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The role of prices in stimulating Vietnamese rice economy

Vo Thanh Danh [1]

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[1] Vo Thanh Danh is lecturer at School of Economics and Business Administration, Cantho University – Cantho, Vietnam. The author will be grateful for comments sent to: vtdanh@ctu.edu.vn.

Abstract

The main objective of the study was to estimate the supply response of rice in Vietnam. The dynamic adaptive adjustment and rational expectations models were used to select an appropriate supply response model for rice under different price expectation hypotheses. Results showed that rice farmers were rational in forming the price expectations behavior, making supply decisions based on information available in the past. The rational expectations supply response model with the cobweb price expectation formation may be considered an appropriate econometric model among the supply response models tested. Results indicated that output supply and marketed surplus were positively responsive to price expectations. As to government programs, policy variables had positive effects on rice production. The institutional factor of the household responsibility system had no contribution to rice production improvement as expectation. As a result, other factors involving technological progress and market regulations should be regarded as potential tools to sustain rice production. The price expectations played an important role in decision making of rice farmers. An appropriate price policy becomes an alternative way to enhance rice production in the country.

Key words: Dynamic adaptive expectations, price expectations, rational expectations hypothesis, supply elasticity.

1. Introduction

Agriculture plays an important role in the economic development of any country, and Vietnam is no exception. Its most important crop, rice, comprises more than 85 percent of the total food crop. Rice is cultivated in both irrigated paddy and rain fed culture on 75 percent of cropped land. Rice is grown on more than half the agricultural land in the country and represents over 60 percent of the planted area. Almost 80 percent of the rural households grow rice and half of them produce a surplus for sale. The Vietnamese rice farmers are heavily commercialized (IFPRI, 1997). Paddy production is mostly for market selling. An IFPRI survey (1997) showed that 70 percent of all households in Vietnam grow rice, but that 60 percent are net buyers of rice. Having experienced the fast growth in the last two decades, the growth rate of rice production has been declining in recent years. Consequently, there is a need for the government to sustain support for rice production improvement through government programs. Information on how rice production will respond to economic and social factors is necessary to design government programs toward sustainable rice production in the future. This study primarily looks into government program and other market factors that can stimulate rice production in Vietnam.

2. Theoretical framework and analytical method

The supply behavior of agricultural products has received continuing interest in a large number of studies, including rice. Specifically, the issue of price responsiveness of farmers always dominates the literature. It was believed that farmers in less developed countries are neither price responsive nor neutral to other economic stimuli (Deshpande, 1996). This is attributed to the structural characteristics of underdeveloped agriculture. While farmers coped with the problem of limited marketing information, government programs in the rice sector encouraged farmers to increase rice volume to improve rice revenues. This led to the question of whether rice farmers are affected by the constraints of limited marketing information or they are able to form expectations in their supply decision reactions. The former hypothesis can be examined using the dynamic adaptive expectation supply response model, while the latter hypothesis can be tested with the rational expectations supply response model. In this study, because of the arguments in favor of less developed market, the first hypothesis, accompanied with a dynamic adaptive expectations supply response model, is deemed appropriate to address the constrained information issue in Vietnam.

There are five price expectations formation hypotheses - adaptive, cobweb, extrapolative, polynominal, and rational expectations. Then, the respective supply response models, which are the dynamic adaptive expectations supply response model and the rational expectations supply response models with the complete supply-demand system are formed in the study. In addition, the supply response model based on the supply-demand system with respect to the previous price reaction is also estimated so that the best among these supply response models will be chosen for the rice commodity in the country.

The presence of the autocorrelation problem in the autoregressive models raises some theoretical considerations for statistical estimation. The ordinary-least-square (OLS) technique cannot be used because it is not only biased but also inconsistent. Therefore, the appropriate estimation procedure is

to transform the original regression equation into other transformed regression equations in which the disturbances are not serially autocorrelated. Four methods were applied for the autoregressive models: OLS with serial autocorrelation correction, Prais-Winsten transformation with assumption of the structure of autocorrelation known, Cochrane-Orcutt transformation with assumption of the structure of autocorrelation unknown, and nonlinear least-square.

