Vol. 16(5), pp. 567-573, May, 2020
DOI: 10.5897/AJAR2020.14825
Article Number: 5241C0863520
ISSN: 1991-637X

http://www.academicjournals.org/AJAR

ACADEMIC JOURNALS

African Journal of Agricultural Research

Full Length Research Paper

Risk assessment of the economic efficiency of rubber production: Case of smallholder rubber production in QuangBinh Province, Vietnam

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Received 2 March, 2020; Accepted 21 April, 2020

The paper reviews the economic risk of rubber production due to fluctuations of input factors, product price, natural disasters, epidemics, interest rates, and market demand. The data collected in this work were analyzed with accounting of production costs methods and accounting results and production efficiency method, benefit-cost analysis, sensitivity analysis and scenario analysis. QuangBinh, a province in Vietnam was used as the case study of this research; the area has great potential to develop smallholders producing rubber. QuangBinh rubber smallholders play an important role in developing local economy and creating jobs. However, this model has been facing risks, leading to a low economic efficiency. The study evaluates the overall economic efficiency of smallholder rubber production and business in Quang Binh Province in the context of risks: product price risk and interest rate risk. It also analyzes the relationship between selling price and interest rate with economic efficiency of smallholder rubber production.

Key words: Economic efficiency, economic efficiency in the context of risks, risks, risks of rubber, rubber, smallholder rubber production.

INTRODUCTION

In recent years, the world economy has been volatile coupled with the adverse effects of climate change that have caused many risks and reduced economic efficiency in agricultural business and rubber business. In particular, many scholars have carried out research on risks and economic efficiency in different areas. Research on risks in agricultural production has been done in three areas: The impact of natural factors (natural disasters, climate change ...), input factors (varieties, fertilizers, soil, farmers' qualifications, etc.) and the government impact factors on policies and legal framework. Several other studies address how to control risk in agricultural production with methods such as insuranceindex, risk classification and risk management tools. This study evaluates the factors that affect the efficiency of rubber production and business, factors leading to inefficient rubber production, economic efficiency analysis methods and policies to improve economic efficiency. Although there have been a lot of research on risks and economic efficiency in rubber

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production, there has not been any that aims to build a theoretical framework for assessing economic efficiency in relation to risks. Therefore, the paper aims to assess the economic efficiency of rubber production in the context of high risks, including factors responsible for risk like selling prices and interest rates, using QuangBinh Province, a locality in Vietnam as a case study.

MATERIALS AND METHODS

Based on the theoretical and practical research on risks and economic efficiency in rubber and smallholders' rubber production, the paper identifies the theoretical basis of smallholder rubber, rubber production risks and economic efficiency of rubber production. In particular, smallholder rubber is defined as a form of small-scale production; a situation in which farmers' households invest capital or lend money to farmers to invest in production and business development. In smallholder farms (with less than 4 haper household) plants are often scattered in them; the farms are scattered around where the farmers live (Dinh, 2000).A number of authors define risk as, "Risk is a measurable uncertainty" (Frank Knight); "Risk is uncertainty that may be related to the occurrence of unexpected changes" (Allan Willett); "Risk is a random sum that can be measured by probability" (Irving Preffer) or "Risk is a value and outcome that is currently unknown" . According to Arthur and Micheal, "Risk is the potential volatility in the results; occurs in almost every human activity, when there is a risk one cannot predict the exact outcome. The presence of risk causes uncertainty, risk can occur at any time, an action leading to unpredictability or loss" (Bui, 2005; Doan, 2013). In this study, the author determines that rubber production risks are events not intended by the producers such as natural disasters, epidemics, price fluctuations, changes in laws, farming techniques and measurable damage to rubber business results and efficiency. Regarding economic efficiency, according to Richard (1984), economic efficiency is the effective allocation of resources to bring surpluses to producers and consumers.

