Metadata of the article that will be visualized in OnlineFirst

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2	Article Sub- Title		
3	Article Copyright - Year	**INRA and Springer-Verlag France 2016 (This will be the copyright line in the final PDF)**	
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45	Schedule	Received	4 September 2014
46		Revised	
47		Accepted	11 November 2015
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49	Keywords separated by ' - '	Competitiveness - Rice - Heterogeneous agent model - Benin - C21 - Q12 - Q18	
50	Foot note information		

Rev Agric Food Environ Stud
DOI 10.1007/s41130-016-0019-0

RESEARCH ARTICLE

Microeconomic analysis of the competitiveness of rice production in Benin

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Received: 4 September 2014 / Accepted: 11 November 2015

Abstract This paper aims at analysing the competitiveness of rice production in Benin in 2010. It uses the policy analysis matrix (PAM) as a tool and the heterogeneous agent model. Unlike previous studies, it assesses the competitiveness at the microeconomic level. The data used were collected in Benin from 265 rice farmers selected randomly. The results indicate that rice production is financially profitable for 84.2 % of the farmers and economically profitable for 63.4 % of them. Rice farmers do not have a comparative advantage on average in rice production. However, the analysis of the distribution of domestic resource costs (DRC) indicates that 63.4 % of rice farmers have a comparative advantage in rice production. The effective and nominal protection coefficients indicate that the majority of producers are subsidized. Yield, unit cost of labour and price of fertilizers are the main determinants of the producers' competitiveness.

Keywords Competitiveness · Rice · Heterogeneous agent model · Benin

JEL Classification C21 · Q12 · Q18

Introduction

Food security is a major development issue in Africa. Thus, freeing people from hunger is a constant challenge for leaders of developing countries. This requires policy makers to pay attention to certain products in the formulation of food security policies. Rice, with its ever-increasing consumption is one staple food which is crucial in the development strategies of most African countries.

Despite rising global prices, domestic demand for rice has been growing at a rapid pace in Africa in general due to changing consumer preferences, rising incomes and growing urban populations (Nwanze 2006). Thus, rice has changed from being a luxury to a staple food; indeed, once considered as a food of the rich and for holidays, rice has gradually become a common food item for ordinary people. The growth rate of rice consumption increased from 3.4 % between 2005 and 2007 to 7.9 % between 2008 and 2010 in Benin (FAO 2013). It is, therefore, necessary to make great efforts to meet the national requirements for this crop.

Benin's rice production was 49,245 and 124,975 tons in 2000 and 2010, respectively, against 17,476,516 and 26,373,695 tons for whole Africa. Benin's production represents 0.28 and 0.47 % in 2000 and 2010. Thus, in Benin, rice production has been increasing in parallel to the rise in consumption. The 2009–2010 cropping season showed a 174 % increase in national production compared with the 2001–2002 season (Adégbola et al. 2011a). Despite these changes seen in rice production in recent years, nowhere in Africa has production been able to keep pace with demand, and countries instead have come to rely on imports to fulfil demand. The growing dependency on rice imports threatens a country's scarce foreign currency reserves and may increase its vulnerability to global price shocks and hence raises overall concerns about food insecurity.

The goal of a government is to reduce imports and then become an exporter. Achieving this goal requires an improvement in the competitiveness of production not only to produce rice more efficiently but also to better face competition from imported rice. To do this, policy makers need to be informed with quality indicators which better reflect the reality of the national situation.

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Several studies have been conducted on the competitiveness of the rice sector in Benin through the policy analysis matrix (PAM), developed by Monke and Pearson (1989), for example, the work of Adégbola and Sodjinou (2003), Arouna and Affomassè (2005) and Adégbola et al. (2011b). These studies have been limited to an accounting model and have used the representative agent model using aggregate data in terms of averages to assess competitiveness. These authors confined their research to the assessment of the level of competitiveness, without determining factors explaining this competitiveness.

The present research aims at analysing the competitiveness of rice production in Benin in 2010. Unlike previous research in which indicators of PAM were estimated at the macro or meso level, this study measures the indicators at the micro level, that is to say, individual by individual. It exposes the limits of the representative agent model for analysing competitiveness. In addition, it investigates the factors explaining the competitiveness of rice production in Benin.

The rest of the paper is organized as follows. "Methodology" presents the methodology and "Results" discusses the results. At last, "Conclusions" concludes and offers some suggestions for improving rice competitiveness.

Methodology

Data used

The study used both primary and secondary data. The primary data were derived from agricultural surveys conducted by both the Africa Rice Centre (AfricaRice) and the National Institute of Agricultural Research in Benin (INRAB) in 2010. The data were collected from 265 rice farmers selected randomly. Secondary data were collected about transportation costs, port charges, storage costs, production subsidy, import/export tariffs and exchange rates. All this information was obtained from the National Institute of Statistics and Economic Analysis (INSAE), transporters, importers and the customs department.

