable characteristics as λ_j. Thus, conditional on both the observables in $\boldsymbol{x}_i$ and the unobservables in t_{ij}, the estimated partial effect of integration can be considered as the causal effect. The independently distributed random error is denoted as ε_i.

The estimation of the impact of vertical coordination on household welfare proceeds as in Deb and Trivedi (2006). When $\rho_1 > 0$, farms owned by processing companies (estate farms) have higher per capita consumption than non-integrated farms, on average, and when $\rho_2 > 0$, contract farms have higher per capita consumption than non-integrated farms, again on average. Apart from enabling us to compare effects of two forms of vertical coordination, the joint model allows direct interpretation of selection effects through factor loadings λ_1 and λ_2. If $\lambda_2 > 0$, the unobserved characteristics that induce a farmer to participate in contract farming are associated with a higher consumption. Because better-skilled farmers are expected to opt for contract farming, $\lambda_2 > 0$ is interpreted as evidence of favourable selection. Adverse selection is present if $\lambda_2 < 0$. Analogous interpretations apply to λ_1 with respect to estate farms.

Participation in contract farming has previously been instrumented using a randomly assigned hypothetical measure of farmers' willingness to pay for participation in contract farming (Bellemare, 2012), membership in a farmer group (Rao & Qaim, 2011), distance between respondent's farm and the farm of the village leader (Miyata et al., 2009), transaction costs related to the purchase of inputs (Roy & Thorat, 2008) and measures of respondent's trustworthiness (Warning & Key, 2002). I take a different route and use two instrumental variables that capture network and information effects to remedy endogeneity problems in the estimation.

The choice of instruments is based on the observation about the strong influence of social collateral and information on vertical coordination outcomes (Reardon et al., 2009). By this, I assume that the costs of search, selection, information, procurement and investment decrease with the proximity and the knowledge about primary production. I use two village-level indicator variables as instruments, because the occurrence of vertical coordination in a certain area might imply lower transaction costs for processors. Expecting to observe a positive relationship between the history of contracts in a certain village and subsequent occurrence of contracts, the first instrument is the number of years since the first contract in the village. In similar vein, the second instrument is the share of estate farms in a specific village, assuming that processors will have lower cost of establishing links with farmers in familiar localities. Both of the instruments help to partial out the bias caused by individual predispositions. Using the prevalence of different forms of vertical coordination in a particular area in previous years that can be considered exogenous with respect to individual-specific unobservable factors and household welfare enables us to decrease the endogeneity bias.

4. Results

4.1. Determinants of Vertical Coordination

In this section, I analyse which variables can inform on vertical coordination status of a farm. As Table 1 shows, the vertical coordination depends on several indicators of human, social and physical capital of catfish farmers. Columns (1) and (2) show results from the multinomial logistic regression; columns (3) and (4) show the first stage results from the 2SLS estimation with instrumental variables and columns (5) and (6) show the equivalent for the MSL model. The results of three models are fairly consistent in terms of the sign and significance of control variables.