Economic efficiency is allocated based on the following conditions: (i) the value of one type of goods produced by an individual must be equal to the price of converting one commodity into another, (ii) the consumption value of the direct factors must be equal to the cost of converting the inputs into goods, (iii) the values are determined by the consumers of the inputs, and the output should be equal to the marginal products (Richard, 1984). This study identifies the economic efficiency of production and business of smallholder rubber plantation as a category; it reflects the comparative relationship between economic results and economic costs which households growing rubber spend to achieve in the rubber production and business cycle. Economic efficiency evaluation of rubber production is usually based on annual economic accounting indicators and long-term investment analysis criteria. However, to assess economic efficiency in the context of risk, it is necessary to analyze the fluctuations of the long-term indicators in terms of negative or positive correlation with risks. Therefore, the study uses sensitivity analysis method. Sensitivity analysis is an analysis of the relationship between insecure input quantities and output quantities. In other words, sensitivity analysis aimsto identify parameters that have a significant effect on the feasibility of a project and quantifying this level of influence. The analysis is to change the value of a project parameter and re-run the appraisal model to see how the NPV, IRR and evaluation criteria change. Sensitivity analysis in the risk assessment of rubber production and business is the determination of the variables thathave the most impact on the net benefits of rubber production and business and quantify their influence. This analysis includes testing the impact of the variation of selected costs and benefits on IRR and NPV of the rubber business production model.To accomplish the research objectives, the study uses the followings research methods:

Method of collecting data

Secondary data are the documents published through books, newspapers, summation reports and results of research works related to risks and economic efficiency of rubber production and business. Primary data are collected through questionnaire for smallholder rubber households. The sample size of the survey is determined by the following formula:

$$n = \frac{\mathrm{N}}{1 + \mathrm{N}(e)^2}$$

With the confidence of 95% and P = 0.5, the sample size with permissible error was ± 5%. The sample investigated was identified as n = 195; the number of households surveyed was 200 households. The data were collected according to the statistical method of stratification based on the life cycle of rubber trees. The surveyed households were selected randomly at each survey location.

Accounting of production costs

Determining the cost of rubber production was determined in 2 periods: the period of basic construction and the period of business. The study identified a basic construction period of 7 years from the year of planting rubber, including reclamation costs, new planting and interest expenses if any. Business period is from the 8th year; the cost includes labor cost, fertilizer cost, cost of production tools, depreciation cost of garden (all expenses for basic construction period allocated to years of economic periods) and financial expenses.

Accounting results and production efficiency

The actual yield of latex harvested for 1 ha of rubber of the surveyed household was calculated. The productivity data are usually obtain edvia interviews, household interviews and consideration of the statistical data on the productivity of the adjacent year (year) of the statistical office. The results and efficiency criteria are calculated as follows (Richard, 1984):

$GO = Q_i * P_i$

Where:
GO: Revenue collected per hectare of rubber tree area (VND 1,000)
Qi: Latex output of one hectare of rubber (kg)
Pi: Price of 1 kg of latex (VND 1,000)

Intermediate cost (IC)

This is the total amount of regular expenses spent to buy and rent inputs and services during the production of the total product.

Value-added (VA)

The value of products created during the manufacturing period. It is

the difference between the value of production and the intermediate cost.

VA = GO – IC

Mixed income (MI)

This is the remaining added value after deducting expenses: depreciation of fixed assets, taxes and fees (if any).

MI = VA - depreciation of fixed assets - Tax - Bank interest (if any)

Profit:

Profit = MI - expense of family labor - expense of in kind of a household

Evaluation of production efficiency through indicators: GO / IC, MI / IC, LN / IC, VA / IC.

Benefit-cost analysis method: The research uses the benefit-cost analysis method in two ways: (1) Analyzing the annual cost benefit for the business period. The data used are primary data. Annual costs include expenses incurred during the year such as costs of supplies, production tools, labor, allocated depreciation of gardens and allocated financial expenses. Basic construction expenses are evenly distributed among the years of the business period; (2) cost benefit analysis for the entire production cycle, using NPV, BCR and IRR indicators. Benefits and costs arising in different years are realized at reasonable discount rates. The criteria are calculated by the following formula:

$$\text{NPV} = \sum_{t=0}^{n} B_t \frac{1}{(1+r)^t} - \sum_{t-o}^{n} C_t \frac{1}{(1+r)^t}$$

Where:
n: Number of life cycles of a rubber tree
t: Year of investment
Bt: Benefits of rubber trees in year t
Ct: Cost of rubber tree year t
r: Discount interest rate (% / year)
If NPV is > 0, the investment in rubber business is effective and profitable. Conversely, if NPV is <0, financially, this investment is ineffective and should not be implemented.