Microeconomic framework of competitiveness

The producer theory is the basis for the analysis of microeconomic competitiveness. From this theory, the relationship can be made between the profit, which is a microeconomic concept, production costs and competitiveness.

The profits generated by a farm (π) can be expressed as:

$$\pi = \sum_j p_j y_j - \sum_k w_k x_k \quad (1)$$

where p is the price of the output j, y the quantity of output j, w the price of input k and x the quantity of input k.

The first term corresponds to the revenue and the second to the cost. The financial profit from rice production is of particular interest and is calculated using market prices. Economic profit is calculated using the same formula as the financial profit but the calculation uses economic prices. According to Tallec and Bockel (2005), economic prices are values that replace market prices in theoretical calculations when it is considered that the market price does not represent the true economic value of the good or service. Thus, the economic prices are exempt from all distortions. For non-tradable inputs like labour, the market price is considered as the economic price. For tradable inputs, the economic price is derived from the market price by subtracting taxes and adding subsidies. Regarding the economic price of rice, the 25 % broken Pakistani rice has been considered as an equivalent to local rice. Thus, information on the structure of the price of this rice was used to calculate rice parity price. There are import parity price and export parity price. The import parity price of a product is equal to its border price plus transport costs (including any processing and transformation costs) and all expenses (other than taxes and subsidies) intervening between the point of entry and the place of consumption. The export parity price of a product is equal to its border price *minus* transport costs (including any processing and transformation costs) and all expenses (other than taxes and subsidies) intervening between the place of production and the point of exit (Tallec and Bockel 2005). This research uses the import parity price of rice.

According to Nézeys (1993), there are four types of competitiveness: price competitiveness, technological competitiveness, structural competitiveness and cost competitiveness. This research focuses on cost competitiveness. Price competitiveness is the ability for a country or a farm to offer prices lower than those of competitors. Technological competitiveness relates to innovation, research and the accumulation of technological knowledge. Structural competitiveness is the strength and efficiency of a national economy's productive structures, its technical infrastructure and other factors determining the "externalities" in which firms can build (Chesnais 1986). Cost competitiveness is the ability of a business to compete with others on the basis of its cost of production. This research focuses on cost competitiveness.

The domestic cost ratio (DRC) is a measure of comparative advantage and cost competitiveness. From Eq. (1), it is possible to derive the concept of DRC based on economic prices.

In a market economy, the main objective of the producer is to maximize its financial profit (π). Assuming the farm produces only rice, Eq. (1) becomes

$$\pi = py - \sum_k w_k x_k \quad (2)$$

where p and y relate to rice production.

The business is profitable for the producer if π is positive, that is to say, if the value of the product (here rice) is greater

than the total cost of inputs used to produce it. A positive profit may come from the work of the producer or from a transfer of resource from society. The transfer is known, in economic jargon, as a subsidy. So, what is the competitiveness of the production activity without the subsidies? And what would be the competitiveness of the production activity without the various distortions? These questions demonstrate the importance of estimating the economic price and then economic profit.

From the expression of financial profit defined above, it is possible to derive the concept of economic profit and DRC, which are both based on the reference price. Considering the final good (that is to say rice), the inputs used to produce it can be broken down as follows:

- Imported inputs (m), called tradable goods, and which may undergo taxes or receive subsidies
- Local resources or domestic factors (l), called non-tradable goods. They are not subject to taxes and not subsidized

Taking into account this decomposition, economic profit (EP) for producing rice is given as follows:

$$\mathrm{EP} = py - \sum_m w_m x_m - \sum_l w_l x_l \tag{3}$$

A good is economically profitable if its economic profit is positive. If more than one type of good is produced and if we want to compare the economic profits of these goods, it is sometimes difficult to allocate resources, especially if the goods are not expressed in the same units or if they are produced using different technologies. To neutralize the effect of units and technologies of production, the notion of DRC has been developed by arithmetic manipulation of economic profit. From Eq. (3), EP > 0 if

$$py - \sum_m w_m x_m > \sum_l w_l x_l \tag{4}$$

This implies that

$$1 > \frac{\sum_l w_l x_l}{py - \sum_m w_m x_m} \tag{5}$$

where

$$\mathrm{DRC} = \frac{\sum_l w_l x_l}{py - \sum_m w_m x_m} \tag{6}$$

Thus, when the DRC ratio is strictly positive but less than 1, it indicates that domestic production of the specific good is internationally competitive: the opportunity costs of domestic production (the numerator) are less than the added value of the output at world prices (the denominator). Considering the farm level, it indicates that this firm contributes to the strong positioning of the country to export the product. At the national level, it indicates that the country should export more of the good under consideration. A DRC greater than 1 or less than 0 (when the denominator is negative) shows a lack of competitiveness for the good, and thus the low desirability of domestic production compared to the international market.

