Ann. UP, Série Sci. Nat. Agron. Décembre 2019; Vol.9 (No.2) : 49-60

ANNALES DE L'UNIVERSITÉ DE PARAKOU
Série « Sciences Naturelles et Agronomie »
ISSN : 1840-8494
eISSN : 1840-8508
Parakou, Bénin

Estimation of Optimal Portfolios of Governance Structures for Improving Benin' Rice Producers' Income

Ogoudélé Simon CODJO[1*], Rose FIAMOHE[2], Sylvain KPENAVOUN[1], Denis ACCLASSATO[3], Gauthier BIAOU[4]

[1] Faculty of Agriculture, University of Abomey-Calavi
[2] Africa Rice Center (AfricaRice)
[3] Faculty of Economics, University of Abomey-Calavi
[4] Faculty of Agriculture, National University of Agriculture of Benin

Reçu le 4 Février 2019 - Accepté le 20 Décembre 2019

Estimation de portefeuilles optimaux des structures de gouvernance pour améliorer les revenus des producteurs de riz du Bénin

Résumé : La volatilité des prix des produits agricoles est l'un des problèmes critiques qui affecte fortement le revenu des petits producteurs ; par conséquent, pourrait contribuer à aggraver la pauvreté. Cet article utilise une analyse de portefeuille pour identifier le portefeuille optimal de modes de transaction pour la commercialisation du paddy. Les données ont été collectées au Bénin en 2015 auprès de 300 producteurs du paddy. Les résultats indiquent que le portefeuille optimal de deux modes de transaction consiste à vendre 17% et 83% du riz produit sur le marché au comptant et à travers le contrat formel, respectivement. Le meilleur portefeuille pour la combinaison de trois modes de transaction consiste à vendre 13%, 57% et 30% de la production par le biais du marché au comptant, d'un contrat formel et des associations de producteurs. Enfin, un portefeuille consistant à vendre respectivement 10%, 25%, 43% et 22% de la production sur le marché au comptant, le contrat informel, le contrat formel et les associations de producteurs constitue le meilleur portefeuille pour l'utilisation de quatre modes de transaction. Le contrat formel est inclus dans tous les meilleurs portefeuilles identifiés et présente le pourcentage le plus élevé. Par conséquent, ces contrats formels peuvent être utilisés pour augmenter les revenus des producteurs de riz et réduire les risques de fluctuation des prix. Les portefeuilles développés dans cette recherche peuvent être utilisés pour conseiller les producteurs de paddy pour une meilleure décision de commercialisation du paddy.

Mots clés : Sélection optimale de mode de transaction, analyse du portefeuille, simulation stochastique, paddy, Bénin.

Code JEL: G11, Q11, Q12.

Abstract: Prices volatility is one of the critical problems that highly affects smallholder producer's income; therefore, it might contribute to deeper poverty. This study applies portfolio analysis to identify the optimal portfolio of governance structures (GSs) selection for paddy marketing. Data were collected in Benin in 2015 from 300 rice producers randomly selected. The results indicate that the optimal portfolio of two GSs consists of selling 17% and 83% of the production through spot market and formal contract, respectively. The best portfolio of three GSs consists of selling 13%, 57%, and 30% of the production through spot market, formal contract, and farmer association. Finally, a portfolio that consists of selling 10%, 25%, 43%, and 22% of the production through spot market, informal contract, formal contract, and farmers association, respectively, is the best one in the case of four GSs. Formal contract is included in all the best portfolios identified and always presents the highest percentage. Therefore, these formal contracts can be used to enhance rice producers' revenues and reduce price fluctuation risk. The portfolios developed in this research can be used to advise paddy producers for a better marketing decision.

Keywords: Optimal GS Selection, Portfolio Analysis, Stochastic Simulation, Rice, Benin.

JEL code: G11, Q11, Q12.

1. Introduction

Price fluctuation on agricultural markets is one the of most significant factors that influences producers' incomes. According to Rapsomanikis and Sarris (2008), various uncertainties such as prices fluctuation, weather instability, and some idiosyncratic shocks such as illnesses can highly affect producers' revenues and be especially detrimental to small scale poor producers in developing countries. Accordingly, agricultural business is a risky business with unstable revenue due to the uncertainty about the prediction of the future (Broll, Welzel, & Wong, 2013; Hardaker, 2004; Kobzar, 2006).

Uncertainty about market price might highly jeopardize farmers' decision-making. They might struggle about the varieties to produce to guarantee marketing outlet. Furthermore, they may face difficulties in deciding not only the appropriate time to market their products but also the marketing option to use to mitigate the risk of income fluctuation. Accordingly, risk is part of farmers decision making process. Two main types of risk are usually described in the literature: financial risk and business risk (Hardaker, 2004).

Financial risk is related to farm financing, including credits constraints, leverage, leasing, and interest rate variability (Hardaker, 2004). Business risk springs from production risk (weather instability) and from market risk (price fluctuation, change in demand and supply). Price volatility affects all countries that produce commodities, but the problem is more serious in developing countries (Page & Hewitt, 2001). Accordingly, strategies to deal with risk are important in producers' decision-making process in developing countries. Managing risk involves selecting among alternatives or to diversify farm enterprise (Broll *et al*., 2013; Markowitz, 1991; Sharpe, 1970). According to Williamson (1979), governance structure selection is considered as part of the firm optimization problem. During the our data collection producers have stated the diversification of the GSs as a strategy used to cope with market risk.

A GS is an organizational option used by an economic agent to carry out a transaction. Economic agents, when coordinating their activities, adopt GSs, which, according to Williamson (1975), allow them to minimize transaction costs. These GSs include the spot market, hybrid forms (contractual forms) and hierarchy. As stated by producers during the field work, by combining GSs, their objective is to minimize the risk of price fluctuation to keep their revenue as stable as possible. Accordingly, the combination of GSs may be a strategy to face revenue fluctuations. As Arinloye (2013), this research resolves around four GSs, including spot market (SM), informal contract (IC), formal contract (FC), and farmers association (FA).

