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REPORT

Ghanaian rice commodity chain comparative advantages

Frédéric Lançon

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• **iram Paris** (siège social)

49, rue de la Glacière 75013 Paris France

Tél. : 33 (0)1 44 08 67 67 • Fax : 33 (0)1 43 31 66 31

iram@iram-fr.org • www.iram-fr.org

• **iram Montpellier**

Parc scientifique Agropolis Bâtiment 3 •

34980 Montferrier le Lez France

Tél. : 33 (0)4 99 23 24 67 • Fax : 33 (0)4 99 23 24 68

Content

1. Introduction

This note is a follow-up to a study of the Ghanaian rice commodity chain carried out in the framework of a capacity building action for the GRIB (C.Coronel, 2008). Whereas the study focused on the rice market chain configuration, rice stakeholders' interactions and constraints and their business profitability, this note put the outcome of the study in a broader policy perspective by looking at the comparative advantage of the rice production. While the reader would certainly benefit from consulting the study report to get more insight into the organization of the rice commodity chain, this note can be read separately as it is.

The objective of this note is to provide GRIB members and secretariat several considerations on the current determinant of the efficiency of the rice economy and related critical issues in order to backstop their contribution to the policy debate. To facilitate the ownership of the content, references to analytical issues are limited as much as possible; experts can however refer to the detailed computations presented in appendix.

2. Rice policy issues in Ghana

The Ghanaian rice economy has acknowledged a remarkable transformation in the last decade with a rapid and sharp increase in per capita annual average consumption, which has shifted from around 10 kg in the mid-nineties up to 30 kg in the recent years (recent surveys indicates that per capita consumption in urban areas are above 40 kg). This rice diet transition is closely associated with the rapid increase of rice imports, which have increased at a commensurate pace during the last years, from around 100,000 tons in the mid-nineties to more than 400,000 tons in the recent years, Ghana becoming the fifth largest rice importer in Sub-Saharan Africa.

This rice diet transition have been triggered by a combination of factors including increasing urbanization of the Ghanaian population looking for more convenient food than meals based on traditional cereals, an increase in per capita income induced by the economic growth and by the low price of rice on the world market during the late 1990's and early 2000's. While the local rice economy has initially benefited from this rice market development and acknowledged an increase in its production from around 80,000 tons in the early nineties up to 150,000 tons in the late nineties (in milled rice equivalent), rice production is stagnating since then. Accordingly, the share of the domestic rice production in the total rice consumption has declined below 25%.

In order to support the local rice economy, a tariff of 20% has been enforced on rice import compounded with a Value Added Tax of 10% that is actually collected on imported rice only.

This policy option contrasts with the package of macro-economic and sectoral reforms implemented since the early nineties that led to an increasing openness of the Ghanaian economy to international competition.

The mitigated effect of this trade policy option has triggered a lively debate among policy makers and stakeholders of the local rice and imported rice commodity chain. An increase of the tariff has been considered for a while in 2003 and eventually rejected by decision makers, while stakeholders of the local rice economy are increasingly concerned by the enforcement of the ECOWAS Common Exterior Tariff in 2008 that would lead to a reduction of the tariff level to 10%, in line with the tariff applied in the West African Economic and Monetary Union. The recent sharp increase in the rice price on the world market is also a new element of the policy debate that should be taken into consideration.

In short the rice policy debate focuses on whether the local rice economy is able to operate in an economic environment open to the international competition or if its development requires the enforcement of a tariff on rice import. If the selected policy option is to enforce a tariff on rice import the ensuing question revolves around the level of the tariff that should be applied taking into consideration the interests of both rice producers and rice consumers and the actual impact of the tariff enforced on rice production profitability. Thus, the starting point of the policy debate is to assess to what extent the Ghanaian economy has a comparative advantage in producing rice.

3. Method for measuring the comparative advantage of an economic activity

3.1. The concept of comparative advantages

The concept of comparative advantages basically considers if a country should produce a good with its own domestic resources (labour, capital, land) to supply its population and possibly for export, or if it is more economically efficient to import this good and to allocate the spared domestic resources to the production of other goods for which the country has a comparative advantage.

The rationale of comparative advantage has been elaborated within the framework of the international trade and welfare economy theory, on the bases of which the policy packages of trade liberalization and public intervention reduction have been formulated. The underlying principle of this conceptual framework is that, if competition prevails, market forces (i.e. prices resulting from supply and demand confrontation) are the best mechanism for allocating resources (such as labour, capital, land) across various activities. Even though the relevance of this conceptual framework for understanding how an economy works is questioned by several scholars and practitioners it remains the dominant framework on the bases of which economic policy are formulated and as such keep a pivotal position in the policy debate. Hence, in practical terms any contribution to the policy debate will gain in impact and consideration if it refers even in a critical perspective to this framework.

3.2. The computation of a Policy Analysis Matrix

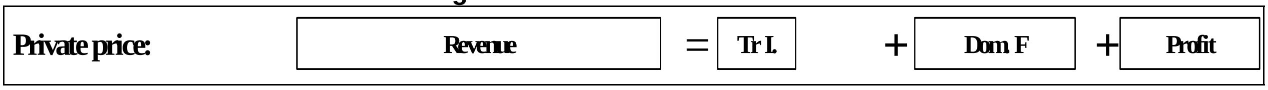
In practice, the comparative advantages of a productive system are measured through the computation of several accounting entities and ratios that have been gradually developed through applied research. In the eighties these computations have been consolidated into one analytical framework, named the Policy Analysis Matrix (PAM). This analytical framework has been widely used to assist in decision making through monitoring trade liberalization processes especially in European, South-East Asian and Sub-Saharan countries from the eighties onward.

The distinction between tradable goods and domestic factors is at the core of the conceptual framework. Tradables are goods and services that can be internationally traded and include both intermediate inputs required during the process of production (i.e. fertilizer, seeds, fuel, machines) and the final output of the production process (i.e. milled rice). It should be emphasized that tradables include any inputs and outputs even if they are not actually internationally traded (i.e. seeds produced by farmers are considered tradable, as well as fuel wood used for rice parboiling). The second category of costs are the domestic factors which include basically labour and capital (money) required to produce the final output, even though labour and capital cannot be any more considered as “pure” domestic factors in a globalized world where international migrations are frequent and where financial markets are increasingly integrated. However it is considered that the price or the value of domestic factors is mainly determined by local factor markets conditions, especially for labour.

This concept of "domestic factor" is central to the concept of the comparative advantages as they correspond to the resources available from which goods can be produced within the national economy. Since there is a limited quantity of domestic factors available, their optimal allocation and combination are crucial to ensure the maximum level of efficiency. The profit generated by a selected system is measured by subtracting tradable inputs and domestic factors values from total tradable output value. Considering that the total output sale is the revenue of the system, this accounting identity can be noted as: Revenue = Tradable input + Domestics Factors + Profit.