To choose the most appropriate model among the price expectations formation hypotheses, the price expectations formation model developed by Habibullah (1988) using all variables in the REH model and polynominal price expectation were used. In addition, the other three models used included cobweb, extrapolative, and polynominal models with OLS and non-linear least square estimation methods (NLS). The best predicted value of P_t^e among the five models was specified as actual values in estimating the model as a whole.

3. Policies affecting rice production

Institutional Policy

The agrarian reform program in Vietnam began in 1981, but implementation was effectively considered only in 1986 through Resolution no. 10 released by the Standing Committee of the Communist Party. The so-called household responsibility system was introduced, allowing farmers to have rights on their own land. This led to the reallocation of collective agricultural land and assets to farm households. From 1986 and in the later years, farmers can make production decisions and market their products as well, things they were not able to do during the centralized economy in 1975-1981. The analysis of the effect of this institutional change is necessary to understand the rice production development in the country before and after the reform policy.

Market Policy

Market incentives were the main sources of rice production increase in the country. Export liberalization and the depreciation of the Vietnamese currency in 1988-1992 strengthened the export market for rice surpluses and prevented farmgate prices from falling as production expanded. Market policies adopted in the reform period allowed farm households to exercise their own right on production processes to satisfy market demand rather than government requirements. In this period, government programs have the twin objectives of increasing rice production and price stabilization. Market reforms promoted marketing activities and improved the profitability of various marketing agents as witnessed by the surge in capital investment of the private sector in the early 1990s (IFPRI, 1996).

Price policy

Because of the importance of prices as a determinant in rice production improvement, understanding the price behavior is necessary for this study. Cointegration analysis was used to examine the existence of a stable, long-run relationship between prices in the domestic and world markets. Statistically, when a long-run linear relation exists among different series, these series are said to be cointegrated (Engle and Granger, 1987). Thus, the presence of cointegration between two series shows a long-run interdependent relationship. The absence of cointegration between two series

shows that there is no interdependent relationship. The cointegration equation between farmgate prices and world prices for the period 1975-2002 is represented as follows:

$$P = 7.408WP - 4075.88 \quad (1)$$

t-value (3.745)

where P: farmgate price (VND/kg)
WP: world price (USD/t) with Thailand 5% rice broken export price as a proxy.

Because the correlation coefficient WP is significantly different from 1, it indicates that, in the long run, there is no interdependence between domestic price and world price.

Export policy

Rice surpluses are mostly contributed by the Mekong River Delta and partly by the Red River Delta. The objective of the rice export policy is to guarantee the domestic demand and to export the remaining rice surplus after maintaining the national food security level. The annual average rice export during 1989-1995 was approximately 1.7 million tons, with a growth rate of 7 percent per year. The removal of export taxes and quotas contributed significantly to the improvement in export quantity. In 1989-2002, the exported rice quantity increased by 105,000 tons per year with an annual growth rate of 6 percent. Moreover, there was a significant difference in export quantity before and after the rice export promotion program. After removing taxes and quotas on rice export, the export quantity increased by 1.1 million tons compared with the period characterized by trade barriers.

4. Findings and discussions

Statistical description of modeled variables

Table 1 presents the statistical description of the variables introduced into the supply response models in this study. The time series related to the period 1975-2003. Because supply response models usually involve autocorrelation problems, the normality and serial correlation tests of the series are necessary to obtain information for econometric estimations. The information on rice prices was extremely important in the price expectation formation models. To test the normality of a time series, the Jarque-Bera (JB) test was used. To test the problem of serial correlation, the joint hypothesis test of Ljung-Box Q-statistic is chosen among alternative testing techniques.