Policy analysis matrix: limits and criticisms

The different indicators used to assess competitiveness and draw policy recommendations are derived from PAM. Despite its advantages, PAM has been the subject of several criticisms. The main criticism is that the PAM is a static model. In addition, it assesses only the direct effects of policy measures. It does not take into account the interactions between the sector studied and other sectors of the economy. Further, PAM uses world prices as reference prices for tradable inputs and these prices may be subject to many distortions, particularly because of the protectionist policies of developed countries. Finally, PAM is based on the assumption that production is characterized by a Leontief technology with fixed technical coefficients (Nelson and Panggabean 1991).

In addition to its limits, PAM is based on the representative agent model. Financial and economic budgets are developed for an individual who is assumed to represent all economic agents of a given category (e.g., producers, processors, traders) or using a particular technology in a particular area. However, the representative agent model has been criticized by many economists (Lucas 1976; Kirman 1992; An et al. 2009). Among the most sophisticated critics, Kirman (1992) considers that the reduction of a group of heterogeneous agents to a representative agent is not simply an analytical convenience but is unjustified and often leads to erroneous and misleading conclusions. Taking a similar view to Kirman (1992), An et al. (2009) have shown that it is often not possible to account for the overall behaviour of an economy based on a fictional representative household. Taking the example of the consumption and the aggregate real wages, An et al. (2009) show that taking into account fluctuations in a macroeconomic time series using the optimality conditions of a representative household requires preferences that are inconsistent with economic theory.

The calculation of indicators of PAM at the macro level is often justified by the absence or lack of data at the individual level. However, even when aggregation is perfect, some authors suggest that measuring the competitiveness of a country

or a sector does not make sense. According to these authors, the important thing is the individual competitiveness of enterprises or farms (Brinkman 1987; Harrison and Kinnedy 1997; Krugman 1994). According to Porter (1990), seeking to explain the national competitiveness is inappropriate. The most determined opponent, by far, to the concept of competitiveness applied to a country is Krugman (1994), who suggests that the use of this concept to determine the level of competitiveness of a country is a dangerous obsession.

Determinants of competitiveness

New developments in the theory of economic growth (Grossman and Helpman 1990) and of industrial organization (Jacquemin 1987), both representing a response to the limitations of the neoclassical model, helped shed light on the factors affecting competitiveness (Lachaal 2001). These factors have been addressed in several ways in the literature but in fact they share some similar aspects.

Lachaal (2001) has distinguished national factors from international factors. Nationally, resource endowments, technology, productivity, product characteristics, fiscal and monetary control, and, at last, trade policy seem to be the most important factors that determine the competitiveness of an industry and/or firm. At the international level, competitiveness depends on a multitude of factors. Among the most important are the exchange rate, the international market conditions, the cost of international transport and finally preferences and arrangements between different countries.

According to Latruffe (2010), some determinants are controllable by farmers while other determinants are beyond farmers' control. The first category includes the size of the farm; its organizational type; factor intensity; farm specialization; degree of commercialization; and social capital which includes the farmer's age, education level/type, gender and time spent on farm. These social capital variables are often included as proxies of the farmer's management capacity which are not directly observable. The second category includes the national factor endowments (i.e. resources in labour, land and capital) and demand conditions (i.e. the population's tastes and preferences for products), government intervention in the agricultural sector, public expenditures in research, extension and infrastructures and finally the location of activities.

Courleux and Dedieu (2012) identified three types of determinants of cost competitiveness: soil and climatic factors and the location of activities, technical factors relating, and economic efficiency factors relating to general economic conditions. The soil and climate factors and location of agricultural activities are very important as these are strongly influenced by weather conditions. By affecting yields, soil and climatic conditions determine, to a large extent, production costs incurred for each unit produced.

Factors relating to the technical and economic efficiency are, in contrast to the soil and climatic factors, directly attributable to the choice of the producer in the organization of the production system. One way to address technical efficiency is the notion of "physical productivity" of inputs, that is to say the ability to produce a *maximum* number of units from a given set of inputs, e.g. the number of tonnes of grain produced on a hectare.

The general policy and regulatory framework obviously affect the cost competitiveness of agriculture and food of a country. The determinants relating to policy and regulation include monetary and banking policies which affect the exchange rate and capacity for access to credit; direct and indirect taxation; and incentives induced by accounting standards, environmental and energy policies, availability and quality of transport infrastructure and logistics, labour policy, education, training, research and extension, health standards, competition policy, trade policy and support to the agricultural sector and territorial policies (Courleux and Dedieu 2012).

Analytical techniques

This research uses PAM (Monke and Pearson 1989) to assess the competitiveness of rice production. Unlike previous studies (Adégbola and Sodjinou 2003; Arouna and Affomassè 2005; Adégbola et al. 2011b), where PAM was developed at the macro- or mesoeconomic level, this research has developed PAM at the microeconomic level, that is, for the individual. Therefore, the DRC which is used to appreciate the level of competitiveness has been calculated *per* individual (i.e. producer), and regression has been performed on these DRC to determine the factors explaining the competitiveness of rice production.