The SM does not require any agreement, prior to the selling time, between the buyer and the seller. In such GS, anonymous providers and purchasers meet, agree on prices and leave, and the relationship between the providers and purchasers is not expected to continue beyond the current exchange (Macneil, 1981). The FC is an agreement concluded based on well-defined and unambiguous clauses. This type of contract is written and exhibits the evidences of the clauses of the contract. The IC does not exhibit an official framework that defines the agreement between the producer and the processor. It is based on past relationships and experiences between a seller and a buyer (Bradach & Eccles, 1989, Gibbons *et al*., 1994, Ménard, 2004). In such contract, the terms are established orally without written evidences. Finally, a FA represents a group of producers seeking to protect their interests. FAs are engaged in a wide range of activities, such as the promotion of a product, the development of quality, training, and the provision of information (Shepherd *et al*., 2010). In addition, a FA can collect the products of its members for the sake of marketing. In our study area, producers either use one of these GSs or combine two or more for the marketing of rice.

Research about GSs have been largely embraced in the literature (eg. Bailey & Hunnicutt, 2002; Arinloye, 2013; Williamson, 1975). Those studies generally focus on the magnitude of transaction costs on the GSs (Bailey & Hunnicutt, 2002; Ji, Felipe, Briz, & Trienekens, 2012) or on the factors that influence their choice (Arinloye, 2013; Kpenavoun, 2009; Paulson, Katchova, & Lence, 2010; Williamson, 1975). However, it is still unclear how producers should allocate their production to those GSs to minimize the risk of revenue fluctuation. Moreover, while some producers might be willing to use only one GS other may prefer using two, three or four. Considering that this research focuses on four GSs; there are six possibilities to combine two GSs, four to combine three, and only one in the case of four GSs. This research, first, identifies the highest revenue portfolio and the lowest risk portfolio (in terms of price fluctuation) for combining two or three GSs. Second, this research predicts which portfolio a risk averse and a risk loving producer will prefer.

2. Producer's optimal decision

We consider in this study a rice producer who faces a standard portfolio decision within a risky business environment. This study considers (1) a farmer that produces Q amount of paddy annually, (2) sells paddy through the selected governance structure, and faces an optimal selling decision problem. According to Wil-

* Auteur Correspondant : simcodjo20@yahoo.fr / s.codjo@cgiar.org

liamson (1979), governance structure selection is considered as part of the firm optimization problem. Accordingly, the producer's optimal decision consists of obtaining the maximum outcome for each variance, which one captures the risk level. In other word, the producer would like to minimize risk for each targeted outcome. The revenue is the outcome considered in this research. A pertinent framework to analyze such situation is the portfolio theory. A ''portfolio'' can be defined as a combination of items, which one may be securities, assets, or other objects of interest (Nalley *et al*, 2009). The portfolio theory is an approach developed by Markowitz (1959) to analyze an investment selection to cope with risk. It is a theoretical approach to investment choices assuming that rational investors will seek to minimize their risk for any given expected return, and to maximize their return for any given level of risk (Markowitz, 1959).

In portfolio theory, two important characteristics of investors are described. First, the investors want their return to be high and second, they want it to be dependable and level off (Markowitz, 1959). From our field work, paddy producers stated that they combine governance structures to reduce the risk of paddy selling price fluctuation. Thus, by combining the GSs paddy producers want to maximize their revenue by reducing the price fluctuation risk. A portfolio that provides high return is not necessary the one that guarantee the lowest price fluctuation risk. Conversely, the lowest uncertainty portfolio might provide an undesirable return level (Markowitz, 1959). Between these extreme situations exist the portfolios that present various degree of return and uncertainty. Farmers' choice among these portfolios depends on their willingness to bare risk. Risk loving farmers will prefer the portfolios that provides the highest return no matter the risk associated to that portfolio.

This research applies the portfolio theory to GS choice by adopting a framework similar to that of Nalley *et al* (2009) who developed a model to analyze the portfolio of rice varieties selection of producers in order to optimize their profit while minimizing yield risks in Arkansas. Due to the fact that prices volatility is one of the serious concerns of agricultural market (Broll *et al*., 2013; Hardaker, 2004; Kobzar, 2006), a best portfolio of GSs can be couched by estimating expected income resulting from the combination of GSs.

It is assumed that the objective of the producer is to choose the optimal allocation of the total quantity of rice sold through each GS. The decision variable is x_i is the proportion of rice sold through the GS i. The objective function is presented in equation 1.

$$Max\ R = \sum_{i=1}^{4} X_i P_i Q \quad (1)$$

$$\text{St:} \sum X_i = 1 \quad (2)$$

$$\sum_i Y_i X_i = \alpha \quad (3)$$

$$X_i \geq 0 \text{ for all i} \quad (4)$$

R is the total revenue generated by the selling of one metric ton of paddy rice, X_i is the percentage of the total quantity sold under the governance structure i. Q the quantity of paddy rice sold. In the equation 3 α is the targeted variance, which is the sum of the mean revenue variance. Y_i is the average revenue of the governance structure i.

3. Methodology

3.1. Source of data

The data were derived from agricultural surveys conducted by the Africa Rice Center (AfricaRice) and the National Institute of Agricultural Research in Benin (INRAB). Data were collected in 2015 in the rice development hub of Glazoué which includes the districts of Bantè, Dassa, Glazoué, and Savalou. In each district, a list of active villages in rice production was established with the assistance of members of the rice producers' association. Thus, 15 villages were identified as being active in the district of Bantè, 14 in the district of Savalou, 16 in the district of Dassa, and 19 in the district of Glazoué. Forty-one (41) villages were selected randomly and proportionally to the number of active villages in each district.

Table 1: Details of the producers sampling

Districts	Number of villages active in production	Number of villages selected	Total number of paddy producers in the selected villages	Number of respondents selected
Dassa	16	10	211	70
Glazoué	19	12	235	78
Savalou	14	9	199	66
Bantè	15	10	260	86
Total	64	41	905	300

Survey Benin, 2015

At the level of each selected village, the list of rice-producing households was set with the assistance of producers' association leaders. This list is supplemented by a census of the other producers of the village. A total of 300 producers randomly selected from forty-one (41) villages were surveyed. The number of producers selected in each village is proportional to the number of producers in the village.