$$\text{IRR} = r_1 + (r_2 - r_1) \frac{NPV_1}{|NPV_1| + |NPV_2|}$$

Where
r_1: Lower discount rate at which NPV1> 0 is closest to 0
r_2: Higher discount rate at which NPV2 <0 is closest to 0.
NPV: Actual present value
The IRR to find (corresponding to NPV = 0) will lie between r_1 and r_2
IRR is the discount rate that makes NPV = 0; with this discount rate, rubber plantation is completely unprofitable because the income is just enough to offset the costs. Conversely, if IRR is greater than the interest rate, then production is efficient. The larger the IRR is, the higher the economic efficiency is.

Sensitivity analysis

Two variables were analyzed: price and lending interest rate.These are the two factors that have the biggest impact on the economic efficiency of rubber production. On that basis, the NPV value corresponding to the variable prices and interest rates that vary with a certain percentage was determined. Specifically, NPV was determined according to 2019 survey data, rubber prices and interest rates for the period 2014 - 2019. The analysis results are illustrated through graphs to assess the increase or decrease of NPV values when prices and interest rate change.

Scenario analysis method

Based on practical experience, this work proposes the situations for risk variables (input variables affecting production activities). This is to consider the change of a result variable and consider the change of economic efficiency criteria for smallholder rubber production when there are changes of many risk factors at the same time.

RESULTS

Assessing the impact of risk on the profit of rubber growers

The synthesis results in Table 1 show the risk of natural disasters causes maximum damage followed by cultivation, pests and diseases, product variety and price risks

Economic efficiency of rubber smallholdings in relation to product price risk

In Figure 1, at interest rates of 9%, the possibility for NPV of 01 hectares of rubber plantation under smallholder model to be greater than 0 is quite high and reaches 98%. Considering the direct relationship between price and NPV, price has a strong impact on change of NPV.With an estimated price change from VND 6,000/kg to 20,000/kg, NPV values change from VND 28.495 to 383.706 and the average value is VND181.416. Rubber latex prices are related directly to the NPV value obtained and the dependence of NPV on the price level is high.

Economic efficiency of smallholder rubber model in relation to loan rate risk

The NPV analytical results of smallholder rubber model in QuangBinhat different lending rates from 2013 - 2019 and of rubber latex price in 2019(10,000VND/kg) (Figure 2) shows that the interest rate has a direct influence on the value of NPV obtained. However, NPV value fluctuates due to interest rates, ranging from 1,168VND to 79,781VND. This range is lower than the impact of price, which is at VND10.000; NPV is greater than 0 in all cases of interest rate in stages from 2013 to 2019.NPV analysis, according to interest rate fluctuations and price in the period 2013- 2019, provides positive results. Most of the NPVs obtained from smallholder rubber model are greater than 0 in all cases. When looking at some specific NPV, in which farmers can decide the point at NPV is

Table 1. Economics efficiency of smallholder rubber business under risky conditions.

Type of risks	Frequency (persons)	Proportion (%)	Impact on profit (%)		
			Maximum	Minimum	Mean
Natural disaster, weather	200	100	100	4	26.83
Pest	200	100	30	1	8.28
Seedling	177	88.5	20	1	5.11
Technical cultivation	197	98.5	35	2	12.26
Seedling price	177	88.5	5	0.03	0.84
Pesticide price	200	100	7	0.09	1.5
Fertilizer price	200	100	7	0.1	1.6
Labor cost	200	100	10	0.2	2.2
Selling price	198	99	20	1	7.54
Changing in demand	0	0	-	-	-
Lacking of capital	200	100	15	0.5	6.54
Interest rate increase	200	100	17	0.5	6.34

Source: Survey results and calculations in 2019.