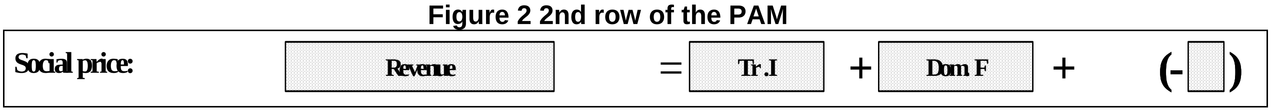
This accounting identity is computed using two price systems. The first line of the PAM contains the value for this accounting identity measured at private prices, which are the price currently used by the different agents to purchase their inputs and domestic factors and sell their outputs (Figure 1).

Figure 1: 1st row of the PAM



The second row of the PAM gives the value of the same identity when it is measured at social prices. Social prices are the prices that would prevail if the value of tradables (outputs and inputs) and domestic factors were not modified either by the economic policy in place (through tariff, tax, subsidy, price intervention) or by markets market imperfections (market segmentation, missing market) resulting in price levels that do not reflect the true scarcity of outputs, inputs and production factors. In short the second row of the PAM can be seen as a "benchmark" that will be used to asses the economic efficiency of the system (Figure 2).

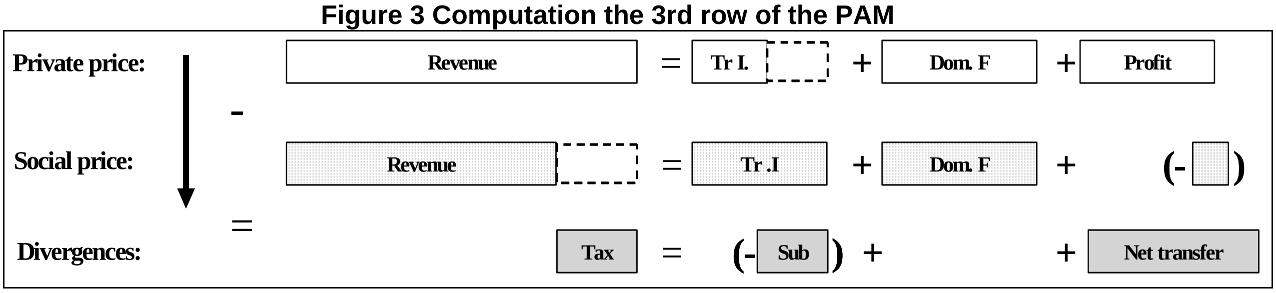
Figure 2 2nd row of the PAM



Consequently, the third row of the PAM obtained by subtracting the social values from the private values indicates the magnitude of the transfers induced by the current policy and market environment between the prevailing situation at private price and the optimal one at social price (

Figure 3).

Figure 3 Computation the 3rd row of the PAM



It is worth noting that the concept of "transfers" is not limited to the actual release of funds to the subsector under the form of public subsidies but also include "implicit subsidies" resulting from policy measures or market imperfections that modify input or output price levels. For instance a ban on the importation of a given output resulting in a high price on the local market for this output will be counted as a transfer to the rice sector from the rest of the economy because the consumers will pay a higher price for rice than they would have if the ban was not enforced. Further more, these transfers can be both positive (in favour of the system analyzed) or negative, when economic agents of a selected system will have to pay a higher price for purchasing a tradable input due to high level of taxation applied to import it. For instance a tax on fuel is considered as a transfer from the agents using fuel to the rest of the economy.

The PAM, a three-lines by three-column table, is built on the bases of these accounting identities and provide all the different accounting values needed (noted from A to L) to compute the ratios required for the analysis of the comparative advantages (Table 1).

Table 1 The Policy Analysis Matrix

	Revenues	Trad. Inp.	Domestic Fac	Profit
Market prices	A	B	C	D
Social prices	E	F	G	H
Divergences	I	J	K	L

3.3. Indicators of comparative advantages

The PAM provides straightforwardly a range of indicators for assessing the comparative advantages of a productive system. If D is positive the system generates profit under the current policy and market conditions and is said to be competitive or profitable.

Similarly, if H is positive the system is able to generate profit without benefiting from any transfer from the rest of the economic systems or conversely transferring resources to the rest of the economy; in this case the system is said to be economically efficient or to have a comparative advantages.

The computation of a single PAM for one specific system provides only a limited set of information for policy formulation that requires choosing between different alternatives. It is therefore much more relevant to build a PAM for different technical combinations of inputs and domestics factors or for different categories of outputs or for different periods of reference to analyze changes across time. The comparison of PAMs, developed for different technologies or different products, relies on the computation of ratios that are scale, product and time independent in order to derive meaningful comparison. Different types of ratio have been developed that provide indication on the different dimensions of the comparative advantages.

Several ratios can be computed on the basis of the PAM values assessing the comparative advantages of a given commodity chain from different perspectives. To shorten this methodological presentation we will only present the ratios that will be retained in the analysis hereafter.

The Domestic Cost Resources ratio (DRC) measures the level of comparative advantages achieved by the selected systems [DRC=G/(E-F)]. If the DRC is above one, the system has no comparative advantages, meaning that the production of one unit of output will mobilize more domestic resources than value added created. If the DRC is below one the system has a comparative advantages, and the system is said to be economically efficient.

4. Computing the PAM for selected Ghanaian rice commodity systems

4.1. Selection of the systems to be assessed

The rice study has characterized eleven rice commodity systems on the basis of the marketing channels (local, regional and inter-regional trade between surplus areas and main local rice consuming areas), the type of rice cropping systems (irrigated, lowland and upland rainfed), traders and milling technology (Engelberg and rubber roller). Consolidated accounts aggregating the costs and the revenue at the system level using observed "market prices" has been produced for each system. Three systems have been selected for the current analysis based on their explanatory capacity. We have focused on the so-called "inter-regional systems" targeting major urban markets (Kumasi, Accra, Techiman) where the competition between local and imported rice is more acute and can be considered as emblematic of the rice issue. We have also considered the larger system in terms of volume marketed and last but not least, systems that combine different types of technology at the farm and processing level and the type of milled rice marketed (parboiled milled rice or straight milled rice).

The characteristics of the three selected systems are presented in Table 2. Two systems (System 8 and 7) [1] target urban consumers in the central region (Ashanti, Bronga-Ahafo) supplied from the Northern region where the largest rice surplus are available. These two systems are mainly discriminated by the type of rice cropping systems associated: irrigated systems for system 8 and lowland unbunded rainfed system 7. This will allow taking into account in the analysis the effect of rice production technology intensification on the comparative advantages of the Ghanaian rice economy. The third system targets the Accra market from the surplus areas of the Volta region. It combines an improved milling technology (using rubber roller) and the production of paddy rice under rainfed upland conditions.