Table 1. Determinants of vertical coordination

	(1)	(2)	(3)	(4)	(5)	(6)
Dependent variable	Estate	Contract	Estate	Contract	Estate	Contract
Estimator	Multinomial logit		2SLS first stage		MSL[a] first stage	
Aquaculture area size (log)	0.088	-0.019	0.037*	-0.015	0.532	0.040
	(0.080)	(0.033)	(0.021)	(0.019)	(0.454)	(0.233)
Household size (log)	-0.314**	0.137	-0.092**	0.066	-1.771**	0.347
	(0.137)	(0.102)	(0.040)	(0.057)	(0.737)	(0.618)
Age of the household head	-0.010*	0.008*	-0.004**	0.004	-0.046*	0.033
	(0.005)	(0.004)	(0.002)	(0.003)	(0.028)	(0.027)
Secondary education	-0.068	0.166**	-0.010	0.123**	-0.073	0.977**
	(0.148)	(0.083)	(0.045)	(0.049)	(0.850)	(0.394)
Share of children 15 and under	-0.030	0.270	-0.057	0.191	0.858	2.229
	(0.285)	(0.181)	(0.110)	(0.124)	(1.863)	(1.368)
Household labour	0.032*	-0.042	0.017**	-0.015*	0.111	-0.178
	(0.019)	(0.027)	(0.008)	(0.008)	(0.080)	(0.177)
Asset index	0.057	-0.009	0.015	-0.007	0.285	0.056
	(0.103)	(0.041)	(0.029)	(0.024)	(0.589)	(0.249)
Experience with catfish	-0.017	-0.012	-0.004	-0.011**	-0.124	-0.107**
	(0.015)	(0.009)	(0.003)	(0.005)	(0.082)	(0.052)
Community meetings	0.028	0.019	0.012*	0.012	0.236**	0.196**
	(0.023)	(0.014)	(0.007)	(0.008)	(0.107)	(0.080)
Religious	0.132	-0.171**	0.038	-0.073	0.493	-0.886**
	(0.117)	(0.078)	(0.037)	(0.047)	(0.766)	(0.450)
Renting land	0.053	-0.152*	0.004	-0.069	-0.010	-1.054
	(0.149)	(0.085)	(0.052)	(0.061)	(0.979)	(0.865)
Distance to buyer (log)	0.024	-0.010	0.004	-0.013	0.140	0.010
	(0.036)	(0.022)	(0.011)	(0.016)	(0.197)	(0.134)
Distance to nearest health centre (log)	-0.059	0.045	-0.024	0.027	-0.268	0.197
	(0.047)	(0.030)	(0.017)	(0.020)	(0.252)	(0.161)
Average village-level price	1.38e-06	8.33e-06	4.29e-07	4.94e-06	0.00002	0.00006*
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Share of estate farms in a village	0.015***	-0.004***	0.009***	-0.002***	0.088***	0.001
	(0.002)	(0.001)	(0.000)	(0.001)	(0.011)	(0.010)
Years since the first contract in the village	0.001	0.038***	0.005**	0.030***	0.092*	0.270***
	(0.009)	(0.009)	(0.002)	(0.006)	(0.054)	(0.054)
Constant			0.270***	-0.030	-1.037	-4.323**
			(0.100)	(0.139)	(1.544)	(1.701)
N	270	270	269	269	269	269
Pseudo R^2	0.549	0.549	0.717	0.367		
Kleibergen-Paap Wald F statistic			21.74	21.74		

Notes: Columns (1) and (2) show marginal effects. Significance levels: * p<0.10, ** p<0.05, *** p<0.01. Robust standard errors clustered at village level are in parentheses. Estimation results are probability-weighted. [a] MSL stands for maximum simulated likelihood treatment regression.

Column (3) in Table 1 shows a positive relationship between the aquaculture area size and the likelihood to be estate farmer. A positive relationship is also found for the multinomial logit estimation in column (1) and the MSL estimation in column (5), but the magnitude is not statistically significant. Estate farming is more likely for younger farmers with smaller households, whereby processors prefer investing in larger farms where they employ workers who still have not started their families. Possibly the inability of farmers to farm on their own – seen as the inability to secure sufficient amount of capital and support through a business network – leaves them with no other choice but to become employed by a processing company. This was corroborated in the qualitative interviews where several interviewees mentioned that they would gladly establish their own farm were it currently affordable. Just as contract farming, estate farming is more likely if the household head attends community meetings.

The probability to produce under contract increases if the household head has completed any form of secondary education. Experience with catfish production negatively affects the probability of contract farming, implying that processing companies possibly look for specific skills rather than experience in choosing contract farms. Contracts are more likely for farmers who attend community meetings and who are not religious. Farmers who observe higher village-level prices of catfish are more induced to contract.

The instruments significantly predict the vertical coordination outcomes. The statistical significance of the first instrument – the share of estate farms in a specific village – is high for the estate farm outcome and the sign is as expected: higher prevalence of estate farms in a specific village increases the likelihood of finding employment on estate farms. At the same time, higher incidence of estate farms decreases the likelihood of contract farming, shown in columns (2) and (4). The presence of estate farms for contract outcome is not significant in the MSL estimation in column (6). The second instrument – number of years since the first contract has been signed in the village – is statistically significant. The direction of influence is positive for both contract and estate farms. This finding means that the early adoption of contract farming in a specific village will increase the probability of contracting more farmers in the future, and it will also increase the probability of establishing estate farms. The F-statistic for a test of joint significance of the two used instruments is 21.74, precluding weak instrument concerns (Stock & Yogo, 2005)[2].

4.2. Welfare Effects of Different Vertical Coordination Forms

Panel (a) in Table 2 shows that consumption expenditure depends on the farm type. The relationship is seen applying the OLS, 2SLS and treatment MSL estimation. Using different estimators, I show a positive impact of contract farming on household welfare. The OLS regression shows that securing a contract with a processing company can potentially increase household welfare by 27 per cent. Controlling for the unobserved heterogeneity with 2SLS and MSL estimators, I obtain about four and three times higher impacts, respectively. The effect of contract farming in the 2SLS regression in column (2) is the highest at 112 per cent, surpassing the 90 per cent gain obtained in the MSL estimation. In contrast, the effect of estate farming is not significant even at the 10 per cent level of significance in any specification.