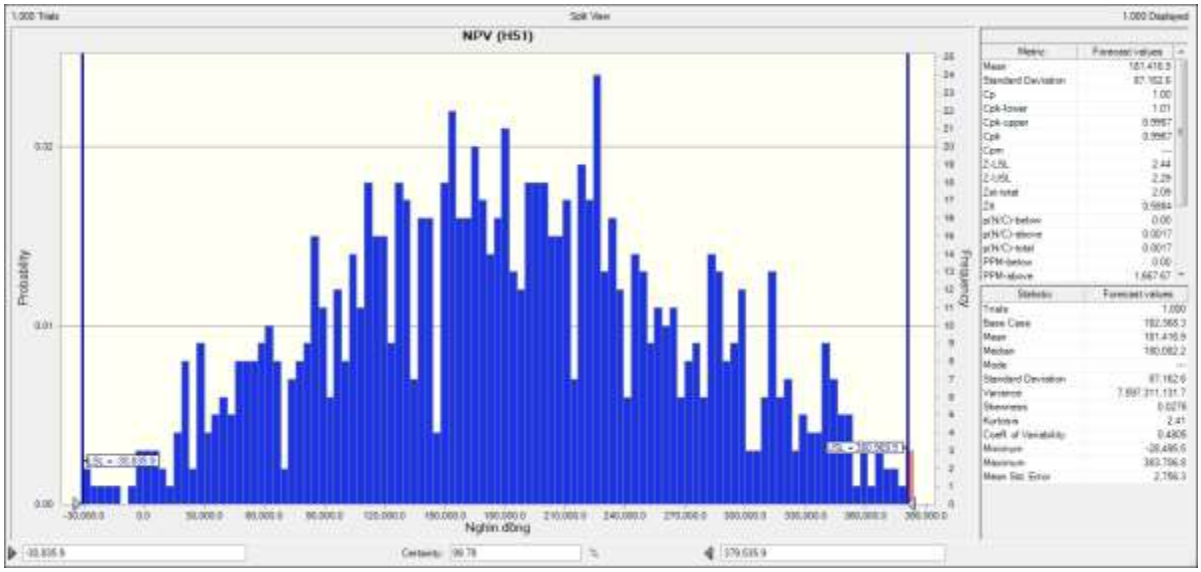

Figure 1. NPV distribution of smallholder rubber according to variation of rubber latex price from 2013 to 2019.

greater than 50%, it could be concluded that despite the risk, business will still be profitable if the level of prices and interest rates is fluctuating around 2019.

Economic efficiency in relation to product price and loan rate risks

NPV analysis results show the variability of latex price and interest rates from 2013-2019 with latex prices from VND 7,000/kg or more. The NPV in this case is positive; even with the highest interest rate at 17.5% in 2014, the NPV is still higher than 0 in all cases of more VND 10,000 /kg for rubber latex. However, current prices are maintained at VND 10,000/kg, so the NPV is positive (Table 2). There are many factors affecting the business of rubber production such as price, interest rate, etc. However, at 7,000VND/kg prices or higher and interest rates at 17.5% or less, the NPV in all cases would be positive. These show that the investment in small holder rubber production in QuangBinh Province has high economic efficiency.

Analyzing the relationship between selling price and lending interest rate with economic efficiency of smallholder rubber production

The relationship between the product price and interest rate changes compares well with prices and interest rates

