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Understanding the impact of environmental uncertainty on efficiency performance indicator of Thai rice millers

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Keywords
millers, environmental, uncertainty, efficiency, performance, indicator, understanding, thai, impact, rice

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Introduction

Many firms are attempting to have sustainable efficiency to maintain a long-term competitive advantage (Porter, 1985). To succeed that, environmental uncertainty is investigated to understand its effect on firms' performance in order to manage them properly. The number of studies has addressed the effect of environmental uncertainty on performance indicators of individual firm and a supply chain. Uncertain factors along a supply chain refer to supply, demand, process uncertainty (Davis, 1993; Ettlie and Reza, 1992), control and planning uncertainty (Childerhouse and Towill, 2004), competitor uncertainty (Ettlie and Reza, 1992) transportation uncertainty (Wilson, 2007) which negatively impact on supply chain performance (Bhatnagar and Sohal, 2005; Davis, 1993; Paulraj and Chen, 2007) and force firms to implement supply chain management strategies (Paulraj and Chen, 2007). On the other hand, customer, supplier, competitor, and technology uncertainty do not impact on supply chain management practices (Li, 2002). Thus, the main objective of this research is to examine environmental uncertainty affecting on efficiency of rice millers that is one member of rice supply chain in Thailand. In other words, the research question of this study is “in the rice millers in Thailand, what are the key uncertain factors having greatest pessimistic impact on their efficiency performance indicator?”

Thai Rice Millers

A rice miller is one member of rice supply chain in Thailand as shown in Figure 1. After harvesting paddy rice in wet season, the purchase of paddy rice can be directly between farmers and rice millers, or indirectly between Thai government and farmers noted as rice pawning with guarantee rice price from the government. Some paddy rice from farmers who crop rice for their own consumption is milled by small or local rice mills (capacity of 1-12 tons / 24 hour). Meanwhile, some paddy rice from a medium-large size of rice farm is milled by medium (capacity of 30-60 tons / 24 hour) and large mills (capacity of 100 tons / 24 hour), and can be packed for domestic demand and international demand. (Thai Rice Foundation under Royal Patronage, 2006). Rice millers in Thailand are very important organisations to process paddy rice to be rice because rice is a key agricultural product of Thailand for the
reason that rice farms make up over 50 percent of farm land use in Thailand, and rice farmers is around 56% of Thai population (Krasachat, 2004), and Thailand is the main rice exporter in the world rice market (David, 1992). In addition, the majority of rice inventory is owned by rice mill firms.

Conceptual Development and Hypotheses

Environmental Uncertainty

Uncertainty circle concept in industry is divided into four sides: demand, supply, control and process that reduce firm's performance (Childerhouse and Towill, 2004). Similarly, three main sources of variability of supply chain are supplier performance, manufacturing process, and customer demand which force supply chain members to hold safety stock that reduce supply chain performance as well (Bhatnagar and Sohal, 2005; Davis, 1993). Based on modelling simulation approach, uncertain transportation in the case of disruptions may create fluctuated inventory level that also can lead to reduce supply chain performance (Wilson, 2007). In contrast, with empirical approach, supply, demand, competitor, and technology uncertainty are not significantly related to strategic supply chain management practices (Li, 2002) and might not be linked to their performance. The sources of uncertainty of agri-food business can be “perish ability of products, variable harvest and production yields and the huge impact of weather conditions on customer demand” (Jack G. A. J. van der Vorst and Beulens, 2002, p.415). However, uncertain factors in agri-business are not different from previous studies. Supply, demand and distribution, process, and planning and control uncertainties lead to poor agri-food supply chain performance by influencing firms to contain non-value-adding activities such as safety buffers in time, capacity and inventory in food industry (J. G. A. J. van der Vorst, 2000). Consequently, it should be investigated whether supply, demand, process, planning and control, and competitors' action uncertainty affect on Thai rice miller performance.

Government regulation can provide both risks and benefits to business in many ways. For instance, the changes in government policy in Philippine agri-industry leading to uncertain rice of copra injure economic performance of copra market (Mendoza and Farris, 1992). Government policy has played an important role in Thai agricultural production as well because agricultural products are very crucial in Thailand. The main reason is that almost 80% of Thai are involved agricultural activities in rural area (IRRI, 2007). Thai government intervene agricultural production in many views such as export rice tax (Roumasset and Setbooonsarrng, 1988) and reducing rice capacity (Yao, 1999). For example, during 1993-1996 Thai government had a policy to reduce rice production capacity and increase legume production capacity. However, this policy could not bring benefits to farmers as the government expected (Yao, 1997, 1999). The main law that is involved paddy rice trade in Thailand is paddy rice pawn laws that the government guarantee the standard price of paddy rice by purchasing paddy from farmers at standard price that is set annually and unpredictable (Department of Internal Trade, 2008). Indeed, government policies of developing countries
are turbulent and unpredictable (Badri, Davis, and Davis, 2000). Therefore, it is very important to investigate that the uncertain government policy might significantly impinge on performance of rice millers in Thailand.