PAM is a double-entry accounting matrix used for analysis of the competitiveness and comparative advantage of commodity systems in an open economy. To apply the PAM method, the first step was the construction of a table of private budgets of production activities, using quantities and prices of inputs and outputs at actual market values. The next step led to the construction of a table of social budgets, using economic prices for corresponding inputs and outputs. The economic prices of tradable commodities are given by comparable world prices. These prices were compared with domestic prices at the same location (farm gate), over the same period, and with comparable quality. Table 1 shows the structure of PAM.

Several indicators can be derived from PAM. They include EPC, NPC and DRC. The EPC = (A − B) / (E − F) is equal to the ratio of value added using private prices (A − B) to value added using economic prices (E − F). An EPC value greater than 1 suggests that government policies provide positive incentives to producers, while values less than 1 indicate that producers are unprotected through

Q1

t1.1 **Table 1** Structure of policy analysis matrix (PAM)

t1.2		Revenues	Costs		Profits
t1.3			Tradable inputs	Domestic factors	
t1.4	Private prices	A	B	C	D
t1.5	Economic prices	E	F	G	H
t1.6	Divergences	I	J	K	L

Source: Monke and Pearson (1989)

policy interventions. NPC is the ratio of private prices to economic prices and can be estimated for both revenue (output) (namely A/E) and cost (namely B + C / F + G). If the ratio is greater than 1, it means that producers are protected or receive subsidies. The reverse is true for the case of taxation. The DRC = G / (E − F) measures the comparative advantage or cost competitiveness.

Main assumptions

In order to achieve the objectives, some assumptions were made.

Twenty-five percent broken Pakistani rice was shown by Houndékon (1996) to be the equivalent of local rice in Benin, and it has been used to calculate rice parity price.

In 2010, the average annual official exchange rate was US$1 to 486.12 CFA francs (FCFA). Therefore, US$1 is equivalent to 486.12 FCFA. The exchange rate on the parallel market was 500 FCFA.

The "free on board"[1] price of 25 % broken Pakistani rice was US$148/ton.

The cost of every input was separated into tradable and non-tradable components; thus, every cost of input is divided into two parts. Some inputs have greater proportion of tradable element than others. For example, labour and land are regarded as 100 % non-tradable, since labour used is usually unskilled. Material inputs such as machinery and fertilizers tend to have a significant proportion of tradable elements. The decomposition coefficients of intermediate inputs, which contain tradable and non-tradable inputs, are identical to those of Lançon (2000). As regard to small machinery use, the coefficient corresponding to unskilled labour is 0.4. Those corresponding to capital and tradable inputs are, respectively, 0.1 and 0.5. With regard to agricultural equipments, the values are 0.1 for unskilled labour, 0.1 for capital and 0.8 for tradable inputs.

[1] The free on board price is a term of sale under which the price invoiced or quoted by a seller includes all charges up to placing the goods on board a ship at the port of departure specified by the buyer.

Empirical model: factors explaining producers' competitiveness

The logarithm of the producers' DRC ($DRCpro_i$) is regressed on a set of potential determinants, including input costs and the share of capital in costs (z_i^1 to z_i^3), sociodemographic characteristics of the producer (h_i^1 to h_i^4), yield, type of ecological zone of the farm, household size, access to credit and department (i.e. administrative area) where the producer is located. The demographic characteristics of the household are included in the model to take into account the competitiveness potential of each producer. The ecological zone and the department can control for some of the variability due to agro-climatic characteristics of the production environment. Access to credit can capture the impact of credit policies.

$$\ln(DRCpro_i) = \alpha + \beta_1 h_i^1 + \beta_2 h_i^2 + \beta_3 h_i^3 + \beta_4 h_i^4 + \lambda_1 \ln(z_i^1) + \lambda_2 \ln(z_i^2) + \lambda_3 \ln(z_i^3) + \gamma \ln(Yield_i) + \delta Dep_i + \mu Eco_i + \tau HS_i + \rho Crd_i + \varepsilon_i \quad (7)$$

$DRCpro_i$	DRC of producer *i*
h_i^1	Binary variable indicating whether the head of farm has followed agricultural training (1 if yes, 0 if no)
h_i^2	Binary variable indicating the gender of the producer (1 if male, 0 if female)
h_i^3	Binary variable indicating the main activity of the producer (1 if agriculture, 0 if other)
h_i^4	Binary variable indicating the duration the activity was carried out in the producer's home village (1 if ≥10 years, 0 if <10 years)
z_i^1	Price of fertilizer used in rice production (in FCFA/kg)
z_i^2	Unit cost of labour of rice production (in FCFA/person day)
z_i^3	Share of capital in the total cost
$Yield_i$	Rice yield (kg/ha)
Dep_i	Binary variable indicating the department of producer (1 if Collines, 0 if Atacora)
Eco_i	Categorical variable indicating the type of ecological zone of the farm (1 if upland, 2 if lowland, 3 if other)
HS_i	Household size
Crd_i	Binary variable indicating whether the producer has received credit (1 if yes, 0 if no)
ε_i	Error term

The model was estimated by ordinary least squares. Heteroscedasticity was corrected by White's method. The assumption of normality of the residuals was verified by the Kolmogorov–Smirnov test. The existence of multicollinearity was assessed using a correlation matrix.