During the survey, the data were collected mainly on the socioeconomic characteristics of respondents such as the sex, the age, the education level, and the membership of producers associations. In addition, the GSs used by famers to sell rice, the quantity of rice sold through each GS, and the price of selling of paddy through each GS were also collected. For example, if a producer sells 100kg of his production, he may use only two GSs by selling 70kg in the first and 30 kg in the second. Other producers may use three of four GSs, and so, share out the quantity of paddy sold through these GSs.

3.2. Description of scenario analysed

The goal of the present research is to identify the best portfolio based on the number of GS that producers would like to use among the four addressed in this research. Six possibilities exist to choose two GSs among four, four possibilities for combining three GSs and, finally only one option exists in the case of four GSs. When the producer decides to use two GSs, the following combinations are possible: SM and FC, SM and IC, SM and AP, FC and IC, FC and , IC and AP. Firstly, the optimal portfolio is estimated in each scenario as described in table 2. Secondly, the scenarios are compared in terms of revenue and risks (mean-variance) to identify the highest revenue portfolio and the lowest risk one. The portfolio risk is measured by the mean-variance of the revenue obtained by combining GSs.

Table 2: Description of the scenarios analyzed

Scenarios	Governance structure (GS)			
	SM	IC	FC	FA
	Choice of two GSs			
SM and IC	1	2	-	-
SM and FC	1	-	2	-
SM and FA	1	-	-	2
IC and FC	-	1	2	-
IC and FA	-	1	-	2
FC and FA	-	-	1	2
	Choice of three GSs			
SM, IC, and FC	1	2	3	-
SM, IC, and FA	1	2	-	3
SM, FC, and FA	1	-	2	3
IC, FC, and FA	-	1	2	3
	Choice of four GSs			
SM, IC, FC, and FA	1	2	3	4

4. Results

4.1. Comparison of the average price of selling of paddy rice through the GSs

Table 3 presents the average prices of selling of the paddy rice through each GS. The standard deviation of the price on each GS is used to appreciate market risk (C.A, 1999; Hull, 1991). SM displays both the highest average selling price and standard deviation. Although the SM offers the best selling price, the transaction costs that can be associated with that GS may be higher than that of the others GS. In case the producers should transport the paddy to a physical market, they don't have the guarantee that the product will be sold the first time. Furthermore, the existence of middlemen on the market may abate the net price that receive the producer. IC presents the lowest average selling price. By using IC, producers usually receive pre-financing from the processors based on a trust. As a compensation for the financing, the producers usually receive a low price. The price receive through formal contracts is almost the same as that of SM. However, that GS presents the lowest standard deviation, meaning that it has the lowest risk of price fluctuation. That option could be a good one for producers since it combines a relatively high price of selling and a low risk of price fluctuation.

Table 3: Average selling price (US $/ton) of rice through the GS

GSs	Average price	Standard deviation
Spot market	261.83	27.15
Informal contract	221.79	15.86
Formal contract	259.84	11.34
Farmer association	250.08	14.52

Survey Benin, 2015

4.2. Simulation of the selling price of rice on each GS

The figures 2 and 3 present the probability density function (PDF) of the simulated prices of one ton of paddy for each GS. These figures present the chance of selling paddy more than producers' current average income when they decide to use only one GS. The producer's average income per ton of paddy sold is equal to 257.43 US $/ton. FC displays the highest percent of selling rice at more than $257.43 with 58%, following by SM with 56%. IC presents the lowest chance of selling one ton of paddy at more than per ton income with only 1%. The SM price holds the largest standard deviation, meaning that it presents the highest risk of the price fluctuation. In the opposite, the smallest standard deviation is associated with FC. Based only on prices analysis, both a risk lover and a risk averse producer will prefer to sell exclusively their paddy rice on the

spot market. Indeed, the high risk attached to spot market is a positive risk. In all, the risk loving producers will prefer SM since they make more money because that GS has a thicker tail on the right side and risk averse producers will choose it since it has a thinner left-hand tail. However, the decision of producers is not made only based on the price of selling. The price of selling might be high but displayning substantial transact costs, which may affect negatively the revenue. Therefore, producers could abjure a high price GS due to the transact costs that can lower the profit. Producers make a tradeoff between a high price GS and a low transaction cost one, which usually leads them to combine two or more GS.