Dynamic adaptive expectation supply response model

There are four methods applied for the dynamic adaptive expectations supply response models in this study: OLS with serial correction or OLS with AR(1), Prais-Winsten, Orchrane-Orcutt, and nonlinear least squares (NLS). Results showed that the price expectations formation hypothesis in the adaptive expectations supply response models did not behave well to explain farmers' reaction in making decisions related to rice production and cultivated rice area. Consequently, these models have no potential in providing the appropriate information for the interpretation of rice farmers' behavior, although the production adjustment process relatively made sense − that is, current rice production was significantly affected by previous production.

Table 1. Statistical description of variables used in the supply response models.

VARIABLE	UNIT	MEAN	STD. DEV.	SKEW-NESS	KUR-TOSIS	JB TEST	Q-TEST[a]
Farmgate price (P) [b]	VND/kg	1888	648	1.77	5.57	2.515 (0.000)	12.795 (0.000)
Per capita income (I) [c]	Million VND	1.39	0.31	0.39	1.86	2.2257 (0.329)	24.936 (0.000)
World price (WP) [d]	USD/t	285	66.5	0.58	3.49	1.8271 (0.401)	12.157 (0.000)
High-yielding varieties ratio (HY) [c]	Time	0.13	0.09	0.24	1.41	3.2208 (0.200)	24.943 (0.000)
Fertilizer use (Fz) [c]	kg/ha	138	76	0.17	1.80	1.7984 (0.407)	25.171 (0.000)
Spring season-to-total cropping ratio (CROP) [c]	Time	0.50	0.09	-0.00	1.72	1.9233 (0.382)	23.725 (0.000)
Irrigated area (IR) [e]	000 ha	2473	629	-0.70	1.82	3.9023 (0.142)	26.112 (0.000)
Export quantities (E) [c]	000 t	2622	1064	0.64	1.89	3.3514 (0.187)	24.936 (0.000)
Cultivated areas (A) [c]	000 ha	6216	818	0.49	1.91	2.5151 (0.284)	24.115 (0.000)
Production quantities (Q) [c]	000 t	19557	7414	0.41	1.80	2.4779 (0.290)	47.049 [f] (0.000)
Consumption Quantities (D) [c]	000 t	18338	5909	0.35	1.90	1.9717 (0.373)	25.142 (0.000)
National Reserve Quantities (G) [c]	000 t	6798	2441	0.37	2.11	1.2995 (0.522)	23.567 (0.000)

[a] application for first-difference level AR(1). [b] General Statistical Office (GSO) for 1975-1990 period; Vitranet cited by Duc Hai for 1991-2000 period; and GSO for 2001-2003. [c] GSO. [d] World price of rice was Thai 5% broken that was collected from IRRI database. [e] FAO database. [f] Application for second-difference level AR(2).
The P-values of all test statistics are given in parentheses.

Price expectations formation models

The fact that price expectations play an important role in the rational expectations models requires testing for the price expectations formation hypotheses before the price information is introduced into the model. There are five hypotheses on price expectations formed by rice farmers: cobweb, extrapolative, polynominal, constrained rational expectations, and combined rational expectations and polynominal models. Table 2 presents the estimation results of the five hypotheses of price expectations formation using three methods of estimation. Results showed that only the cobweb price model using the past price forcasting is suitable for rice price formulation in supply decisions of the farmers.

Rational expectations supply response models

Using the estimation of the rational expectations supply response models under different price expectations formation hypotheses, the result confirms the positive effect of the removal of export rice taxes and quotas on the increase of exported rice quantity. Meanwhile, the effect of world prices on the increase in export volume was not statistically supported in this model, even though the mixed estimated sign caused an ambiguous effect of this policy variable. The rice production quantity in the previous year has a highly significant effect on the volume of government reserve stock in the current year. The marginal value of this estimated coefficient was the same in both methods. This result also allows us to reject the assumption in the rational expectations formation that the information set at the time to form the expectations was available or known. This means that rice farmers formed their supply reactions with respect to past prices and had limited information at the time they formed the expectations. In the rational expectations supply response model using cobweb mechanisms, the signs of the estimators were consistent with the prediction − that is, the supply of rice was positively

responsive to irrigated area, adoption level of high-yielding varieties, fertilizer use, change in cropping ratio, and weather conditions.