In Table 2 it is visible that farm size, age of the household head, labour endowments and asset ownership positively affect consumption expenditure. Likewise, being able to rent land secures higher welfare. Average village-level prices for catfish are positively correlated with consumption, but the size of the coefficient is too small to bear any economic significance. Also, there is a negative association between larger households and welfare.

The lower section of Table 2 shows the MSL estimates of the unobserved heterogeneity bias. Selection on unobservable characteristics appears to be important for both estate and contract farms. The sign of the latent factor λ_1 is positive and statistically different from zero, indicating a positive selection into estate farming based on the unobservable characteristics relative to that of a random farmer. The sign of the latent factor λ_2 is negative and significant at one per cent significance level, suggesting that unobserved characteristics, which increase the probability of belonging to contract farming group also lead to lower household welfare. This may imply that contracts are appealing to

[2] At 21.74, the F value is higher than critical values proposed by Stock and Yogo (2005). Stock-Yogo weak identification test critical values: 10% maximal IV size 7.03; 15% maximal IV size 4.58; 20% maximal IV size 3.95 and 25% maximal IV size 3.63.

somewhat poorer households with worse relationships with the industry. Conversely, the wealthier households may not need contracts as they can potentially rely on personal connections (unobservable) to secure sales. This explanation seems plausible as the importance of personal ties when choosing suppliers was emphasised in the qualitative interviews with industry representatives. Underscoring this observation, a recent study (Belton et al., 2011) points out the importance of social and political capital in the catfish sector in Vietnam. Describing the labour market in MRD, Akram-Lodhi et al. (2007 p. 168) state that 'labour is typically hired from family and social networks, in order to ease transaction costs'.

Table 2. The effect of vertical coordination on household welfare. Dependent variable is per capita consumption expenditure (log).

	(a) Full sample			(b) Reduced sample[a]		
	(1) OLS	(2) 2SLS	(3) MSL[b]	(4) OLS	(5) 2SLS	(6) MSL[b]
Estate farm	-0.003	-0.041	-0.023	0.038	0.038	0.010
	(0.189)	(0.277)	(0.192)	(0.218)	(0.265)	(0.231)
Contract farm	0.240*	0.753**	0.640***	0.255*	0.705**	0.500***
	(0.144)	(0.366)	(0.176)	(0.150)	(0.346)	(0.166)
Aquaculture area size (log)	0.186***	0.228***	0.214***	0.167**	0.202***	0.188***
	(0.062)	(0.062)	(0.058)	(0.074)	(0.070)	(0.071)
Household size (log)	-0.490***	-0.536***	-0.512***	-0.565***	-0.613***	-0.601***
	(0.155)	(0.149)	(0.146)	(0.157)	(0.151)	(0.155)
Age of the household head	0.016***	0.012**	0.013***	0.019***	0.016***	0.017***
	(0.005)	(0.005)	(0.005)	(0.005)	(0.006)	(0.005)
Secondary education	0.141	0.064	0.071	0.135	0.077	0.107
	(0.138)	(0.143)	(0.131)	(0.161)	(0.162)	(0.154)
Share of children 15 and under	0.570*	0.411	0.452	0.704*	0.595*	0.651*
	(0.331)	(0.305)	(0.311)	(0.370)	(0.360)	(0.359)
Household labour	0.050*	0.055**	0.053**	0.055	0.063	0.062
	(0.025)	(0.024)	(0.023)	(0.045)	(0.041)	(0.043)
Asset index	0.257***	0.250***	0.257***	0.238***	0.228***	0.231***
	(0.067)	(0.063)	(0.063)	(0.075)	(0.075)	(0.073)
Experience with catfish	0.011	0.012	0.012	0.022	0.020	0.020
	(0.011)	(0.012)	(0.011)	(0.019)	(0.018)	(0.018)
Community meetings	-0.033**	-0.039**	-0.037**	-0.035**	-0.040**	-0.037**
	(0.016)	(0.017)	(0.016)	(0.017)	(0.018)	(0.017)
Religious	0.143	0.153	0.140	0.108	0.116	0.107
	(0.145)	(0.136)	(0.137)	(0.155)	(0.145)	(0.148)
Renting land	0.634***	0.727***	0.705***	0.556***	0.650***	0.606***
	(0.201)	(0.195)	(0.200)	(0.156)	(0.169)	(0.161)
Distance to buyer (log)	-0.063	-0.055	-0.052	-0.068*	-0.062	-0.064
	(0.041)	(0.042)	(0.040)	(0.040)	(0.041)	(0.040)
Distance to nearest health centre (log)	-0.037	-0.063	-0.058	0.007	-0.015	-0.007
	(0.054)	(0.055)	(0.054)	(0.067)	(0.068)	(0.066)
Average village-level price	0.00002**	0.00002**	0.00002**	0.00002***	0.00002***	0.00002***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Constant	14.34***	14.48***	14.44***	14.08***	14.22***	14.19***
	(0.387)	(0.377)	(0.358)	(0.461)	(0.451)	(0.452)
N	269	269	269	217	217	217
R^2	0.343	0.306		0.350	0.320	
F	9.56	9.60		10.510	9.202	
λ_1 (estate farms)			0.237**			0.211
			(0.113)			(0.279)
λ_2 (contract farms)			-0.597***			-0.394***
			(0.140)			(0.110)