[1] In order to keep consistency with the study report the numbering of the systems have been kept as they were in the study report

Table 2: Main characteristics of the systems selected for computing the PAMs

Nb	System name	Marketing range	Origin	Destination	Farmer	Trader 1	Trader 2	Milling system	Final output
7	Northern to Kumasi	Inter-regional	Tolon/ Nanton	Kumasi	Unbunded lowland average	Inter-regional - Paddy - parboiled milled rice trader	Retailer Milled rice	Small mill (Engelberg) - 2 processing line	Parboiled milled rice
8	Upper east to Techiman	Inter-regional	Kassina	Techiman	Irrigated non-intensive	Inter-regional - Paddy - parboiled milled rice trader	Retailer Milled rice	Small mill (Engelberg) - 2 processing line	Parboiled milled rice
9	Volta to Accra	Inter-regional	Hohoe	Accra	Upland	Inter-regional - Paddy - milled rice trader	Retailer Milled rice	Medium mill (Rubber roller)	Straight milled rice

It is also important to underline that the three selected systems are the most profitable among the five inter-regional systems analyzed in the study: in principle they present the highest potential in term of competitiveness and possibly in terms of comparative advantage.

4.2. Computation and estimation of the parity price

The consolidated account for each system provides the information needed to compute the first line of the PAM. The computation of the second line will be derived from the estimation of parity price for tradable output and input; shadow price for the domestic factors will be adjusted on the bases of various assumptions. The reference year for the computation of the PAM is 2006.

1.1.1 Real exchange rate

The estimation of tradable good parity price should take into account any distortion that could prevail on the level of the nominal exchange rate (i.e. the exchange rate that apply to get foreign currency from a commercial bank). For instance, an over-valuation of the exchange rate means that less Cedi is needed to get one USD than it would be the case otherwise. Accordingly the price of the imported good in Ghanaian Cedi would be lower than the one that would prevails if the exchange rate would not have been affected by a particular policy measures (such as fixed exchange rate, public control on currency allocation to various importers….). Since the Ghanaian currency market has been liberalized in the last decades the level of distortion between the nominal exchange rate and the real exchange rate should be very limited (the exchange rate that would prevail without any distortions induced by the currency public policy). This is confirmed by the latest macro-economic review carried out by the International Monetary Fund (IMF, 2007). Accordingly while the average nominal exchange rate was computed at 9,170 Cedi for one USD in 2006, the real exchange rate applied to compute tradable parity price was increased by 5% at 9,600 Cedi for one USD.

1.1.2 Parity price for milled rice.

There is a large diversity of types of local and imported rice retailed on the Ghanaian market depending upon a number of quality attributes (perfume, non-perfume, parboiled, straight milled rice, origin of the production). In principle, the comparative advantage of a given commodity chain supposes that the domestic output should have the same attribute as the product available on the world market that will be taken as a reference to compute the parity price. The heterogeneity of the rice marketed requires formulating a particular rationale to compare the local and imported rice.

Looking at the international rice price, we take as a reference the 5% broken rice corresponding to the higher segment of the rice market, since up to the recent years the share of lower quality rice in the Ghanaian rice imports have been rather limited compared to the situation observed in other Western African countries. Furthermore, a large share of the rice imported in Ghana is likely to be parboiled rice (as in the case of Nigeria), which better fit to Ghanaian rice cooking habits and preference. Parboiled rice is generally marketed on the world market at a higher price than straight milled rice. Taking this category of imported rice as a reference might also be justified by the fact that the average income consumers' could shift to the local market if it is more sensitive to price.

Rice price on the world market varies according to their country of origin (Table 3). For instance the 5% broken rice exported by Thailand gets a higher price than the same category of rice exported from Vietnam. Accordingly, the parity price for the milled rice is computed on the bases of a weighted average of the price earned by major rice suppliers to Ghana. Based on data published by the US Department of Agriculture (USDA), USA, Thailand and Vietnam are major rice suppliers to Ghana and it is assumed that each country contribute on average to one third of total Ghanaian import. India might be a supplier but more irregularly. Eventually a parity price of 316 USD/ton has been taken to compute the PAM.

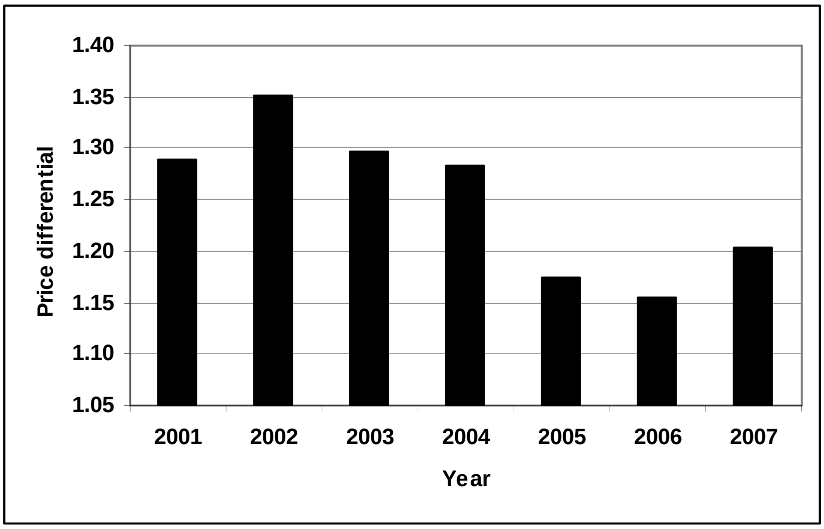
Table 3: International Rice price by category of quality (Annual average FOB; USD/ ton)

Years	IPO index of rice price	Type of rice									
		Usa2/4	Thai100	Thai5	Inde5	Viet5	Inde25	Thai25	Viet25	Pak25	A1Super
2003	87,0	275	201	196	191	183	166	176	167	175	151
2004	108,0	358	244	238	195	224	175	225	212	229	207
2005	118,0	304	291	285	285	256	235	258	240	236	219
2006	126,8	383	311	305	271	268	235	274	248	229	219
2007	143,6	442	337	328	298	312	278	307	294	284	270
Average		352	277	270	248	249	218	248	232	231	213

Source: http://www.arroz.agr.br/site/interarroz/interrice.php

Further to the determination of a world market price, it is also necessary to take into account price differential between local and imported rice induced by variation in quality. The average yearly price differential has been computed on the basis of the retail price data published by SRID at the national level from 2001 to 2007 (Figure 4). To take into account the decreasing trends of the price differential, a differential of 15% between local rice price and imported rice has been factored in for system 8 and 7, which use Engelberg milling technology, while the price differential has been reduced to 5% for the system 9 where paddy rice is milled with rubber roller. It should in principle produce a milled rice of higher quality compared to system 8 and 7.