Table 2. Results of the price expectations formation models using five methods.

VARIABLE	COBWEB MODEL			EXTRAPOLATIVE MODEL			POLYNOMINAL MODEL		
	OLS	OLS WITH AR(1)	NLS[a]	OLS	OLS WITH AR(1)	NLS[b]	OLS	OLS WITH AR(1)	NLS[c]
Constant	697.60 * (0.0256)	936.90 (0.310)	631.80 (0.138)	762.90* (0.035)	663.00* (0.020)	532.80 (0.309)	1046.20* (0.034)	1334.30 (0.624)	-96.60 (0.933)
P(-1)	0.643 * (0.000)	0.519 (0.274)	0.678 * (0.003)	0.609 * (0.002)	0.662 * (0.000)	0.731 * (0.009)	0.660 * (0.009)	0.494 (0.792)	0.411 (0.732)
P(-1)-P(-2)	-	-	-	0.096 (0.638)	0.453 (0.080)	0.369 (0.374)	-	-	-
P(-2)	-	-	-	-	-	-	0.039 (0.886)	0.109 (0.884)	0.845 (0.516)
P(-3)	-	-	-	-	-	-	-0.200 (0.467)	-0.175 (0.649)	-0.593 (0.606)
P(-4)	-	-	-	-	-	-	-0.027 (0.905)	-0.092 (0.848)	0.372 (0.646)
$\bar{R}^2$	0.412	0.375	0.393	0.375	0.357	0.219	0.308	0.246	-0.360
DW	1.87	2.02	1.93	2.03	2.02	2.82	2.02	2.02	1.68

VARIABLE	REH 1 MODEL[d]			REH 2 MODEL[e]		
	OLS	OLS WITH AR(1)	NLS[f]	OLS	OLS WITH AR(1)	NLS[g]
Constant	10906.80 * (0.0187	9704.40 * (0.0456)	38134.60 (0.3180)	13653.80 * (0.0019)	9077.70 * (0.0175)	17863.30 (0.3620)
I	0.00006 (0.9811)	0.00048 (0.8599)	-0.0152 (0.4819)	-	-	-
IR	0.00079 (0.3900)	0.00066 (0.5158)	0.00593 (0.5388)	0.00022 (0.8023)	0.00096 * (0.0470)	0.00036 (0.9699)
HY	-11598 * (0.0377)	-9247 (0.1280)	-22890 (0.4691)	-11041 * (0.0213)	-10583 * (0.0228)	-27719 (0.4917)
Fz	9.304 (0.3090)	8.868 (0.3031)	53.253 (0.5565)	7.900 (0.1456)	2.500 (0.5004)	-13.270 (0.8817)
CROP	3322.60 (0.7327)	2063.50 (0.8312)	-61209.10 (0.5291)	-978.30 (0.8854)	4634.30 (0.2582)	39123.90 (0.7770)
WP	-0.169 (0.7761)	-0.948 (0.7825)	25.325 (0.5160)	-	-	-
WP(-1)	0.758 (0.7659)	0.312 (0.9004)	3.599 (0.8777)	-	-	-
D96	-113.40 (0.8849)	-137.30 (0.8701)	-3079.80 (0.5538)	-	-	-
Q(-1)	-0.00004 (0.7634)	-0.00007 (0.5700)	0.00072 (0.5756)	-	-	-
P(-1)				0.0474 (0.8473)	0.6610 (0.1853)	-1.0756 (0.7557)
P(-2)				-0.1498 (0.5286)	-0.6181 (0.3274)	0.0035 (0.9960)
P(-3)				-0.1292 (0.5882)	0.0198 (0.9724)	0.7270 (0.7360)
P(-4)				-0.1596 (0.4569)	-0.1028 (0.7218)	-0.9391 (0.7180)
$\bar{R}^2$	0.392	0.365	-3.216	0.548	0.536	-1.825
DW	1.66	1.86	2.30	2.53	2.41	2.21

[a] Instrumental variables: C, Q, P(-2), WP, CROP, HY.
[b] Instrumental variables: P(-2), P(-2)-P(-3), Q, HY, WP, CROP.
[c] Instrumental variables: C, P(-5 TO -8), Q, WP, HY, CROP.
[d] derived from Rational Expectation Model.
[e] following Habibullah Model (1988).