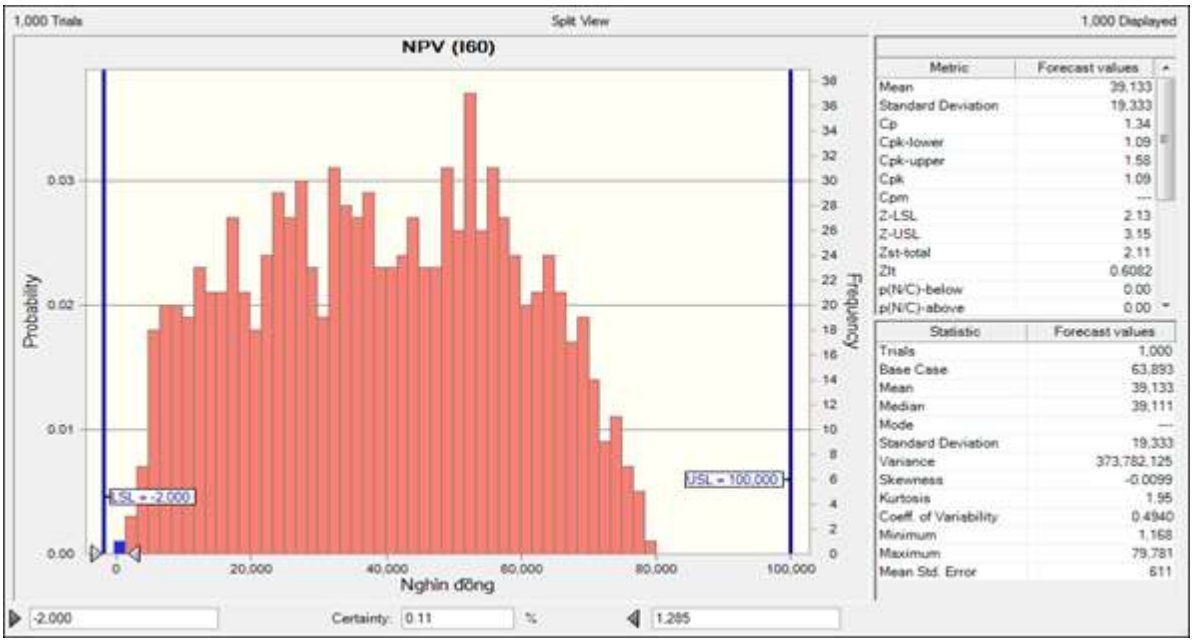

Figure 2. Variation of NPV value according to interest rate in stages from2013 to 2019.

Table 2. Sensitivity of NPV as prices and interest rates vary from 2013 to 2019.

Rate (%) \ Price (Thousand VND)	6.2	6.9	13.0	20.3	13.5	10.8	10
17.0	-35,483	-28,543	35,833	112,528	41,086	12,720	4,315
17.5	-35,609	-28,255	31,940	104,321	36,897	10,127	2,194
11.5	-34,498	-19,958	106,747	258,377	117,132	61,050	44,433
12.5	-35,208	-22,447	88,754	221,831	97,869	48,648	34,065
15.0	-35,845	-26,515	54,794	152,098	61,459	25,470	14,806
10.0	-32,697	-14,904	140,148	325,702	152,857	84,227	63,893
9	-30,836	-10,392	167,765	380,970	182,368	103,512	80,147

Source: Survey results and calculations in 2019.

according to survey data of VND 10,000 and 9%. The results in Table 3 show that NPV, IRR and BCR are quite sensitive to changes of inputs. However, the ability to leave NPV <0 in all situations is quite low. With the increase or decrease of the price, as well as the change of the discount rate, NPV in all cases is NPV> 0. In other words, when interest rates and prices change around the scenario level in 2019, they do not suffer from losses. When prices fall from 10-20% this directly affects sales; this scenario leads to a significant decline of NPV, IRR, BCR.

The analytical results show that, even when the interest rate is much reduced (20%), smallholder rubber production is still profitable. Meanwhile, with the increase in price, there is increase in sales; the NPV, IRR and BCR also increase. For example, with a price increase of 20%, the NPV increases by more than 58,000 and the BCR index increases by 0.27 times compared to the scenario in 2019. Similarly, the decrease in interest rates also directly affects the NPV and BCR. However, for IRR, the change is not too significant. Thus, when compared to the 2019 scenario, although the indicators change with the increase and decrease of price factors as well as discount rates, NPV results are always > 0.

DISCUSSION

A lot of studies have discussed risks and economic efficiency in rubber business. Claire (2010) says that the

Table 3. Summary of CBA criteria for QuangBinh smallholder rubber plantation by scenario.

Scenario	NPV (1.000vnd/ha)	IRR (%)	BCR (times)
Price at VND 10,000 and interest rate of 9% (2019)	80.147	18	1.36
1. Price changes, interest rate 9%			
Downto 10%	50.941	15.3	1.23
Down to 15%	36.338	13.7	1.17
Down to 20%	21.735	12.02	1.10
Up to 10%	109.353	20.4	1.50
Up to 15%	123.956	21.46	1.56
Up to 20%	138.559	22.19	1.63
2. Interest rate changes, fixed price VND 10,000			
Up to 10%	65.387	18.00	1.33
Up to 15%	58.871	18.07	1.31
Up to 20%	52.864	18.00	1.29
Down to 10%	97.595	18.00	1.40

Source: Survey results and author calculations in 2019.