Figure 4: Average Price differential between imported and local rice (national average)



Source: computed from SRID

1.1.3 Parity price for tradable input

The computation of parity price for tradable inputs consists in taking into account the level of tariff, tax or subsidy applied to the importation of these goods and to compute a parity price by deducting the value of the tariff or the tax and conversely by adding the value of any subsidy to the current market price. A list of tariff applied for deducting the parity price is attached in annex.

The purchase value of any good used by an agent of the rice commodity systems include a share of domestic factors mobilized to market the tradable input from the harbour to the place where the agent purchases the input. Thus the corresponding purchase value is broken down into a tradable, a labour and a capital component. By convention for tradable input such as fertilizer we assume that the labour and capital required to market the product represent only a minor share of the purchase value (10%).

The breakdown of complex inputs used by the agent of the commodity systems such as transport or milling services required the computation of representative budgets for each specific activity to estimate more precisely the respective share of tradable and domestic factors contained in the price paid by the farmer or the trader. A representative budget has been established for activities that represent a major share of the costs such as transport, milling services (for Engelberg and rubber roller technology) and mechanized agricultural operations (land preparation and harvesting). The decomposition of the purchase value allows also to take into account the impact of tariff and subsidy applied on the tradable use by the suppliers of such an activity on the corresponding parity price of the service. For instance, when the tariff and tax applied on fuel is deducted from the transport budget the parity price for the shipment of good is reduced by 12%. Conversely taking into account the implicit subsidy on electricity resulting from preferential tariff still enforced (World Bank, 2007) the cost of milling at parity price is increased by 19%. The coefficients used for decomposing the value of cost into tradable and domestic factors and the corresponding budget are attached in annex.

4.3. Determining the level of distortion on domestic factors

The estimation of the social value of the domestic factors is less straightforward as it cannot be backstopped by the value of similar input on the world market. A first adjustment can be made taking into account the impact of particular official regulation on factors costs, although no particular evidence of such distortion were found from the literature.

For capital, the interest rate offered by commercial bank is usually used as the opportunity cost faced by agents that invest their capital in a given economic activity. The opportunity cost of a trader who invests its capital in rice marketing will be equal to the value of the interest that it would perceived if he has deposited the same amount of money in a saving account, taking into account differences in the risk associated with the investment. In this case the interest rate proposed by the Bank of Ghana (12% per year) has been taken as the capital opportunity cost at market price. The capital opportunity cost at social price has been computed by deducting the inflation from the interest rate, which gives a rate of 3%.

The assessment of the labour opportunity cost is much more complex. For paid labour we assume that the wage paid to the labourer is the opportunity cost of the labour at both market and social price. For family labour used in rice farming it is not possible to assess thoroughly the opportunity cost of the labour allocated to rice cultivation without taking into account all the different income earning opportunities that the farmer's family would have on the farm and outside the farm. Given the variation that characterized the demand for paid labour in rural areas depending upon the cropping calendar and the type of activities it is difficult to assume that the wage that applied during peak season is representative of the labour value during the slack season of the cropping calendar, where demand for paid labour is very low. For instance, in the Hohoe upland rice production areas, the prevailing daily wage is 15,000 Cedi per day of labour. A rice farmer that would renounce to crop is plot to work as a labourer could only expect to get this income for a limited number of days during the season, let say about 30 days, meaning that his daily wage for the whole rice cropping season of 180 days would be much lower (30 days of labour x 15,000 cedi / 120 days of the whole season = 3,750 Cedi). However, on-farm and off-farm income opportunities should be also taken into consideration. Given the lack of information on this issue we have arbitrarily fixed the opportunity cost of farmers' family labour at 10,000 in the Northern region and at 12,000 in the Hohoe region which is closer to the coastal urbanized areas where more labour opportunities may prevail compared to the Northern region. For less demanding agricultural operations such as bird scaring, which represents a large amount of labour and that is often assigned to children the opportunity cost of labour have been reduced by half.

5. Comparative advantage of the selected rice commodity systems

The PAMs have been computed using specific spreadsheets, which are attached in appendix. The most salient results will be presented and discussed in this section.

5.1. PAMs computed for the selected systems

A first outcome of the computations is that the major source of divergence between the performance of the selected systems at market price and at social prices are essentially due to the variation of value of the milled rice price (revenue), whereas the tariff, tax and subsidy applied on the value of tradable inputs has only a minor effect on the total divergence. For instance, in the case of the PAM computed for System 7 (unbunded rainfed lowland rice produce in the Northern region and marketed in Kumasi) (Table 4) the divergence for tradable input represents only 187 Cedi per kg of milled parboiled rice marketed at Kumasi, while the current tariff and tax applied on imported rice represent a value of 1,587 Cedi per kg of rice marketed at Kumasi. The positive divergence for the tradable inputs means that rice systems spent more money under the current economic environment to deliver one kg of milled rice at Kumasi than it would have if tariff, tax and subsidy on tradable input where removed. However the variation is very marginal. On the contrary the high level of distortion on the output side (revenue) means that the system as a whole would earn much less income if tariff on rice import where removed. The system is still profitable at social price (profit of 328 Cedi per kg), meaning that it has a comparative advantage and is able to compete with imported rice suppliers even without the enforcement of tariff on rice imports. It should be noted, however, that the profitability of the system would be considerably reduced by the removal of the tariff on rice import.

Table 4: PAM for the System 7 Cedi per kg of mille rice marketed in Kumasi from unbunded rice field in Northern region.

	REVENUES	COSTS TRADABLES INPUTS	DOMESTIC FACTORS	PROFITS
PRIVATE PRICES	A 6 905	B 3 200	C 2 017	D 1 688
SOCIAL PRICES	E 5 318	F 3 052	G 1 937	H 328
DIVERGENCES	I 1 587	J 148	K 80	L 1 359

Table 5: PAM for the System 8 Cedi per kg of mille rice marketed in Techiman from irrigated field in Upper-East region.

	REVENUES	COSTS TRADABLES INPUTS	DOMESTIC FACTORS	PROFITS
PRIVATE PRICES	A 6 905	B 2 041	C 2 420	D 2 444
SOCIAL PRICES	E 5 318	F 2 007	G 2 329	H 982
DIVERGENCES	I 1 587	J 34	K 91	L 1 462

Table 6: PAM for the System 9 Cedi per kg of mille rice marketed in Accra from upland field in Volta region.

	REVENUES	COSTS TRADABLES INPUTS	DOMESTIC FACTORS	PROFITS
PRIVATE PRICES	A 6 905	B 1 182	C 4 198	D 1 525
SOCIAL PRICES	E 5 012	F 1 113	G 4 000	H -100
DIVERGENCES	I 1 892	J 70	K 198	L 1 625

The DRCs computed from the three MAPs show (Table 7) that while the commodity systems linking the Northern region to urban markets in Ashanti and Bronga-Ahafo regions have a comparative advantage (DRC inferior to 1), the position of System 9 is much more fragile (DRC = 1.03) which is rather unexpected since a similar analysis carried out in other Western African countries shows that low input rice cropping system tend to have a higher comparative advantage than input intensive rice cropping system (F.Lançon, 2001). This outcome might be due to the value of the technical coefficient (yield at the farm level, quantity of labour used, quantity of agricultural input applied…) and prices that has been taken as a reference to compute the PAM and it therefore critical to take into account the sensitivity of the DRC to technical coefficients and price variations.