Notes: Per capita expenditure level is calculated using OECD adult equivalence scales. Robust standard errors clustered at village level are in parentheses. Estimation results are probability-weighted. Significance levels: * p<0.10, ** p<0.05, *** p<0.01. [a] The reduced sample is created by restricting the number of observations only to observations in the common support range. [b] MSL stands for maximum simulated likelihood treatment regression.

There may be a concern that the identified farm categories are not comparable, violating the common support assumption. In other words, composition effects and heterogeneous characteristics of the three groups may influence some of the findings. Contract farms have the highest spread of expenditure (Figure 1 in the Appendix), so it may be that the result, which measures the mean impact, is driven by a few observations with extreme expenditure levels and that these farmers do not have their counterparts in other two groups of farmers. To avert this concern, I calculate propensity scores (PS) – a conditional probability of receiving the treatment (Imbens & Wooldridge, 2009), based on the observed farmer characteristics. First, I compare non-integrated and contract farmers in the nearest neighbour matching estimation and then compare non-integrated and estate farmers using the same method. Based on the first PS estimation, I find that 10 farmers do not have counterparts in the comparison group (96% fall in the common support range) and in the second estimation I find the same for 44 farmers (84% in the common support). Thus, based on observable characteristics, 9 non-integrated farms would never be classified as contract farms and 37 could never be classified as estate farms.

In panel (b) of Table 2 it is shown that restricting the sample to observations within the common support range yields similar results about the impact of vertical coordination on farmers' welfare. Compared to the full sample, the magnitude of the effect is similar in the OLS and 2SLS estimations (columns (4) and (5)), while the magnitude in the MSL estimation is 25 percentage points lower (column (6)). All estimators on the reduced sample show significantly positive impact of contract farming on welfare. The size of the effect is slightly smaller than for the whole sample, implying that contracts lead to 65 to 102 per cent higher levels of consumption expenditure for participants. The combined results, thus, point to large gains from contract farming.

A significant positive impact of contract farming on consumption from this study is comparable to the impact of 50 per cent in Bellemare (2012), 32 per cent in Warning and Key (2002) and 39 per cent in Miyata et al. (2009). The results are different from the study on vertical coordination in Senegal (Maertens and Swinnen, 2009), which shows that both contract farming and employment on industrial farms increase household welfare. Although the results do not show significant welfare gains for employees on estate farms, I side with Maertens and Swinnen (2009) in concluding that contract farms have higher welfare levels than both non-integrated and estate farmers.

Finding no difference in welfare between employees on estate farms and non-integrated farmers is also an important result. The study shows that the emergence of intensive export sectors is not biased against landless workers who cannot afford to establish their own production. Bearing in mind that the estate farm employees are not landowners, observing that their livelihoods are not different from non-integrated farmers could mean that non-integrated farmers are the most vulnerable group in the sector.

5. Conclusion

Much has changed in Vietnam during the previous decade with the emergence of aquaculture export sectors in which various forms of vertical coordination are replacing spot market transactions. The development of the catfish sector has led to important changes in rural parts of MRD in terms of increased employment opportunities and improved livelihoods. The results show a significant welfare impact of contract farming after controlling for both observable and unobservable farmer characteristics, while the welfare impact of employment on estate farms is not significant.

Even though there are indications that contract farmers capture most of the gain, the result implies that vertical coordination does not preclude traditionally vulnerable farmer groups from participating in high-value export industries through employment. Since the employees on estate farms are not landowners, it is important to see that their livelihoods are not significantly different from non-integrated farmers. This result, thus, indicates that non-integrated farmers are possibly the most vulnerable participants of the catfish sector.