Results

Socioeconomic characteristics of rice farmers surveyed

Table 2 shows descriptive statistics of the sample of rice farmers surveyed. The average total endowment of land for farms is 2.21 ha. The average cultivated rice area is 0.73 ha. This value represents about a third of the farm total area. In Benin, the average small farms' cultivated area is 1.74 ha (Honkpehedji and Agbo 2009). The heads of farm are aged 50 years on average and are usually men (78 % of the sample).

The main inputs used in rice production are labour, seeds, fertilizers and herbicides. Hired labour average wage is 955 FCFA *per* person day. The average quantity of seed used *per* hectare of rice is 59 kg. This value is about the recommendation (50–60 kg/ha) for a germination rate above 80 % (Akintayo et al. 2008). Most producers (87 %) use seeds from previous harvest.

Unlike the seeds, mineral fertilizers are purchased when the producer decides to use them. The average amount of mineral fertilizer applied *per* hectare is 144 kg. This dosis is less than the recommendation (200–300 kg/ha) (Akintayo et al. 2008). Furthermore, the use of herbicides in rice production is very limited (about 10 % of rice farms).

Financial and economic profitability

Figure 1 shows that for all rice farms, the financial profit varies from −483.52 to 357.24 FCFA/kg. The average financial profit is 78.41 FCFA/kg. This result indicates that rice production is financially profitable (Kinkingninhoun 2003; Chanou 2006; Danhousi 2007; Yegbemey 2010) for an average producer. A detailed analysis of the results shows that there are three relatively homogeneous groups of rice farmers. The first subgroup consists of rice farmers who produce at a loss. They represent 15.85 % (42 producers) of rice farmers and have an average loss of 91.25 FCFA/kg. The second subgroup consists of the rice farmers who earn below the average of all rice farmers. They represent 36.22 % (96 producers) of rice producers with an average profit of 45.25 FCFA/kg. The third subgroup consists of rice farmers who make profits above the average of all rice farmers and is made up of 47.92 % (127 producers) of rice producers. Their average profit is 159.6 FCFA/kg.

Figure 2 shows that the economic profits of rice production vary from −443.08 to 95.77 FCFA/kg. The average social loss is 3.49 FCFA/kg. From this average, it could be concluded that the average rice farmer does not contribute to wealth creation at national level; there is a transfer of resources from society toward the rice farmers. However, the analysis of the distribution of economic profits shows that 63.4 % of rice producers present a positive economic profit. There is therefore a transfer of resources from those rice producers to society. Thus, the policy interventions based on such an average will not have the desired impacts. The representative agent in this case has a behaviour which is opposite to that of the majority of individuals. To better focus interventions, farmers could be divided, in this case, into two relatively homogeneous groups: those who produce rice with negative economic profits and those who make positive economic profits. The first subgroup represents 36.6 % of rice producers with an average loss of 85.03 FCFA/kg. The second subgroup includes 63.4 % of rice producers. They have an average economic profit of 43.58 FCFA/kg. Such a distribution of rice producers could help

Table 2 Descriptive characteristics of the sample

Characteristics	Minimum	Means	Maximum
Total farm area (ha)	0.8	2.21	18.4
Cultivated rice area (ha)	0.4	0.73	8
Male farmers (% of farmers)	–	78.11	–
Main activity is agriculture (% of farmers)	–	91.69	–
Duration in rice production (years)	3	12	23
Age of head of farm (years)	18	50.09	90
Household size	01	5.85	18
Access to credit (% of farmers)	–	25.28	–
Access to training (% of farmers)	–	54.72	–
Quantity of fertilizer (kg/ha)		144.30	
Price of fertilizer (FCFA/kg)	88.25	187.79	391.66
Quantity of seed (kg/ha)	34	59	123.5
Wage rate (FCFA/day)	66	955.55	3291
Value of paddy rice production (FCFA/kg)	75	176.37	411.26
Number of observations		265	