Table 7: Indicators from the baseline PAMs per system

	System 7 - Northern to Kumasi	System 8 - Upper east to Techiman	System 9 - Volta to Accra
DOMESTIC RESOURCE COST (DRC)	0.86	0.70	1.03

5.2. Major determinant of the rice based comparative advantages

The sensitivity analysis consists in looking at the effect of the variation of one variable (price, technical coefficients) on the value of the ratio computed with PAM. The analysis shows that the DRC value is highly sensitive to the level of yield and the parity price (see appendix), while variations on the value of domestic factors (labour opportunity costs, real interest rate) have a much lower effect on the value of the DRC.

Table 8, Table 9, Table 10 display the value of the DRC that would be obtained by different combinations of yield and parity price of the milled rice for each system. For instance, in the case of System 7 for the current parity price of 320 USD per ton, the DRC will be above 1 if the yield achieved at the farm level would decrease from 2,000 to 1,750 kg of paddy rice per hectare. Similarly, in the case of the upland based system (Table 10) an increase in the yield by 10% from 1,000 kg per hectare up to 1,100 kg would result in a DRC below 1.

Table 8: System 7: DRC sensitivity analysis to yield and parity price variations

	Yield level				
Parity price	1500	1750	2000	2250	2500
200	6.58	2.72	1.78	1.36	1.12
220	4.18	2.15	1.50	1.18	0.99
240	3.06	1.78	1.30	1.04	0.88
260	2.41	1.52	1.14	0.93	0.80
280	1.99	1.33	1.02	0.85	0.73
300	1.70	1.18	0.92	0.77	0.67
320	1.48	1.06	**0.84**	0.71	0.62

340	1.31	0.96	0.77	0.66	0.58
360	1.18	0.88	0.72	0.61	0.54
380	1.07	0.81	0.67	0.57	0.51
400	0.98	0.75	0.62	0.54	0.48

Table 9: System 8: DRC sensitivity analysis to yield and parity price variations

	Yield level				
Parity price	3000	3250	3500	3750	4000
200	1.44	1.29	1.17	1.07	1.00
220	1.30	1.17	1.06	0.98	0.91
240	1.18	1.07	0.98	0.90	0.84
260	1.09	0.98	0.90	0.84	0.78
280	1.00	0.91	0.84	0.78	0.73
300	0.93	0.85	0.78	0.73	0.68
320	0.87	0.80	0.74	0.69	0.64
340	0.82	0.75	0.69	0.65	0.61
360	0.77	0.71	0.66	0.61	0.58
380	0.73	0.67	0.62	0.58	0.55
400	0.69	0.64	0.59	0.55	0.52

Table 10: System 9: DRC sensitivity analysis to yield and parity price variations

	Yield level							
Parity price	700	800	900	1000	1100	1200	1300	1400
200	2.04	1.82	1.66	1.53	1.43	1.34	1.28	1.22
220	1.87	1.67	1.53	1.41	1.32	1.24	1.18	1.13
240	1.73	1.55	1.41	1.31	1.22	1.15	1.10	1.05
260	1.61	1.44	1.32	1.22	1.14	1.08	1.02	0.98
280	1.50	1.35	1.23	1.14	1.07	1.01	0.96	0.92
300	1.41	1.27	1.16	1.07	1.01	0.95	0.90	0.86
320	1.33	1.19	1.09	***1.01***	0.95	0.90	0.85	0.82
340	1.26	1.13	1.03	0.96	0.90	0.85	0.81	0.77
360	1.19	1.07	0.98	0.91	0.86	0.81	0.77	0.74
380	1.13	1.02	0.93	0.87	0.81	0.77	0.73	0.70
400	1.08	0.97	0.89	0.83	0.78	0.74	0.70	0.67

For the System 8 based on irrigated rice the initial PAM computed didn't take into consideration the cost of the irrigated scheme development. According to information provided by GIDA the cost for developing one hectare of irrigated field could be estimated at around 15,000 USD per hectare (including dam and canal building) a figure that is commensurate with other sources (FAO, 1997). If the cost for establishing the infrastructure for irrigation is factored in the DRC (with the same yield and parity price level) would increase from 0.74 up to 1.6 and the value of the corresponding transfers from the rest of the economy to this rice system would increase from 1,500 Cedi up to 4,150 Cedi per kg of milled rice deliver at Techiman. There is a debate among scholars whether the cost of the irrigation infrastructure should be factored in for irrigated schemes that have been developed several years ago since they can be considered as "sunk costs" that should be borne in any case by the economy. In other words, while investing in new irrigation scheme development might not be efficient from an economic point of view, the production of rice on existing irrigated schemes can be considered as a viable option since the operation of these cropping systems are profitable at social price. If any new investments in irrigation are considered its might be necessary to improve the cost effectiveness of the scheme building since the system 8's DRC is equal to 1 when the irrigation cost are above 5,500 USD per hectare.

6. Concluding remarks

The assessment of the comparative advantage of the rice commodity systems should be taken as one contribution to the rice policy debate and should not be considered as the only criteria for deciding whether or not it is economically sound to invest in rice cultivation. Firstly the outcome of the computation is highly sensitive to the variations of the prevailing conditions on the world rice market. A system that did not have any comparative advantages in the early 2000 when price on the rice world market were below 250 USD per ton can have a comparative advantage in 2007 when world rice price is 350 USD per ton. Secondly, objectives pursued by any policy are multiple and may combine both economic efficiency and equity objectives.

The selected rice commodity systems do have a comparative advantage but it remains fragile. Keeping in mind that the selected systems were the most profitable in the rice study it means that the comparative advantages of the Ghanaian rice economy remain weak under the current technical performance (yield level) and rice world market environment (level of the milled rice parity price). Put differently, the profitability of most of the rice system would be put at stake without any form of price support for the milled rice output.

The recent increase of rice price on the world market has certainly strengthened the comparative advantage of the Ghanaian rice economy but given the historical high volatility that characterized rice price on the world market it should not be taken as granted. The most recent projections of the expected evolution of world rice price conclude that they would stabilize around a level of 350 USD in the forthcoming five years (OECD-FAO, 2007). Longer-term projections remain very tentative as the world market may change with the evolution of consumers' diet in emerging Asian economies that will put less pressure on rice demand and hence free additional sources of supplies for other importing regions such as Sub-Saharan Africa. In any case, at medium term the changing conditions on the rice world market open a window of opportunity to invest in rice production development in Ghana under sound economic conditions.