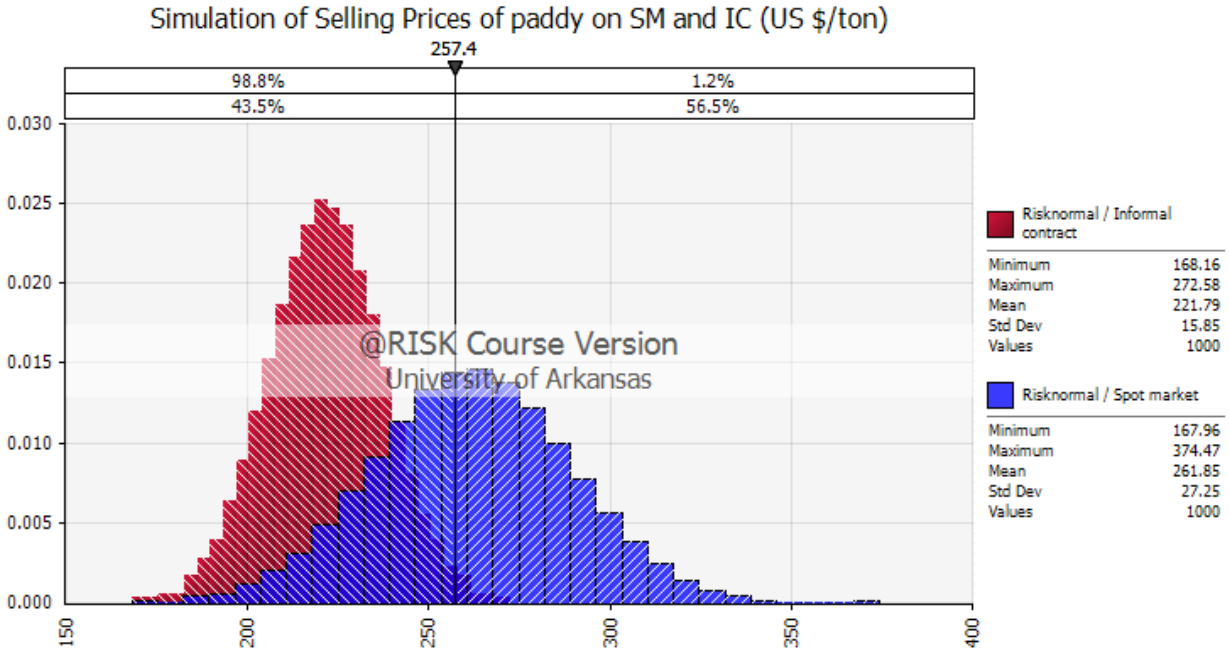

Figure 2: PDF of SM and IC prices

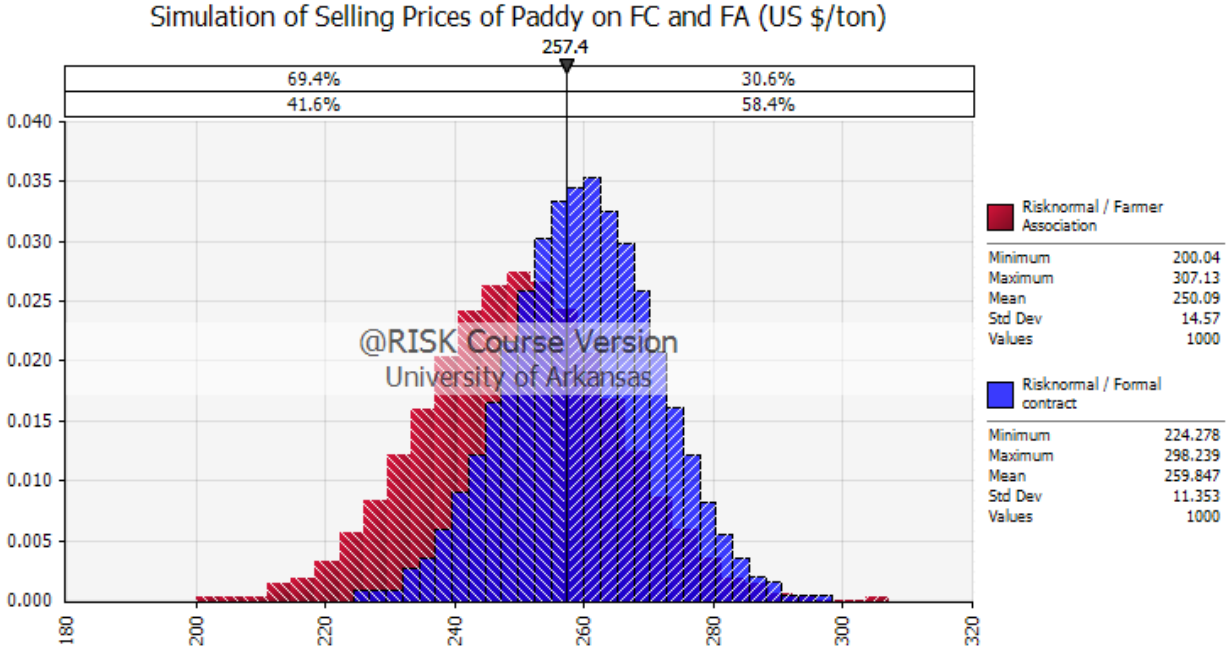

Figure 3: PDF of FA and FC prices

4.3. Comparison of the incomes and risk of the possible portfolios

Table 4 shows the portfolios for the possible combinations of two, three, and four GSs. By assuming that producers are risk averse, the best portfolio is the combination that provides the producer with the lowest risk of the revenue fluctuation. In opposite, a risk loving producer will prefer the high revenue portfolio. Table 4 gives the details about the outcomes of each portfolio in terms of revenue and risk.

In the case of two GSs, the best portfolio in terms of risk consists of selling 34% of the paddy rice through IC and 66% through FC. The revenue associated with that portfolio is \$246.75 per metric ton, which is lower than producers' current per ton average income. The portfolio that provides the highest revenue consists of selling 17% and 83% of the rice through SM and FC, respectively. The venue associated with that portfolio is \$260.17 per metric ton. This value is higher than \$257.43, producers per ton average income.

The safest portfolio in the case of 3 GSs consists of selling 27%, 47% and 26% through IC, FC, FA, respectively. The revenue associated with that portfolio is \$247 per metric ton. The portfolio that provides the highest revenue combines 17%, 57%, and 13% of rice selling through SM, FC, and FA, respectively. The venue associated with that portfolio is \$257.10 per metric ton. The portfolio associated with the highest revenue is almost the same as the average producers' per ton of paddy income.

Table 4: Comparison of the possible combination of GSs

Combination of GSs	Portfolio (%)				Portfolio risk (variance)	Portfolio Revenue (\$/t)
	SM	IC	FC	FA		
2 Governance Structures						
SM and IC	27	73	-	-	173.31	232.65
SM and FC	17	-	83	-	103.37	260.17
SM and FA	23	-	-	77	160.87	252.76
IC and FC	-	34	66	-	82.25	246.75
IC and FA	-	46	-	54	114.77	237.17
FC and FA	-	-	64	36	91.38	256.34
3 Governance Structures						
SM, IC, and FC	13	30	57	-	68.33	248.5
SM, IC, and FA	15	40	-	45	93.91	240.68
SM, FC, and FA	13	-	57	30	77.42	257.10
IC, FC, and FA	-	27	47	26	65.37	247
4 Governance structures						
SM, IC, FC, and FA	10	25	43	22	56.05	248.41

Survey Benin, 2015

There is only a unique portfolio that provides the lowest risk in the case of the combination of four GS. That one consists of selling 10%, 25%, 43% and 22% of the paddy rice through SM, IC, FC, and FA, respectively.

The question raised after the identification of the possible portfolios and their associated outcomes, in terms of risk and revenue, concerns the one a producer should select in each case. The response to that question depends on the nature of the risk, positive or negative, and whether the producer is risk averse or risk loving. Accordingly, it is important to delve further into both options, namely the highest revenue and the lowest risk portfolio, in each case.