[f] Instrumental Variables: C, P(-1), I(-1), IR(-1), HY(-1), FZ(-1), CROP(-1), W(-1), WP(-1), WP(-2), Q.
[g] Instrumental Variables: C, P(-5 TO -8), IR(-1), HY(-1), FZ(-1), CROP(-1), Q, WP.
*, ** = significant at 5% and 10%, respectively.
The P-values of all test statistics are given in parentheses.

In summary, the rational expectations supply response model with the different price expectations formation hypotheses was accepted, although the statistical estimation problems were distinguishable in the estimated values. The differences among estimated coefficients depended on which price expectations formation hypothesis was effective.

Derived demand and supply elasticities

Having the complete demand-supply system, their marginal values were used to calculate the elasticities, which were, in turn, used to derive the marketed surplus price elasticity and other policy considerations. Table 3 presents the calculated values of elasticities in the chosen demand-supply system.

Table 3. Elasticities of REH model using the cobweb price expectation formation hypothesis.

VARIABLES		COEFFICIENT	MEAN	ELASTICITY (e)
DEPENDENT	EXPLANATORY			
(1)	(2)	(3)	(4)	(5)=(3)*(5')[a]
D	-	-	18338397	
	P^e	1543.80	1947.543	$e_P^D = 0.16$
	I	1.8925	1391921	$e_I = 0.14$
G	-	-	6798382	
	Q(-1)	0.329	19121275	$e_G = 0.92$
Q	-	-	19556908	
	P^e	3530.35	1895.6	$e_P^S = 0.34$
	CROP	25812321	0.5	$e_{CROP} = 0.66$
	HY	45585270	1.146186	$e_{HY} = 2.67$
	Fz	35671.21	138.2679	$e_{Fz} = 0.25$

[a] (5') = independent variable mean divided by dependent variable mean.

In this model, the elasticity of high-yielding varieties with respect to rice quantity was elastic with a value of 2.67. It shows that the application of modern rice varieties has a large effect on increasing rice production in the country. For the government reserve inventory, its elasticity was mostly unitary. For instance, an increase in rice production by 1 percent in the previous year would allow the government to build up its inventory at the same rate of rice production in the current year. Another important policy variable, CROP, showed a potential effect on increasing rice production. If the cropping rotation ratio improves, rice production can be further developed in the future. Although the contribution was small, the increase in fertilizer application would also help raise rice production. The results allow us to be more confident that, except for the estimation problem on prices, other estimates in the REH model are consistent with that of the cobweb demand-supply model. Table 4 summarizes the derived elasticities and their differences in the three supply response models. It can be said that the deviation between the base cobweb model and the REH model using the extrapolative price expectations formation hypothesis was small, while that of the REH model using cobweb price expectations formation hypothesis was relatively large.

Upon comparison of the results over time and across studies, the derived elasticities in this model were mostly consistent with those obtained by other studies relating rice commodity behavior. Table 5 presents a comparison of derived elasticities in the estimated supply response function. It is noted that the price responses in this model followed a different pattern by the hypothesis of rational expectations − that is, the price elasticity of demand was positive, reflecting the fact that rice consumers behaved as speculators in the context of rational expectations hypothesis.

Table 4. Comparison of derived elasticities in the different supply response models.