High transaction costs and information asymmetry, when coupled with a weak contract-enforcing environment, which is prominent in developing countries, give rise to vertical coordination of primary production and processing, and the sample has almost identical shares of contract and estate farms. However, the main type of contract employed is a marketing contract, which does not include transferring production or management skills from processors to farmers. Some effort should thus be invested in developing contract schemes that convey longer-term technology transfer opportunities.

Given that this study shows higher consumption expenditure, on average, for contract farmers, it follows that rural development initiatives could focus on expanding the activities of processing companies in terms of higher enrolment of farmers for contracting. To enable this, the crucial policy activity in the sector should be directed to creating an environment conducive to participation of non-integrated farmers in contract farming. Increased numbers of contract farmers in the Vietnamese context could be translated into rural poverty reduction. Caution with contract farming schemes should, however, be exercised, as much effort needs to go into the design of contracts that are equitable and inclusive of smallholders who would not be selected for contracting without a third-party intervention.

There are a few remarks about the results. First, contract farmers in this study are identified as having either marketing or production contracts, which could decrease the precision of the result and complicate the comparison of the result with other studies that mostly analyse outgrower contracts. Second, the dependent variable used in the estimation is consumption expenditure, which is not an ideal measure of farm household welfare (Foster & Rosenzweig, 1995). Ideally, farm profits should have been used had the dataset allowed. Third, the cross-section nature of the data has not allowed assessing the welfare effects over time, so that the unobservable characteristics and endogeneity could be controlled for in a more efficient and consistent manner. However, I hope that this study can serve as a point of departure for further work, especially in comparing the vertical coordination outcomes in the catfish sector with other aquaculture and agriculture sectors.

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Appendix

Table A1. Differences in farm characteristics for different vertical coordination options

Variables	Unit	Whole sample	Non-integrated farmers	Estate farmers	Contract farmers
Aquaculture area size in 2010	Hectare	2.63	1.79	4.51***	1.81
		(4.95)	(3.67)	(5.88)	(4.86)
Household size	Persons	3.74	3.98	3.14***	4.04
		(1.59)	(1.38)	(1.56)	(1.70)
Age of the household head	Years	42.38	45.08	36.44***	44.92
		(12.49)	(12.87)	(11.23)	(11.29)
Having secondary education (1/0)	Per cent	35.14	22.33	43.52***	42.05***
		(47.83)	(41.85)	(49.87)	(49.65)
Share of children 15 and under	Per cent	0.35	18.61	11.26***	20.73
		(0.46)	(0.21)	(0.18)	(0.22)
Household labour	Persons	2.11	2.32	2.04	1.93**
		(1.96)	(1.35)	(3.03)	(1.01)
Asset index	Index	0.01	0.07	-0.14	0.08
		(0.10)	(1.07)	(1.13)	(0.73)
Experience with catfish	Years	8.31	10.61	4.87***	8.98*
		(6.59)	(8.03)	(3.14)	(5.82)
Participation in community meetings	Frequency	2.64	2.29	2.38	3.29**
		(3.32)	(2.81)	(3.93)	(3.15)
Religious (1/0)	Per cent	66.67	77.67	56.47***	63.63**
		(47.23)	(41.85)	(49.87)	(48.38)
Renting land (1/0)	Per cent	19.20	14.56	36.47***	7.95*
		(39.46)	(35.45)	(48.42)	(27.21)
Distance to buyer	Kilometres	24.58	31.66	19.50***	21.21**
		(32.06)	(38.87)	(22.87)	(29.61)
Distance to nearest health centre	Kilometres	16.23	19.53	10.81*	17.59
		(38.72)	(44.58)	(29.29)	(39.21)
Average village-level price	VND/kg	12,404	10,696	13,951***	12,909**
		(7,946)	(7,874)	(7,229)	(8,390)
Monthly household expenditure	VND million	17.73	13.38	15.92	24.65*
		(51.25)	(1.73)	(2.99)	(9.09)
Monthly per capita expenditure	VND million	6.46	4.79	7.52**	7.42
		(14.31)	(0.63)	(1.31)	(2.29)
Number		276	103	85	88

Notes: Non-integrated farms are the farms that sell on the spot market, estate farms are processor-owned farms that are operated by hired labour and contract farmers are households producing catfish on contract with the processing companies. There is no overlap between categories: one household can belong to only one category. Significance levels: * p<0.10, ** p<0.05, *** p<0.01. Standard deviation is in parentheses. Expenditure values are expressed in Vietnamese Dong (VND) million. 1 USD ≈ 20,500 VND. Per capita expenditure level is calculated using OECD adult equivalence scales.