4.4. Simulation of the revenue derived from the highest revenue and lowest risk portfolio

4.4.1. Case of 2 GSs

Figure 4 shows the distribution of the revenue of the portfolio (34% of IC and 66% of FC) presenting the lowest risk and that (17% through SM and 83% through FC) presenting the highest revenue. Both the risk loving and risk averse producers will prefer the combination of SM and FC. Althogh that option is the most risky, the risk associated is in the positive sense. The high standard deviation associated with the revenue of that portfolio is due to the high prices on SM. Therefore, the risk loving producers will prefer it since they make more money because that portfolio has a thicker tail on the right side and risk averse producers will choose it since it has a thinner left-hand tail. Accordingly, the combination of SM and FC is the best portfolio if producers want to use two GSs. With such optimal portfolio, producers have 61% paercent chance to make more than the average per ton of paddy selling income.

4.4.2. Case of 3 GSs

Figure 5 shows the distribution of the revenue of the portfolio (27%, for IC, 47% for FC and 26% for FA) presenting the lowest risk and that (13% for SM, 57% for FC, and 30% for FA) presenting the highest revenue. Both the risk loving and risk averse producers will prefer the combination of SM and FC and FA. Althogh that option is the most risky as exactly in the case of two GS, the risk associated is in the positive sense. The risk loving producers will prefer it since they make more money because that portfolio has a thicker tail on the right side and risk averse producers will choose it since it has a thinner left-hand tail. By using the portfolio generating the highest revenue, producers have 47% chance to make more than the current average per ton of paddy selling revenue.

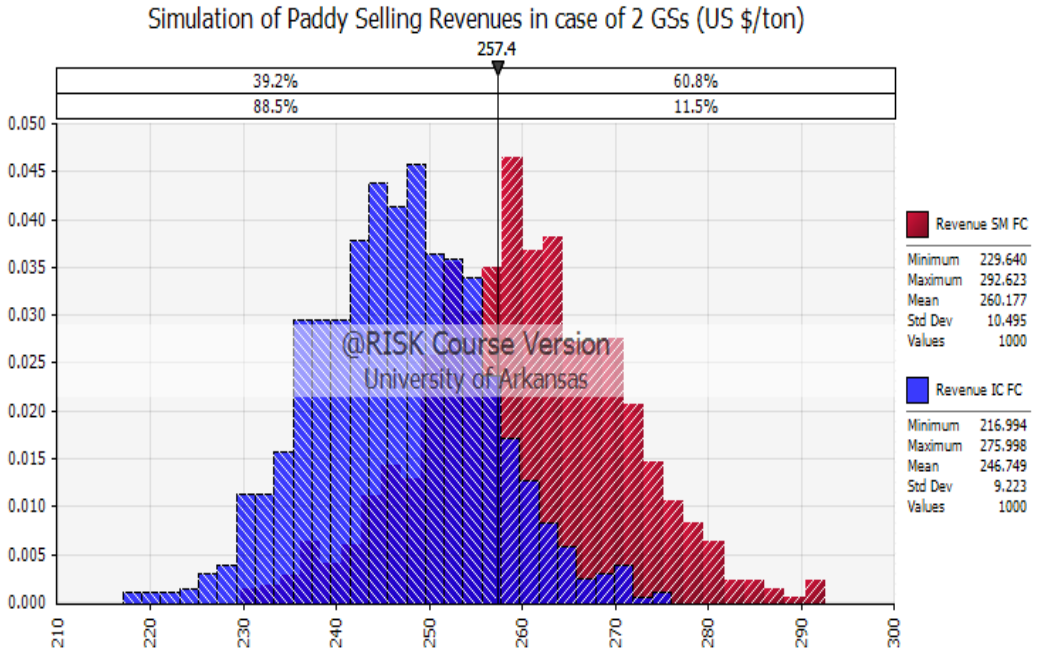

Figure 4: PDF of the revenue of highest return portfolio (SM and FC) and lowest risk one (IC and FC)

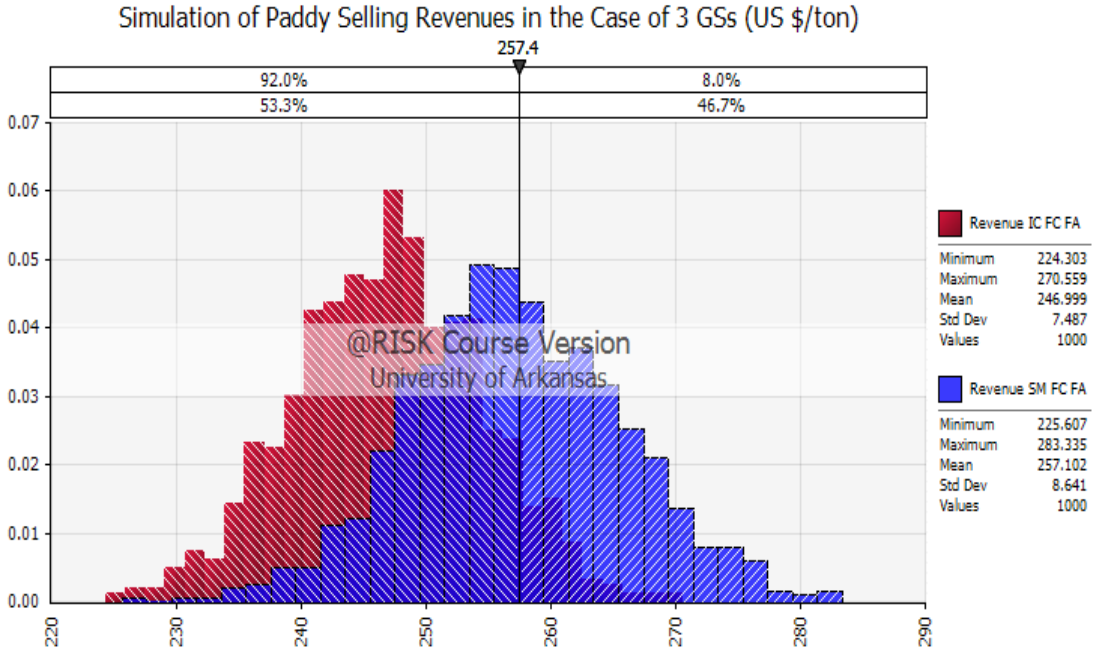

Figure 5: PDF of the revenue of the highest return portfolio (SM, FC, and FA) and lowest risk one (IC, FC, and FA)

4.4.3. Case of 4 GSs

Figure 6 shows the distribution of the revenue of the portfolio presenting the lowest risk for producers. That one consists of selling 10%, 25%, 43% and 22% of the paddy rice through SM, IC, FC, and FA, respectively. By using such a portfolio, the producers are 10% sure to make more than the current average per ton of paddy selling revenue. By willing to take greater risk, producers can increase the revenue of their portfolio.