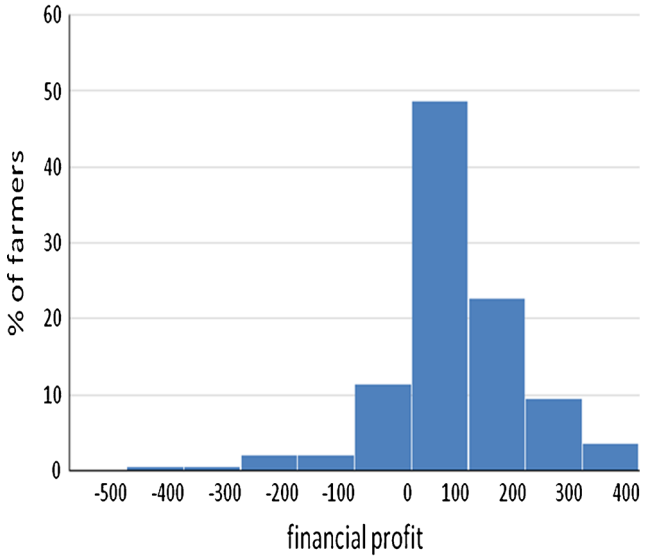

Fig. 1 Distribution of financial profits of producers (FCFA/kg)

target interventions through a more appropriate formulation of policy measures in favour of rice producers.

Analysis of competitiveness

Figure 3 shows that the DRC of producers varies between 0.02 and 6.56. The average DRC is 1.18. From this average DRC, it can be concluded that for 1 FCFA of added value produced in the production of rice, the resources used exceed 1 FCFA. There is thus a loss of wealth for the society. Rice production in Benin is not competitive. However, analysis of the distribution of DRC reveals that 63.4 % of rice producers have a DRC between 0 and 1. That is to say, for 1 FCFA of added value generated in the production of rice, these farmers use resources of value less than 1 FCFA. Therefore, the majority of producers are competitive. In this case, the representative agent reflects the opposite situation of that for the majority of rice producers. Thus, policy measures formulated based on the average value would be incorrect. Further, expenditures for the implementation of these policy measures would constitute waste. This result demonstrates the advantage of the approach used for this research and confirms the view of Kirman (1992) who stated that the reduction of a group of heterogeneous agents to a representative agent is unjustified and leads to conclusions that are usually misleading and often wrong.

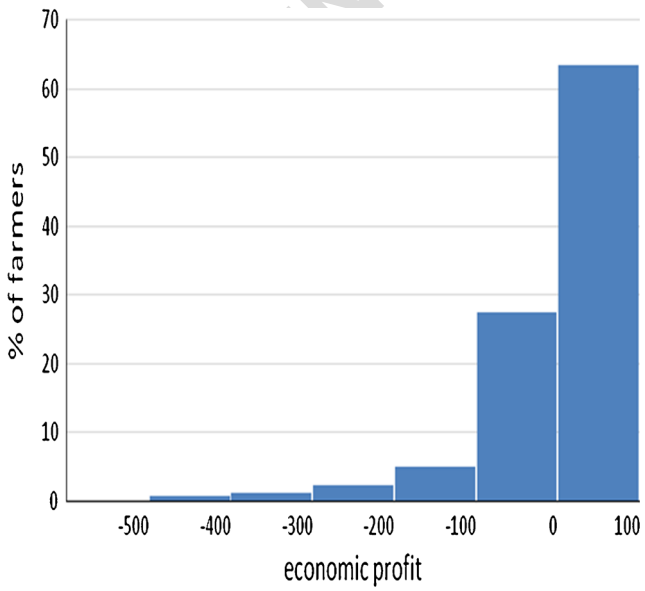

Fig. 2 Distribution of economic profits of producers (FCFA/kg)

Analysis of public policies

Figure 4 shows that 95 % of rice producers have an NPC greater than 1. Thus, these rice producers earn more than what they would in the absence of policy and market distortions. There is therefore a positive protection of rice farmers through the production subsidy. Among the producers who are competitive, 94 % earn more than they would in the absence of policy and market distortion, with an average value of NPC of 1.78. For rice producers who are not competitive, 98 % are favoured with 2.05 as the average NPC. Producers who are not competitive, that is those who use more resources than they generate, are more favoured by policy measures and market distortions than those who are competitive.

Figure 5 shows the distribution of EPC of rice producers; 95.85 % of rice producers have an EPC greater than 1 and less than zero. Thus, the majority of producers receive implicit subsidies. Among the producers who are competitive, 94.6 % are implicitly subsidized with an average value of EPC of 0.35. Therefore, they receive a subsidy of 35 %. For rice producers who are not competitive, 97 % are subsidized, at an average of 44 %. Producers who are not competitive (those who use more local resources than they generate) are more subsidized than those who are competitive. The average EPC of all rice producers is 2.26. From this value, it can be simply inferred that the average producer is subsidized. It is true that the analysis of the distribution of EPC shows that 95 % of rice producers are subsidized. But beyond this proportion, there are some realities that, if taken into account, would lead to more efficient government intervention. Among rice producers who are competitive, 5 % are taxed at 25 % on average, against 3 % who are taxed at 32 % on average for those who are not competitive.