However, the question of the objective pursued by the rice policy remains open for debate. Should the policy put the priority on efficiency objectives and favour the development of the systems that have the stronger comparative advantages or should the rice policy be considered as an instrument for reducing income disparity through the generation of income opportunities? The formulation of a well-founded answer requires taking into account the position of rice in the various farming systems where rice is produced to assess the net impact of a policy that would focus primarily on efficiency objectives. It would assess to what extent farmers' resources could be allocated to other activities that provided comparable income. It goes beyond the analysis carried out on one commodity system. The rather higher comparative advantage of the rice systems based in the North compared to Southern rice systems shows that both objectives are not necessarily conflicting, since rice has certainly a higher economic importance for farming systems in the North than in the South where there is probably more on-farm and off-farm income opportunities.

One major drawback of a tariff policy is that it benefits uniformly to all rice systems in the countries, the one that are economically efficient and the one that are not, meaning that support is given to systems that may better allocate their domestic resources to other agro-food activities. Another issue is that farmers may not get the full benefit of the price increase induced by the tariff if farmers' linkages to market are not efficient, either because there are inefficiency in the marketing systems or because the local rice is not a pure substitute to the imported rice since it does not benefit of the same quality attributes. The performances of paddy production at the farm level remain a key determinant of the economic efficiency of the rice commodity chain, however the benefit of any policy aiming at supporting the value generated by rice production will be ultimately determined by the quality of the technical and organisational process that link farmers' output to consumers. Hence, the enforcement of a tariff on rice import can only be justified if it is conceived as a component of a policy package that addresses the issue of rice system efficiency in a broader holistic approach.

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Appendixes

1. Parity prices computations

Milled rice computation details

	Unit	Source of infor.	Value at Market Price	Value at Social price
FOB to CIF				
FOB price in vietman	USD/ton	Data	316	316.47
Transport cost	USD/ton	Data	80	80
Insurance (FOB+ freight *1.2)	USD/ton	Data	5	5
CIF price at Tema	USD/ton	Data or comp	401	401
Exchange rate		Data	9170	9628.5
CIF price in domestic currency unit	C/ton	Computed	3 679 257	3 863 220
Duties				
Import duty 20% of CIF	%/CIF	0.2	735 851	
Insepection chage, ecawas…	%/CIF	0.02	73 585	
Total duties			809 437	
Price after custom		Computed	4 488 694	3 863 220
VAT + NHIL	Price afer c	0.15	673 304	
Price after VAT		Computed	5 161 998	3 863 220
Handling cost 15USD/ton	C/ton		137 550	
Price at the warehouse in cedi/ kg			5 300	3 863
Wholesaler Transport cost			200	200
Other costs (warehouse, bagging, financial cost)			1000	1000
wholesaler margin (7%)		0.03	455	455
Wholsale price at parity point			6955	5518
Retailer cost	c/kg		103	103
Retailer margin (10%)		0.070	494	494
Retailer price at parity point			7552	6115
Penalties for lower quality		0.15	6567	5318

Decomposition coefficients and tariff used for tradable inputs parity prices computation

Decomposition coefficients and tariff applied for tradable input

	L	QL	K	TI	Chk	Source	Ad valorem rate	source	
Fixed cost									
Irrigation	0.50	0.00	0.10	0.40	1.00	from other study	0.03	CEPS, 2003	assuming low tarif band for building metarial
Building	0.40	0.00	0.30	0.30	1.00	educated guess	0.03	CEPS, 2004	
Bags	0.05	0.00	0.05	0.90	1.00	educated guess	0.03	CEPS, 2004	
Agricultural equipment	0.05	0.00	0.05	0.90	1.00	educated guess	0.03	CEPS, 2004	
Vehicle for transport of goods	0.05	0.00	0.05	0.90	1.00	educated guess	0.24	CEPS, 2004	
Spare parts for motor vehicle	0.05	0.00	0.05	0.90	1.00	educated guess	0.28	CEPS, 2004	
Spare parts for machines	0.05	0.00	0.05	0.90	1.00	educated guess	0.03	CEPS, 2004	
Input									
Agricultural input	0.05		0.05	0.90	1.00	educated guess	0.03	CEPS, 2004	
Fuel	0.05		0.05	0.90	1.00	educated guess	0.24	computed from table provided by consultant	
Services									
Milling engleberg (market)	0.22	0.00	0.41	0.36	1.00	computed from miller budget			
Milling engleberg (social)	0.29	0.00	0.62	0.49	1.40	computed from miller budget applicable to market value and tkaing into account subisdy on electricty (30% of market value)			
Milling rubber roller (market)	0.28	0.00	0.26	0.46	1.00				
Milling rubber roller (social)	0.29	0.00	0.29	0.46	1.04				
Transport	0.11	0.00	0.16	0.73	1.00	computed	0.25		
Mechanized agri. operation	0.09		0.16	0.74	0.99		0.24		
Irrigation maintenance	0.33	0.07	0.12	0.48			0.10	part of the maintenace is using enegy	
Production of electricity	0.05	0.05	0.60	0.30		based on other analysis taking into account that a share of electricity is coming from hydraulic sources	-30.00	subisidy to electricty	

Budgets for computing the share of tradable, labour and capital for complex input

Rubber Roller Miller

Format for Intermediate inputs decomposition coefficients

Interest rate	0.12
per km	

Equipment depreciation

Item	Equipment value	Annual capacity	Capacity needed for activity	Unit of capacity	Life time (year)	Used up portion	Residual value	Ad valorem duty	Fixed duty	Financial cost and import tax	Depreciation
						100%				0	0
Building	20 000 000	255000	255000	kg	30	100%	0	0.00%		1 816 206	666 667
Machine	60 000 000	255000	255000	kg	15	100%	0	3.50%		4 944 720	3 864 734
Electric motor	8 000 000	255000	255000	kg	10	100%	0	3.50%		642 926	772 947
Drying pavement	8 000 000	255000	255000	kg	20	100%				671 030	400 000
						100%				0	0
Total										**8 074 883**	**5 704 348**

Decomposition coefficients

	Value at market price	Coefficients				Values				Coefficient check	Duty on tradable
		L NQ	L Q	K	TI	L NQ	L Q	KI	TI		
Fixed cost											
Equipment cost TI depreciation	5 704 348				1	0	0	0	5 704 348	1	1.70%
Equipment Financial cost	8 074 883			1		0	0	8 074 883	0	1	
Variable cost											
						0	0	0	0	0	
Operator	8 400 000	1				8 400 000	0	0	0	1	
Attendant	3 600 000	1				3 600 000	0	0	0	1	
Watchman	4 200 000	1				4 200 000	0	0	0	1	0%
Electricity	10 200 000	0.1		0.6	0.3	1 020 000	0	6 120 000	3 060 000	1	-30%
Lubricant and spare part	30 000 000	0.1		0.1	0.8	3 000 000	0	3 000 000	24 000 000	1	6%
Government tax	240 000			1		0	0	240 000	0	1	0%
Land rent	840 000			1		0	0	840 000	0	1	0%
						0	0	0	0	0	
						0	0	0	0	0	
Total	71 259 231	**0.28**	**0.00**	**0.26**	**0.46**	20 220 000	0	18 274 883	32 764 348	1	
		Decomposition coefficient									