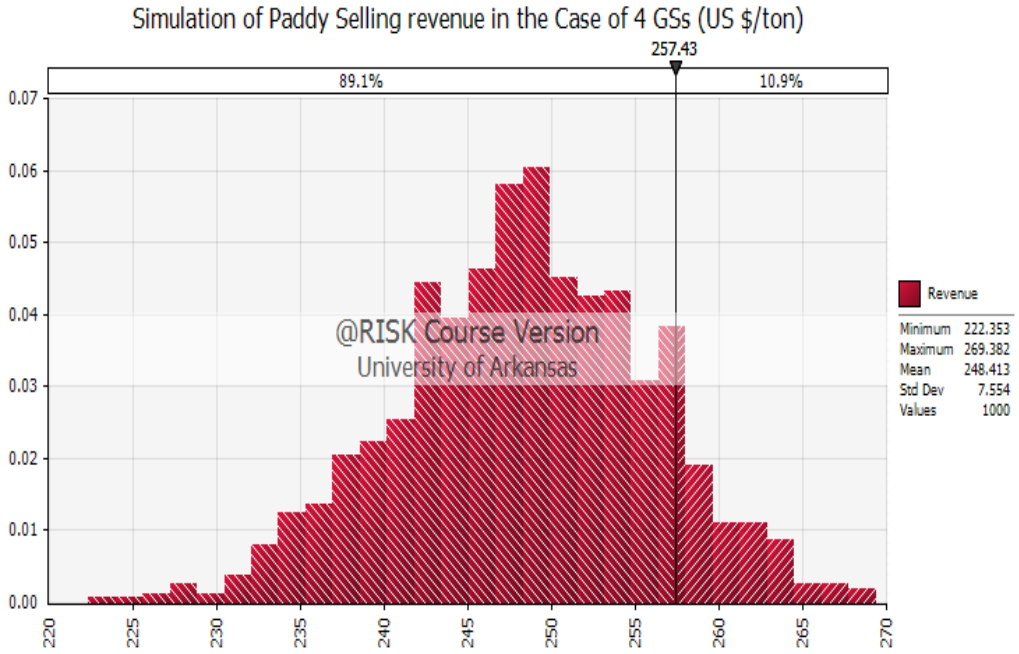

Figure 6: PDF of the revenue of the lowest risk portfolio

4.5. Efficiency frontier analysis for the best portfolios in each case

4.5.1. Case of two and three GSs

Figures 7 and 8 show the distribution of rice producers' revenues according to risk level when they use two and three GSs, respectively. In the case of two GS, the best portfolio consists of selling 17% and 83% through SM and FC, respectively. The venue associated with that portfolio is $260.17 per metric ton. Concerning the combination of three GS, the best portfolio consists of combining 17%, 57%, and 13% of rice selling through SM, FC, and FA, respectively. The revenue associated with that portfolio is $257.10 per metric ton. In both cases, when the risk of price fluctuation increases, the quantity sold through SM increases. The riskiest case consists of selling the entire quantity of rice on spot market. However, such choice provides the highest revenue. This high revenue is the reward of bearing risk for selling paddy on the spot market (Hardaker, 2004).