In term of climate uncertainty, by 2100, several international climate models predict that there will be an increase in incidences of floods in Thailand (3-6 times in a period of 100 years as opposed to 1 in 100 years previously seen) (Yoshida, 1981) that can reduce productivity of Thai rice production. According to historical data, there are evidences that in Thailand, drought or/and flood could damage cultivated rice area considerably. In 1919, for example, the total failed rice area was 43.4% of cultivated rice area caused by drought, and in 1942, 34.3% of cultivated rice area was failed owing to flood (Yoshida, 1981). Since water resources, rainfall and flooding on Thailand and Laos are predicted that receive the effects of climate change, the rice yield might drop by 20 percent in 2040 in many provinces such as Thung Kula field, Chiang Rai, Sakon Na Khon, Sa Kaew and Khon Kaew in Thailand (Sukin, 2004). These prior studies strongly support that climate factors significantly affect to rice production in Thailand. Thus, climate uncertainty will be considered as the uncertain factor in performance of rice supply chain for Thai context.

Efficiency Performance Indicators

Performance measurement of agri-food supply chain should concern on quality of product and process in specific terms of freshness (L. Aramyan et al., 2006) which is distinguishing from general product. The four categories of performance indicators of agri-food supply chain are (i) Efficiency (ii) Flexibility (iii) Responsiveness (iv) Food quality (L. Aramyan et al., 2006; L. H. Aramyan et al., 2007; Luning, Marcelis, and Jongen, 2002). Efficiency of agribusiness is measured by transaction cost metrics and product realization cycle metrics, profitability requiring accurate financial information, distribution of return reflected in quality and chain responsiveness measured in order fill rate, on time delivery etc. and dealt with total information transparency (Wysocki, Peterson, and Harsh, 2006). However, efficiency performance indicators of L. Aramyan et al. (2006) refer to cost of production, distribution, transaction, profit, return in investment and inventory. According to the prior study in agri-food performance measurement and characteristics of rice millers in Thailand, the price of Thai rice can not be too high compared with rice price from their competitors such as Vietnam and Philippine. Thus, efficiency is one main important performance indicators for rice millers in Thailand. According to the study of performance measurement in agri-food supply chains under a case study approach, costs, profit, return in investment, and inventory are proposed (L. Aramyan et al., 2006). Therefore, all seven uncertain factors are hypothesised to be negatively related to efficiency of Thai rice millers as presented in Figure 2.
Methodology and Results

Survey Instrument Development

The instrument employed to test the hypotheses was a postage questionnaire in Thai language to rice millers. A 7-point Likert scale with end points of ‘strongly disagree’ and ‘strongly agree’ was applied to measure variables. Pilot testing of ten managers of rice millers lead the questionnaire to easily be completed, comprehensible, and unambiguous for the respondents’ range of knowledge and responsibility as well as establishing content validity (Flynn et al., 1990). The number of the Kaiser-Meyer-Olkin (KMO) and the Bartlett test of sphericity to test for normality and outliers of 10 item-performance indicators, and 29 items-uncertain factors were 0.628 and 531.515, 0.624 and 2,222.838 respectively, resulting to reliability for using factor analysis because KMO should exceed 0.5, and Bartlett test of sphericity should be significant at \( \alpha = 0.05 \) (Hair et al., 1995). Construct validity then was measured by explanatory factor analysis. The eigenvalues of these components are above 1.0 cut-off point with 76.231% of variation for items of performance indicators, and 67.95% of variation for items of uncertain factors. 0.55 cutting-off point of factor loading was used due to 102 sample size (Hair et al., 1995, p.385), leading to one item of performance indicators discarded. Consequently, four items (the number of sales increases because of activities in marketing, low rice production cost, low distribution cost, and low inventory cost) are comprised to namely efficiency as a dependent variable in multiple regression analysis. Meanwhile, all 29 items of uncertain factors are independent variables variable in multiple regression analysis. Reliability was tested by using Cronbach’s \( \alpha \) for environmental uncertainty and efficiency, resulting 0.886 and 0.842 respectively considered appropriate (Cronbach, 1951).