Coefficient at parity/social price

	5 704 348				1	0	0	0	5 704 348	5 704 348	
	8 074 883			1		0	0	8 074 883	0	8 074 883	
Operator	8 400 000	1	0	0	0	8 400 000	0	0	0	8 400 000	
Attendant	3 600 000	1	0	0	0	3 600 000	0	0	0	3 600 000	
Watchman	4 200 000	1	0	0	0	4 200 000	0	0	0	4 200 000	
Electricity	10 200 000	0.142	0	0.852	0.426	1 448 400	0	8 690 400	4 345 200	14 484 000	
Lubricant and spare part	30 000 000	0.1	0	0.1	0.76	3 000 000	0	3 000 000	22 665 600	28 665 600	
Government tax	240 000	0	0	1	0	0	0	240 000	0	240 000	
Land rent	840 000	0	0	1	0	0	0	840 000	0	840 000	
	71 259 231	0.28	0.00	0.28	0.44	20 648 400	0	20 845 283	32 715 148	74 208 831	1.04
		0.29	**0.00**	**0.29**	**0.46**	0.28	0.00	0.28	0.44	1	

Engelberg miller

Format for Intermediate inputs decomposition coefficients

Interest rate	0.12
per km	

Equipment depreciation

Item	Equipment value	Annual capacity	Capacity needed for activity	Unit of capacity	Life time (year)	Used up portion	Residual value	Ad valorem duty	Fixed duty	Financial cost and import tax
						100%				0
Building	10 000 000	336000	336000	kg	40	100%	0	0.00%		963 036
Machine	28 000 000	336000	336000	kg	15	100%	0	3.50%		2 307 536
Drying pavement	4 000 000	336000	336000	kg	10	100%	0			307 937
						100%				0
						100%				0
Total										**3 578 509**

Decomposition coefficients

	Value at market price	Coefficients				Values				Coefficient check
		L NQ	L Q	K	TI	L NQ	L Q	KI	TI	
Fixed cost										
Equipment cost TI depreciation	2 453 543				1	0	0	0	2 453 543	1
Equipment Financial cost	3 578 509			1		0	0	3 578 509	0	1
Variable cost										
						0	0	0	0	0
Bag handling	1 000 000	1				1 000 000	0	0	0	1
Operator	5 400 000	1		0	0	5 400 000	0	0	0	1
Electricity	20 400 000	0.1		0.6	0.3	2 040 000	0	12 240 000	6 120 000	1
Lubricant and spare part	8 000 000	0.1		0.1	0.8	800 000	0	800 000	6 400 000	1
Government tax	240 000			1		0	0	240 000	0	1
						0	0	0	0	0
						0	0	0	0	0
Total	41 072 052	**0.22**	**0.00**	**0.41**	**0.36**	9 240 000	0	16 858 509	14 973 543	1
		Decomposition coefficient								

Coefficient at parity/social price

	2 453 543				0.958772771				2 372 865	2 372 865
	3 578 509			1				3 578 509		3 578 509
Bag handling	1 000 000	1				1 000 000	0	0	0	1 000 000
Operator	5 400 000	1				5 400 000	0	0	0	5 400 000
Electricity	20 400 000	0.14	0.00	0.85	0.43	2 896 800	0	17 380 800	8 690 400	28 968 000
Lubricant and spare part	8 000 000	0.10	0.00	0.10	0.75	800 000	0	800 000	6 037 736	7 637 736
Government tax	240 000			0		0	0	0	0	0
	35 040 000	0.21	0.00	0.44	0.35	10 096 800	0	21 759 309	17 101 001	48 957 110
		0.29	**0.00**	**0.62**	**0.49**	0.21	0.00	0.44	0.35	1

Mechanized agricultural operations

Format for Intermediate inputs decomposition coefficients

Interest rate 0.12

perd day of operation 7 ha/day 17.5 acres per day 50 days 875

Equipment depreciation

Item	Equipment value	Annual capacity	Capacity needed for activity	Unit of capacity	Life time (year)	Used up portion	Residual value	Ad valorem duty	Fixed duty	Financial cost and import tax	Depreciation
						100%				0	0
Equipment	250 000 000	50	50	days	20	100%	0	3.40%		21 380 720	12 088 975
						100%				0	0
						100%				0	0
						100%				0	0
						100%				0	0
Total										**21 380 720**	**12 088 975**

Decomposition coefficients

	Value at market price	Coefficients				Values				Coefficient check	Duty on tradable	Share of TI
		L NQ	L Q	K	TI	L NQ	L Q	KI	TI			
Fixed cost												
Equipment cost TI depreciation	12 088 975				1	0	0	0	12 088 975	1	24.00%	6%
Equipment Financial cost	21 380 720			1		0	0	21 380 720	0	1		
Variable cost												
						0	0	0	0	0		0%
Driver	1 500 000	0	1			0	1 500 000	0	0	1		0%
Lubricant	10 000 000	0.05	0.05	0.1	0.8	500 000	500 000	1 000 000	8 000 000	1	28%	4%
Spare parts	12 088 975	0.05	0.05	0.1	0.8	604 449	604 449	1 208 897	9 671 180	1	28%	5%
Fuel	220 150 000	0.05	0.05	0.1	0.8	11 007 500	11 007 500	22 015 000	176 120 000	1	24%	91%
						0	0	0	0	0		0%
						0	0	0	0	0		0%
Total	277 208 670	**0.04**	**0.05**	**0.16**	**0.74**	12 111 949	13 611 949	45 604 618	205 880 155	1		
		Decomposition coefficient										

Transport

Format for Intermediate inputs decomposition coefficients

Interest rate 0.12

per km

Equipment depreciation

Item	Equipment value	Annual capacity	Capacity needed for activity	Unit of capacity	Life time (year)	Used up portion	Residual value	Ad valorem duty	Fixed duty	Financial cost and import tax	Depreciation
						100%				0	0
Vehicle	500 000 000	25000	25000	km	15	100%	0	24.00%		46 530 399	26 881 720
						100%				0	0
						100%				0	0
						100%				0	0
						100%				0	0
Total										**46 530 399**	**26 881 720**