Explanatory factors of producers' competitiveness

One of the advantages of the DRC estimation at the microeconomic level is that the results allow us to estimate an econometric model in order to determine the explanatory factors of competitiveness, such as it is commonly done in the case of

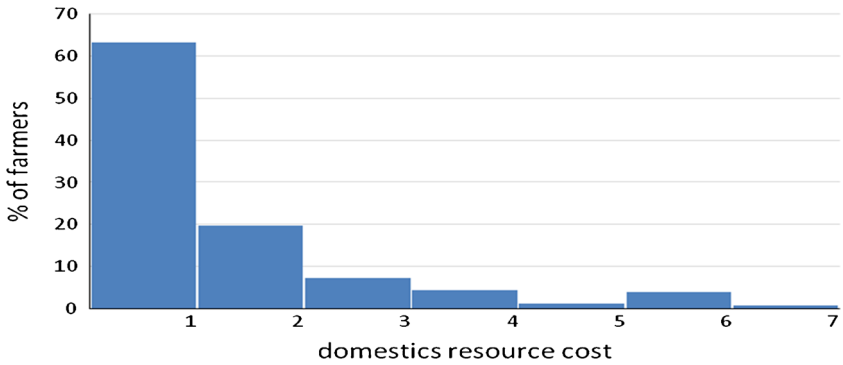

Fig. 3 Distribution of DRC of producers

producers' technical efficiency. The results of this econometric model are shown in Table 3. It should be firstly noted that the model is significant ($P<0.001$) at 1 %. Changes in the competitiveness of rice producers are explained for 56.07 % by variations in the characteristics introduced in the model ($R^2=0.5607$). The robust model is used to correct heteroscedasticity. The normality test of skewness/kurtosis indicates that there is not enough evidence to reject the assumption of normality of residuals ($P=0.33$). The correlation matrix of the explanatory variables shows that all correlation coefficients are less than 0.21.

It appears from the results shown in Table 3 that the area where the farm is located (department), yield, unit cost of labour, training, gender, price of fertilizer and share of capital in total costs have a significant impact on producers' competitiveness at 5 % or less. Household size has a significant impact at 10 %. Finally, the impact of the type of ecological zone, access to credit, age of farm managers, duration of the activity carried out in the village and main activity is not significant.

The elasticity of producers' DRC with respect to yield is −0.59. Thus, a 1 % increase in the yield of rice would decrease DRC by 0.59 %. The increase of yield therefore improves the competitiveness of producers. Adégbola and Sodjinou (2003) have shown that for all production systems, the higher the yield, the better the competitiveness of producers. Thus, our results are in agreement with Adégbola and Sodjinou (2003).

The elasticity of producers' DRC with respect to the unit cost of labour is 0.34. Thus, a 1 % increase in the unit cost of labour would increase DRC by 0.34 %. Thus, the lower the unit cost of labour, the greater the competitiveness is. The competitiveness of rice producers could therefore be improved through access to lower labour costs.

The elasticity of producers' DRC with respect to the share of capital in total cost of production is −0.43. Thus, a 1 % increase in the share of capital in total cost would decrease DRC by 0.43 %. So, the higher this share, the greater the competitiveness. This means that a suitable investment in capital can improve the level of competitiveness. Indeed, what inflates the capital cost is the purchase of big equipments, such as a tractor, or their renting.

The price of fertilizer has a positive and significant effect on competitiveness at 5 %. The elasticity of producers' DRC with respect to the price of fertilizer is 0.24. Thus, a 1 %

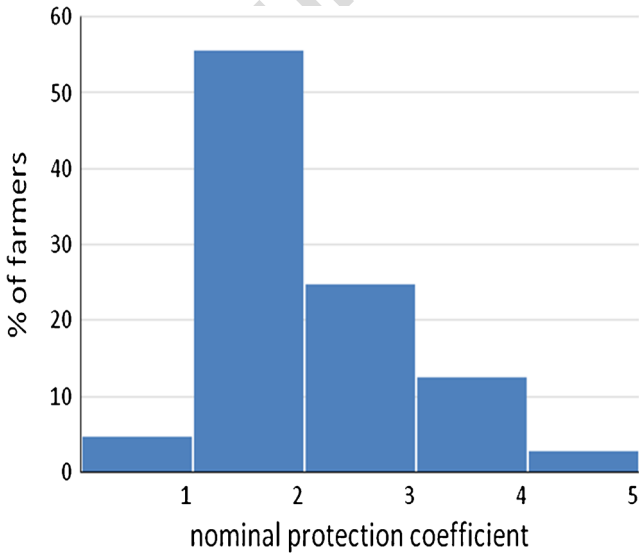

Fig. 4 Distribution of nominal protection coefficient (NPC)