Some assumptions of multiple regression analysis were tested. Multicollinearity was also tested by the determinant value of the correlation matrix. The determinant value of factor analysis of performance indicators is 0.004 that is greater than 0.00001 considered that these data have no problem on it (Field, 2005). Meanwhile, multicollinearity of uncertain factors as independent variables was also tested by collinearity statistics; tolerance value accepted at greater than 0.1 and variance inflation factor (VIF) accepted at less than 4.0 (Hair et al., 2010, p.201). Tolerance and VIF of these data range from 0.7 to 0.919, and from 1.089 to 1.609 respectively considered that multicollinearity problem is not concerned. Outliers, normality, linearity, homoscedasticity and independence of residuals were tested with examinations of scatter plots. All above assumptions are considered to underpin the use of multiple regression analysis.

Sample

The final draft of questionnaire was then mailed to 698 rice mill companies all around Thailand, but 46 questionnaires were returned due to, for instance, incomplete address, or business failure. 112 questionnaires were returned, but 10 of them were abandoned due to incomplete information, resulting in an effective response rate 14.61% that is considered generally for survey in developing country (Ahmed et al., 2002). The final sample included 7.84%, 28.43%, and 61.765% of small, medium, and large milling capacity respectively. 16.67% are both rice millers and rice exporter, and 79.63% are only rice millers. Additional, 62.96% have joined paddy rice pawn policy of government for last 5 years, and 31.48% have not. The average amount of paddy rice milled is 21,456.27 tonnes per year. The average inventory of paddy rice is 7,555.92 tonnes per year.
Multiple regression analysis was employed to test the relationship between seven uncertain factors and efficiency performance indicators as presented in Figure 2. With stepwise method, there are four independent variables (the throughput time of rice processing can vary, the volume of customer demand is difficult to predict, the new government regulation is introduced unexpectedly, and drought occurrences are unpredictable in each year) entering to regression model equation. Unstandardized coefficients (β) are 0.138, -0.190, 0.263, -0.165 accordingly. With t-test of each β, it found that all β are significant at α = 0.05. The dependent variable is efficiency: factor score of the number of sales increases because of activities in marketing, low rice production cost, low distribution cost, and low inventory cost. R square of the model is 0.218 meaning that 21.8% of the variability in the efficiency is accounted for by the four items of uncertain factors and other 25 items of uncertain factors were excluded. Using an analysis of variance (ANOVA) to test whether the model is significant, the F-ratio is 6.776 at significant level 0.05.

The hypotheses linking demand uncertainty (H2), and climate uncertainty (H7) to efficiency of Thai rice millers were found to be significant in a negative effect. Other hypotheses were found to be insignificant in negative effect to efficiency.

Conclusion and Discussion

The empirical support for the uncertain volume of customer demand and uncertain drought occurrences were significantly related to efficiency in the expected direction. This findings supports that higher demand uncertainty leads to higher unstable of inventory level, higher delay of delivering finish good to customers and finally lower efficiency in every business (Ettlie and Reza, 1992; Jack G. A. J. van der Vorst and Beulens, 2002) as well as agribusiness (J. G. A. J. van der Vorst, 2000). Generally, the water lever and time of disappearance of standing water can directly affect on rice yield in stage of rice production in farmland (Fukai, Basnayake, and Cooper, 1999). Furthermore, the amount and distribution of rainfall is the most important factor limiting yields of rainfed rice (De Datta, 1981a) and in Thailand, around 62% of rice crop area was rainfed land (IRRI, 1991). In additional, the study of Seetanun and De Datta (De Datta, 1981b; 1973) support that time of harvest and season affect the milling yield of rice. Therefore, uncertain drought occurrences can have indirect effects on rice millers in case of generating the vast fluctuation of paddy rice from farmer, and in direct effects on the milling yield. That circumstance force rice millers to face difficulty of managing sustainable efficiency. Interestingly, the higher variation of throughput time of rice processing, and the higher variation of the new government regulation introduction can be related to higher efficient. These issues should be addressed as the future studies in deeply investigation such as qualitative research method.

Limitation of the study

102 sample sizes is considered that less statistical power because the minimum ratio of observations to independent variables is 5:1 (Hair et al., 2010, p.175). As there are 29 independent variables of environmental uncertainty, 145 sample sizes should be reached to validate the generalizability of the results. Furthermore, R square of the model is fairly low (0.218) comparing with enter and backward method that R square can reach 0.583 with all 29 variables entering the model and 0.553 with 20 variables remaining in the model respectively.
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