instability in agricultural production evolves in an increasingly complex direction. These instabilities may result from weather, price fluctuations, seasonal output, supply-demand correlation, energy price fluctuations. Sarba (2011) in studying the effectiveness of the production of natural rubber in Indonesia, identified that prices have a direct and large impact on farmers' income; Somboonsuke et al. (2002) commented that low rubber prices were a major obstacle for rubber growers. Jagath et al. (2010)in Sri Lanka focused on analyzing factors affecting inefficient production. The authors found that the main reason for reducing the economic efficiency of smallholder rubber production is the fluctuation of prices, which has a direct influence on the income of rubber growers. The study pointed to the ineffective use of inputs and concluded that there was no point in increasing inputs but use efficiency has to be improved to increase the profitability of the household. Sarba (2011) studying the factors affecting the growth of production capacity in the rubber industry, concluded that there is need for government's reformed policies on licensing trade liberalization. It does not help industry and agriculture to expand its capacity; most of them use their own production capacity and have not yet used up this capacity. Approaching other research methods, Ririnet al. (1999)assessed the importance of rubber trees in the Indonesian economy, including the price change affecting the profitability of growers. The authors also use a bio-economic model to assess production efficiency between the standard model and the second model after introducing risk factors.

Thus, in the study of theory and practice of risks and economic efficiency in rubber production and trading, the works mainly discussed each in different aspects. There are works that only study risk factors or risk control in agricultural production and risk analysis methods. Researching on the economic efficiency of rubber production, researchers refer to the history of rubber and rubber plantation formation and development, the role of rubber plantation and the factors affecting production and business efficiency of rubber; factors leading to inefficient rubber production, economic efficiency analysis methods and policies to improve economic efficiency. There has not been any study to assess the economic efficiency of rubber production and business in relation to risks. Therefore, thisstudy assesses the economic efficiency of rubber production in the context of risks.Smallholder rubber production in Quang Binh province, Vietnam ensures novelty and creativity. The work uses the common theory to form the theoretical basis of smallholder rubber model, risks in rubber production and assess the economic efficiency of rubber production, thereby forming methodsto study and evaluate the economic efficiency of rubber production and business in the context of risks. It evaluates the model of smallholder rubber in Quang Binh province, Vietnam. The research results have supplemented and enriched the theory of risk and assessed economic efficiency in rubber production and business; it is an important source of reference for organizations and individuals to study and implement issues related to rubber and rubber production and business. At the same time, they are important practical bases to help smallholder rubber households and local authorities at all levels in Quang Binh Province have strategies and solutions to minimize risks and improve economic efficiency.

Conclusion

Small-scale rubber production has many fluctuations, long production cycles, and different annual productivity;

so if based on the results of assessing economic efficiency at a time, it will lead to risks for producers. Therefore, the evaluation of economic efficiency of smallholder rubber production in the context of risk is the assessment of economic efficiency under uncertain future conditions; so the results of the research reflect the most comprehensive and accurate expression. The article has studied systematizing the theory and practice of risk research, assessing economic efficiency in rubber plantation production. Then, the concepts of smallholder rubber, risks of rubber production, economic efficiency of rubber production and sensitivity analysis method have been used as a basis for theoretical research. The results of the study showed that smallholders in rubber without risk conditions will be highly effective, in the context of reduced profitability and reduced efficiency with the level of each type of risk.

Risk from strong storms has the greatest impact that can reduce profits by 100% and, on average, reduce profits by 26.8%. Other risks have lower impacts; but there are some with more significant impacts such as the risk of falling product prices, rising interest rates or risks due to unsecured farming techniques. Studying the context of the current risks in QuangBinh province, investing in smallholder rubber is effective; the author analyzes the fluctuation of NPV value by latex price and interest rate in the period of 2013-2019. It shows that, with prices ranging from 7,000 VND/1kg of fresh latex or more and interest rates ranging from 17.5% or less, NPV in all cases are positive. At the same time, analyzing the scenario of selling price and lending interest rate shows that the indicators NPV, BCR and IRR all change according to the increase and decrease of price factors as well as discount rates but NPV always achieve results> 0 The results of this analysis show that in the current risks, investment in smallholder rubber production and business in QuangBinh province is still effective.

CONFLICT OF INTERESTS

The authors have not declared any conflict of interests.

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