Decomposition coefficients

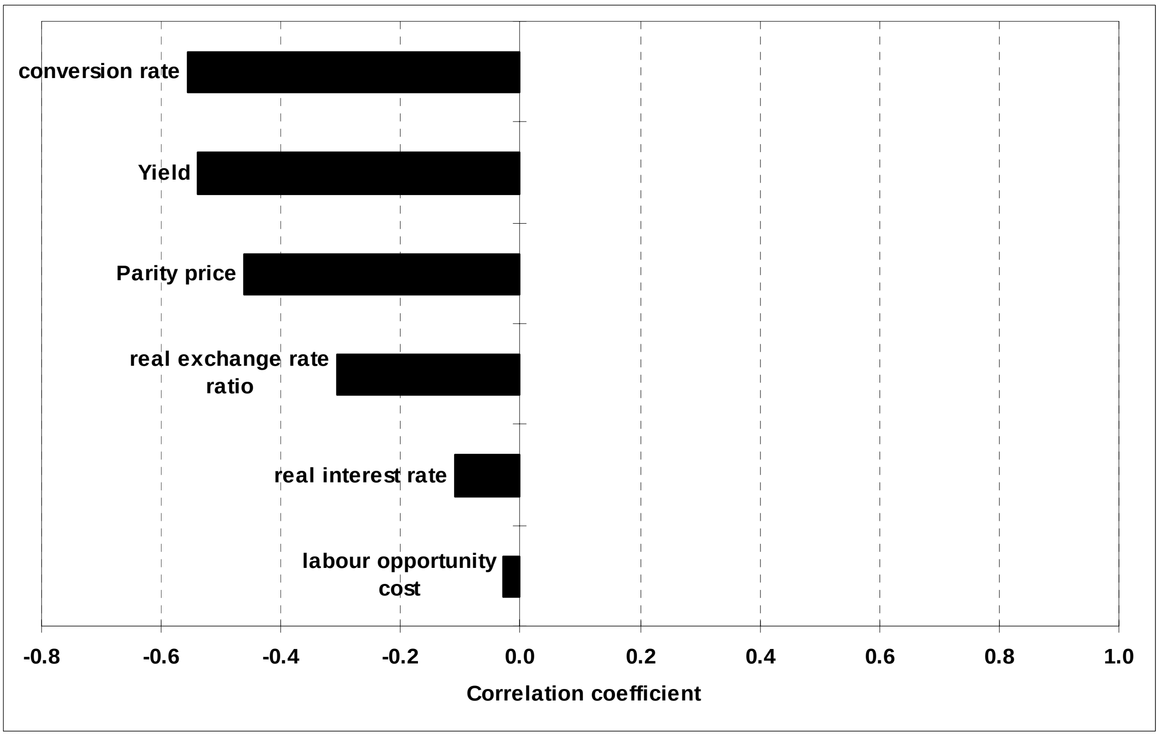
	Value at market price	Coefficients				Values				Coefficient check	Duty on tradable	Share of TI
		L NQ	L Q	K	TI	L NQ	L Q	KI	TI			
Fixed cost												
Equipment cost TI depreciation	26 881 720				1	0	0	0	26 881 720	1	24.00%	6%
Equipment Financial cost	46 530 399			1		0	0	46 530 399	0	1		
Variable cost												
						0	0	0	0	0		0%
Driver	14 400 000	0	1			0	14 400 000	0	0	1		0%
Lubricant	25 000 000	0.05	0.05	0.1	0.8	1 250 000	1 250 000	2 500 000	20 000 000	1	28%	4%
Spare parts	50 000 000	0.05	0.05	0.1	0.8	2 500 000	2 500 000	5 000 000	40 000 000	1	28%	9%
Fuel	500 000 000	0.05	0.05	0.1	0.8	25 000 000	25 000 000	50 000 000	400 000 000	1	24%	87%
						0	0	0	0	0		0%
						0	0	0	0	0		0%
Total	662 812 120	**0.04**	**0.07**	**0.16**	**0.73**	28 750 000	43 150 000	104 030 399	486 881 720	1		
		Decomposition coefficient										100%

2. Sensitivity analysis

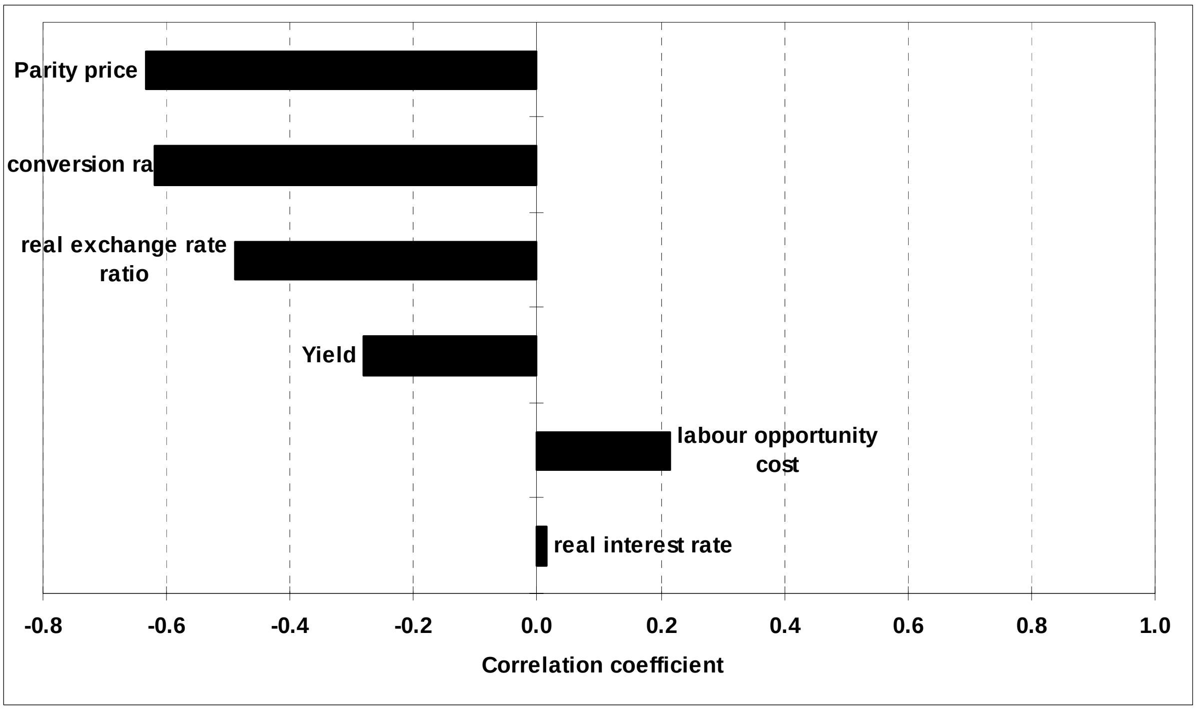
Sensitivity of the Domestic Resource Cost ratio to various variables:

System 7

System 8



System 9


Parity price
conversion ra
real exchange rate ratio
Yield
labour opportunity cost
real interest rate
-0.8
-0.6
-0.4
-0.2
0.0
0.2
0.4
0.6
0.8
1.0
Correlation coefficient

3. *Policy analysis matrices*