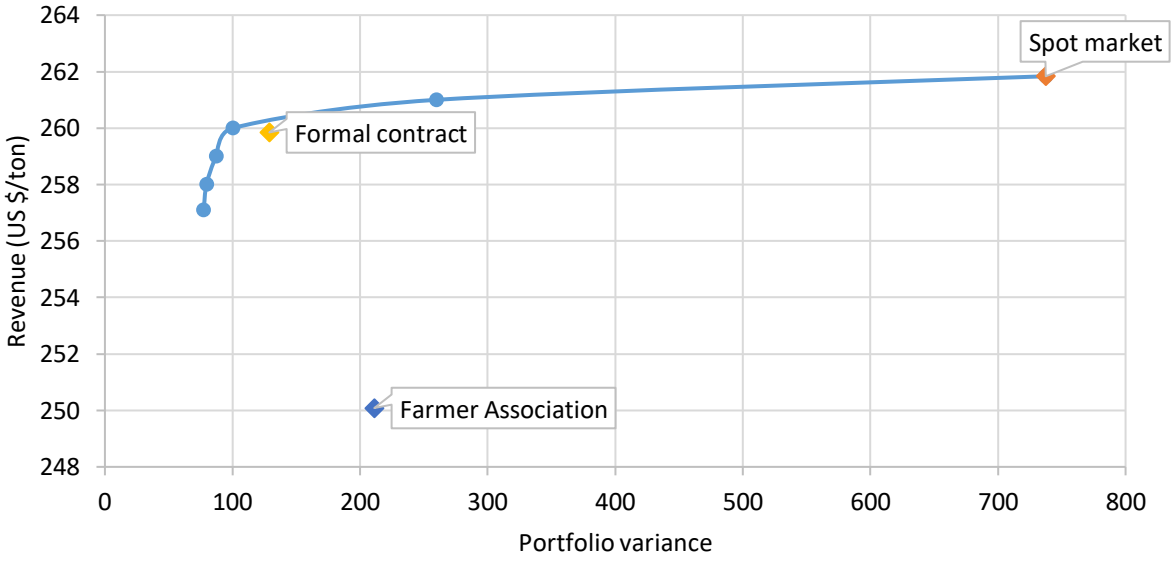

Figure 7: The Efficient Mean-Variance Frontier for the Selection of Two GS

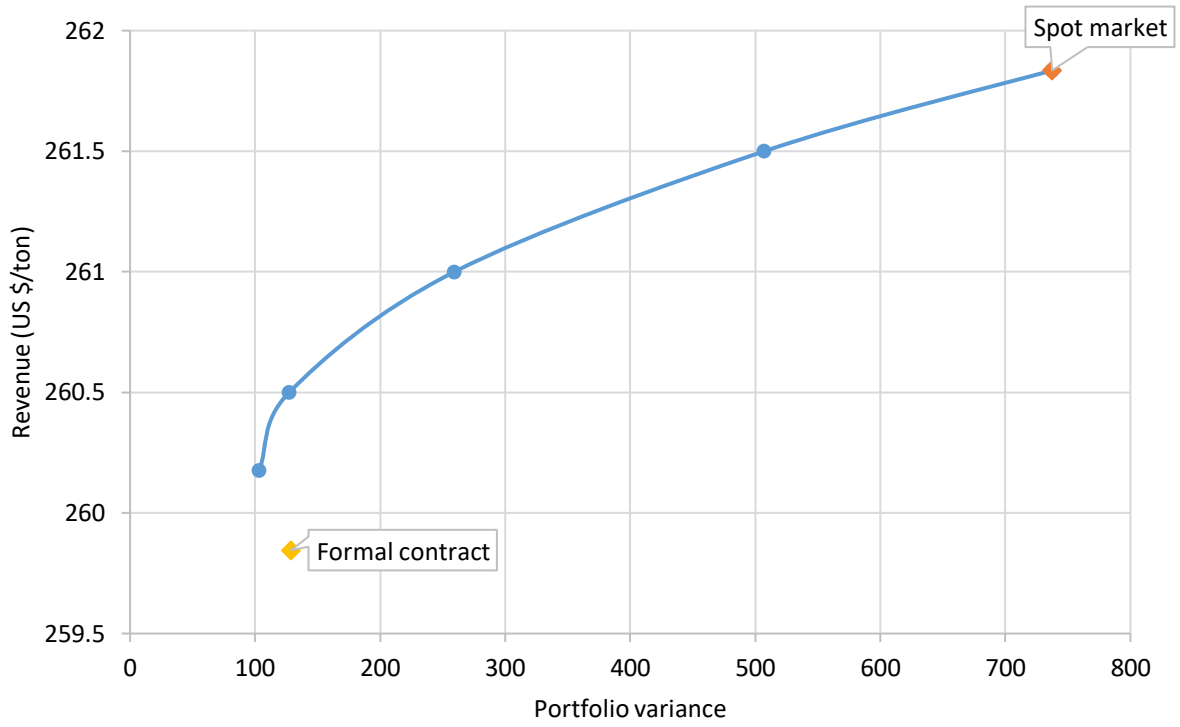

Figure 8: The Efficient Mean-Variance Frontier for the Selection of Three GS

4.5.2. Case of four GSs

Figure 9 shows the distribution of rice producers' revenues according to the risk level. The optimal solution, combining the optimal revenue to the lowest risk, is obtained by selling 10% of the production through SM, 25% through IC, 43% through FC, and 22% through FA. Considering that the revenue is computed for 1000 kg, the best portfolio will consist of selling 100 kg through SM, 250 kg through IC, 430 kg through FC and 220 kg through FA. The revenue associated with that portfolio is estimated at $248.41 per metric ton of paddy rice, which is below the current average revenue of producers. However, the producer is sure to get such amount. Although the spot market has the best price of selling of paddy rice, the best portfolio considers selling only 10% of the rice through that governance structure. Indeed, the spot market presents the highest variance of prices, and so the highest risk of revenue fluctuation. In opposite, formal contracts display the lowest risk, which make that governance structure heavily considered in the best portfolio.

In case the producers would like to ensure the minimum possible risk level, they should sell the totality of the rice through formal contracts. Conversely, all the rice should be sold on the spot market if the producers want the highest revenue. In this specific case, the risk associated with the revenue is also the highest.