ELASTICITIES	COBWEB MODEL	REH MODELS WITH PRICE EXPECTATION FORMATION OF		ABSOLUTE DIFFERENCES BETWEEN	
		COBWEB	EXTRA-POLATIVE	(2) & (3)	(2) & (4)
(1)	(2)	(3)	(4)	(5)	(6)
Price elasticity with respect to consumption (e_P^D)	-0.012	0.16	0.15	0.17	0.16
Income elasticity (e_I)	0.139	0.144	0.145	0.005	0.006
National reserve stock with respect to production (e_G)	0.92	0.92	0.92	-	-
Price elasticity with respect to rice production (e_P^S)	0.10	0.34	0.15	0.24	0.05
Cropping rotation ratio with respect to production (e_{CROP})	0.78	0.66	0.70	0.12	0.08
Modern varieties ratio with respect to production (e_{HY})	1.82	2.67	1.87	0.85	0.03
Fertilizer use with respect to production (e_{Fz})	0.30	0.25	0.34	0.05	0.04

Table 5. Comparison of derived elasticities of supply response function, Vietnam, 2003.

ELASTICITY	VALUES DERIVED		
	ESTIMATION 1[a]	ESTIMATION 2[b]	ESTIMATION 3[c]
Price elasticity with respect to demand	-0.012 to 0.16	-	-0.01 to 0.43
Price elasticity with respect to supply	0.10 to 0.34	0.22	0.20 to 0.40
Income elasticity	0.139 to 0.145	-	-0.01 to 0.43

[a] Derived from this study. Its deviations are due to different estimation methods.
[b] Khiem and Pingali (1995). The study used data over the 1976-1992 period.
[c] IFPRI (1996) under the VASEM model.

5. Summary and conclusions

Conclusion

Rice production in Vietnam has considerably improved since the country moved toward a free market economy. The main objective of this study was to estimate the supply response of rice. Two supply response models were used in this study: the dynamic adaptive expectations and the rational expectations supply response models. Besides technological, institutional, and market factors, the price expectations formation hypotheses were considered a main component to construct these supply response models. On the marketed surplus model, the home consumption function and marketable sale function were involved in constructing the price response of marketable surplus. The determinants of the marketed surplus equation were derived from the supply response models and published data as well.

In the adaptive expectations supply response model, besides the introduction of the production adjustment process, the price expectations formation hypothesis allowed farmers to learn from their

mistakes through adaptive expectations in the light of past experience. Then, autoregressive error correction methods were used to estimate this Nerlovian-type model. However, the partial dynamic expectations model was statistically accepted with the long-run acreage response function, although the adaptive price expectations formation hypothesis was still significantly rejected.

Regarding the rational expectations supply response model, the price expectations formation hypotheses were developed using cobweb, extrapolative, polynominal, and rational expectations on prices. Based on the statistical significance criteria of these price formation models, the cobweb and extrapolative price formation processes were chosen as appropriate price predictions in the rational expectations supply response model. The test for rationality of price prediction was applied in these two price prediction models. The results showed that rice farmers were rational in forming the price expectations. Among the supply response models relating the price expectations formation hypotheses, the rational expectations supply response model with the cobweb price prediction process could be applied to estimate the supply response of rice in Vietnam. The results showed that rice farmers formed their supply reactions with respect to past prices and had limited information at the time they formed the expectations.

Recommendations

The following measures are suggested:

In finding an appropriate econometric model of supply response for rice, the acreage response function is recommended to be used rather than a supply response function. In a developing country such as Vietnam, production could be a function of land, labor, and natural resources rather than a function of cash input and policy stimuli.

Because the institutional factor of household responsibility system cannot sustain rice production in the agrarian reform period, other factors involved with technological progress and market regulations should be considered as potential sources to increase rice production in the country.

Because of the positive effects of irrigation investment, adoption of high-yielding varieties, crop shifting, and fertilizer use on rice production, government programs involving these factors should be enhanced.

Enhancing the marketing information system enables farmers to obtain qualified information in forming supply reaction decisions. Through farming extension organizations, a qualified information system including technological and market information needs to be built in order that farmers can access the necessary information in making production and market decisions.

Price policies are potential tools to stimulate rice supply if institutional and other market policies fail to enhance rice production. The fact that price elasticity of supply and marketed surplus price elasticity were relatively large is a strong argument toward considering the price factor as an important component in forming the agrarian reform policy.

The fact that the domestic rice market is isolated from the world rice market in the analysis requires the institution of policy reforms in changing the market structure of rice. That is, domestic price should reflect the world price.

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