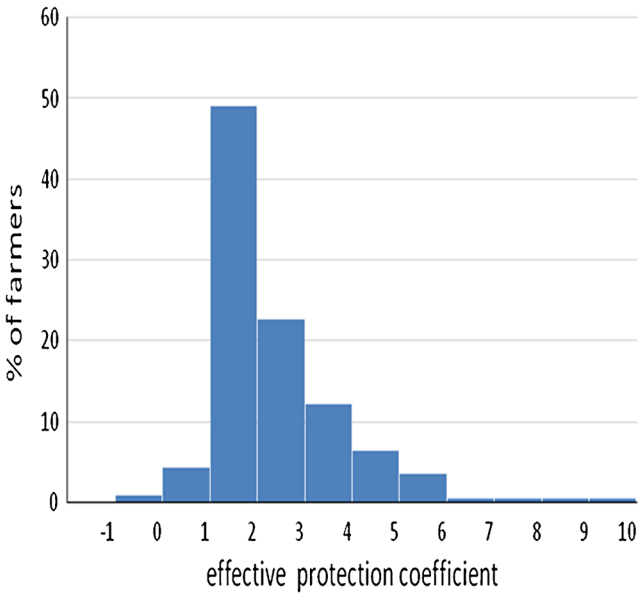

Fig. 5 Distribution of effective protection coefficient (EPC)

Q1

t3.1 **Table 3** Explanatory factors of the competitiveness of the producers

t3.2 Independent variables	Coefficients
t3.3 Location of the farm (department)	
t3.4 Collines	–
t3.5 Atacora	−0.499 (0.098)***
t3.6 Type of ecological zone	
t3.7 Other	–
t3.8 Upland	−0.32 (0.22)
t3.9 Lowland	0.13 (0.12)
t3.10 Gender	
t3.11 Male	–
t3.12 Female	−0.22 (0.11)**
t3.13 Yield	−0.59 (0.07)***
t3.14 Unit cost of labour	0.34 (0.07)***
t3.15 Household size	0.03 (0.01)*
t3.16 Access to credit	0.11 (0.11)
t3.17 Age	0.0001 (0.003)
t3.18 Training	−0.25 (0.09)***
t3.19 Share of capital in the total cost	−0.43 (0.04)***
t3.20 Price of fertilizer	0.24 (0.12)**
t3.21 Duration activity carried out in the village	
t3.22 <10 years	–
t3.23 ≥10 years	−0.16 (0.15)
t3.24 Main activity	
t3.25 Other	–
t3.26 Agriculture	0.04 (0.14)
t3.27 Constant	−5.03 (0.96)***

Logarithm of producers' DRC as the dependent variable. Robust standard errors in parentheses

*Significant at 10 %; **significant at 5 %; ***significant at 1 %

622 increase in the price of fertilizer increases the DRC by 0.24 %.
623 A policy which would allow purchase of fertilizer at low cost
624 would thus improve the competitiveness of producers.
625 The producer's education and gender have a positive and
626 significant effect at 5 % suggesting that women are more
627 competitive than men. This could be explained by the fact that
628 women often operate a small farm and it is easy for them to
629 better take care of it.

630 Conclusions

631 Benin's rice production has enormous potential. This article
632 aimed at analysing the competitiveness of rice producers in
633 2010 at the microeconomic level. Our main results are sum-
634 marized below.
635 Financial profits are positive for 84.2 % of the producers,
636 economic profits are positive for 63.4 % of the producers. The
637 distribution of producers' DRC indicates that 63.4 % of rice
638 producers are competitive. The average producer's DRC does
639 not reflect the image of the majority of rice producers.
640 Choosing the right policy implies identifying the cause of
641 the lack of competitiveness. Thus, based on this research, the
642 competitiveness of rice production could be improved through
643 actions focused on the determinants identified. Government
644 should favour the access of farmers to high yield varieties.
645 Furthermore, given the result that a high cost of labour has a
646 negative impact on competitiveness, policies must improve
647 farmers' access to equipment that can be partly substituted
648 to labour. In fact, at the time of harvesting lack of labour is
649 acute because every farmer wants to quickly harvest. That
650 situation increases the cost of labour and has a negative impact
651 on competitiveness. As a whole, to improve competitiveness,
652 policies should favour access to various inputs and at the low-
653 est price.
654 Improving the income of producers could contribute in
655 reducing the level of poverty. However, knowledge of the
656 actual situation of the study population is a prerequisite with-
657 out which policy measures could be harmful. This research
658 has confirmed that the representative agent model is less suit-
659 able for analysis especially when it comes to formulating pol-
660 icy measures. Indeed, the representative agent hides real het-
661 erogeneities. Improved intervention requires knowledge of
662 some details that the representative agent usually fails to
663 produce.
664 As shown in the paper, the representative agent model pre-
665 sents several limits. Thus, future research should less focus on
666 this approach in order to help design policies that reflect more
667 reality.

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