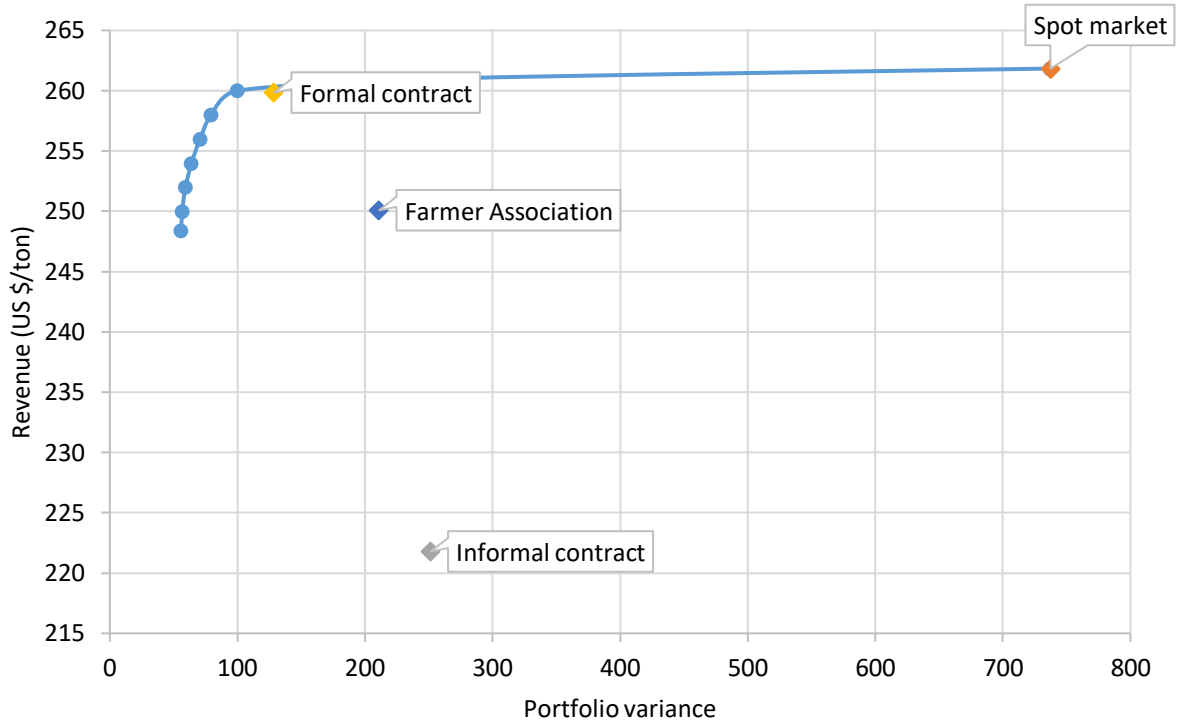

Figure 9: The Efficient Mean-Variance Frontier for the Selection of Four GS

5. Conclusion and discussion

Prices stability is of paramount importance to mitigate market risk and ensure producers' wellbeing. Producers will not be willing to invest in production or to increase it if they do not have appropriate strategies to deal with their products' prices fluctuation. The portfolio developed in this study can be used to advise producers about rice marketing. Such portfolio will reduce producer's vulnerability to price instability. The best portfolio identified in this study when the producers would like to use two, three, and four GSs include formal contract. As a result, the formal contracts play a key role in reducing producers' revenue fluctuation. This study suggests selling 83%, 57%, and 43% of the production through formal contracts when the producers decide to use, two, three, and four GSs, respectively. Such strategy allows producers to minimize the risk of revenue fluctuation. Accordingly, this study confirms the role of contract farming in hedging against income risk. According to MacDonal (2004), marketing contracts can be used to reduce income risk through the payment mechanism specified in the contract. A large body of literature support contract farming role in managing market risk (e.g. McBride & Key, 2002; Grosh, 1994; Bijman, 2008).

The findings of this study also suggest that producers should sell 30% and 22% of their production through association of producers when they use three and four GSs, respectively. This result is significantly different from that of Woldie (2010). This author suggests that an optimal earning is obtained if banana producers sell between 70% and 85% of their production to farmer cooperative. Due to formal contract role in reducing the risk of producer's income fluctuation, interventions aiming at reducing producers market risk should target formal contracts. Also, future research should focus on analyzing producer's willingness to accept formal contract's attributes. That research will identify important attributes that can be used to design contract that will more likely be successful.

CONFLIT D'INTERET

Les auteurs n'ont déclaré aucun conflit d'intérêt.

REFERENCES

Arinloye, D.-D. A. (2013). Governance, marketing and innovations in Beninese pineapple supply chains: A survey of smallholder farmers in South Benin. PhD thesis, Wageningen Universiteit, 194p.

Bailey, D., & Hunnicutt, L. (2002). The role of transaction costs in market selection: market selection in commercial feeder cattle operations. 2002 Annual meeting, July 28-31, Long Beach, CA (19894).

Bijman, J. (2008). "Contract Farming in Developing Countries: An Overview." Working Paper, Wageningen University.

Broll, U., Welzel, P., & Wong, K. P. (2013). Price risk and risk Management in Agriculture. Contemporary Economics, 7(2), 17-98. doi:10.5709/ce.1897-9254.79.

Carter, C.A. (1999). Commodity futures markets: a survey. The Australian Journal of Agricultural and Resource Economics, 43(2), 209-247. doi:10.1111/1467-8489.00077.

Grosh, B. (1994)."Contract Farming in Africa: An Application of the New Institutional Economics." Journal of African Economies, 3(2):231-261.

Hardaker, J. B. (2004). Coping with risk in agriculture. Cambridge, MA Wallingford, Oxford shire: CABI Pub.

Hull, J. (1991). Introduction to futures and options markets. Englewood Cliffs, NJ: Prentice Hall.

Ji, C., Felipe, d. J., Briz, J., & Trienekens, J. H. (2012). An Empirical Study on Governance Structure Choices in China's Pork Supply Chain. International Food and Agribusiness Management Review, 15(2), 121-152.

Kobzar, O. A. (2006). Whole-farm risk management in arable farming: portfolio methods for farm-specific business analysis and planning. PhD thesis, Wageningen Universiteit, 168p.

Kpenavoun, S. (2009). Réformes des marchés agricoles : coûts de transaction, choix des modes de transaction des producteurs et dynamique de l'efficience du marché des céréales : cas du maïs au Bénin. PhD Thesis, Université de Liège. Gembloux Agro-Bio Tech, 172p.

McBride, William & Nigel, Key. Economic and Structural Relationships in U.S. Hog Production. U.S. Department of Agriculture, Economic Research Service, Agricultural Economics Report No. 818, February, 2003.

Markowitz, H. (1959). Portfolio selection: efficient diversification of investments (Vol. 16). London; New Haven, Yale University Press.

Nalley, L. L., Barkley, A., Watkins, B., & Hignight, J. (2009). Enhancing Farm Profitability through Portfolio Analysis: The Case of Spatial Rice Variety Selection. Journal of Agricultural and Applied Economics, 41(3), 641-652. doi:10.1017/S1074070800003126.

Page, S., & Hewitt, A. (2001). World commodity prices: still a problem for developing countries? London: Overseas Development Institute.

Paulson, N. D., Katchova, A. L., & Lence, S. H. (2010). An Empirical Analysis of the Determinants of Marketing Contract Structures for Corn and Soybeans. Journal of Agricultural & Food Industrial Organization, 8(1). doi:10.2202/1542-0485.1282.

Rapsomanikis, G., & Sarris, A. (2008). Market Integration and Uncertainty: The Impact of Domestic and International Commodity Price Variability on Rural Household Income and Welfare in Ghana and Peru. The Journal of Development Studies, 44(9), 1354-1381. doi:10.1080/00220380802265439.

Sharpe, W. F. (1970). Portfolio theory and capital markets. New York: McGraw-Hill.

Unterschultz, J. R. (2000). Managing Market Risk in Western Canadian Agriculture. Canadian Journal of Agricultural Economics/Revue canadienne d'agroeconomie, 48(4), 527-537. doi:10.1111/j.1744-7976.2000.tb00408.x.

Williamson, O. E. (1975). Markets and hierarchies, analysis and antitrust implications: a study in the economics of internal organization. New York: Free Press.

Williamson, O. E. (1979). Transaction-cost economics: the governance of contractual relations. The journal of Law and Economics, 22(2), 233-261.

Woldie, G. A. (2010). Optimal farmer choice of marketing channels in the Ethiopian banana market. Journal of agricultural & food industrial organization, 8(1).