ASSESSING MARKET REFORMS ON TUNISIA'S LOW RAINFALL AREA : A MULTI-MARKET MODEL ANALYSIS

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SUMMARY

The implications of market liberalization and drought policy on agriculture, and particularly the low rainfall area (LRA), are investigated within a multi-market model framework. The model divides the country into three agro-ecological regions (the low rainfall area, the high rainfall area, and the rest of the country) and includes commodities of particular interest to the LRA. These are : barley, sheep meat, pasture and lamb. Other commodities (e.g., wheat, beef meat, olive oil and forage) are included to capture the substitution and complementarity effects across regions. The results indicate that market liberalization has important implications in terms of efficiency, equity and environmental sustainability. First, agricultural market liberalization is efficient as the net welfare is positively affected. Second, neutral market liberalization, as it is simulated, is equitable in that, no major differential impact on regional agricultural incarnes is noted. Last, market liberalization could have important implications on environmental sustainability. The analysis in this paper suggests that liberalization would attenuate range degradation through reduction in the derived demand for pasture and by moving lamb fattening to the high rainfall area, thus decreasing the pressure on the LRA's resource base.

Key words : Low rainfall area, Market liberalization, Multi-market model and drought policy.

Les effets des réformes sur les zones à pluviométrie limitée en Tunisie : Une analyse multi-marché

RÉSUMÉ

Dans ce travail, les effets de la libéralisation et des mesures de politique de sécheresse sur l'agriculture des zones à pluviométrie limitée en Tunisie sont explorés dans le cadre d'un modèle multi-marché. Ce dernier est spécifié au niveau régional divisant ainsi le pays en trois zones agro écologiques (la zone à pluviométrie limitée, la zone à pluviométrie élevée et le reste du pays) et incorpore, dans le cas de la zone à pluviométrie limitée, l'orge, la viande ovine, les produits du parcours et l'agneau. Pour capturer les effets de substitution et de complémentarité inter régions, d'autres produits tel que le blé, la viande bovine, l'huile d'olive et les fourrages sont incorporés.
Les résultats de ce travail indiquent que la libéralisation a des effets considérables sur l'efficience, l'équité et l'environnement. En effet, la libéralisation améliore l'efficience économique mesurée ici par l'indicateur du bien être général. Elle est équitable car il n'y a pas de différences majeures des effets sur les revenus agricoles à travers les trois régions agro-écologiques. Enfin, la libéralisation améliore l'environnement en atténuant la dégradation des parcours.

Mots clés : Zone à pluviométrie limitée, Libéralisation, Modèle multi-marché, Politique de sécheresse.

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INTRODUCTION

For the past two decades, Tunisia has been undergoing major reforms, which call in most cases for market and trade liberalization (Agricultural Structural Adjustment Program, GATT reforms, Free Trade Area with the European Union). Indeed, input subsidization schemes that provide little incentives for resource conservation, price support programs that distort market allocation of resources and heavy border protection making food more expensive for consumers are being increasingly recognized as inefficient ways to achieve food security and rural development objectives. However, despite this general out looking policy orientation, the government continues to intervene in several markets using price fixing instruments for strategic commodities and subsidizing feed grains. This intervention is justified by the need to correct for market imperfections and to alleviate the effects of drought particularly on small farmers in Tunisia's low rainfall area (LRA) where barley and sheep production are the most important income generating activities.

The extensive and systematic use of these instruments, however, could affect production incentive structure and lead to biased use of agriculture production resources. Indeed, subsidizing feed grains appears to have favored livestock/barley system at the expense of forage production and pasture. This resulted into putting increasing pressure on the fragile environment of the country's LRA, with the incursion of cultivation into marginal rangelands and overgrazing of this area. Further, periodical drought subsidies, which are not targeted, seem to have weakened market institutions (insurances) and lessened farmers' motivation to adopt drought-proofing technologies.

The important question to ask then is whether a private-led type of growth strategy with less border protection, less price support and reduced input subsidies will disproportionately hurt more the farmers in the LRA than those in the higher potential zones. Of particular interest to Tunisia, a country concerned about food self-sufficiency and security, are issues related to the extent by which market liberalization may affect the agricultural balance of trade. How does the removal of input subsidies such as feed grains affect barley and meat production, the number of animals and farm incomes ? What is the likely impact of agricultural policy reforms on the fragile environment of the country's LRA ? While these issues constitute an unprecedented set of questions that need to be addressed, it is surprising that little research has been done to provide a quantitative assessment of market reforms on the agricultural sector.

ANDERSON (1998) argues that, while in many situations agricultural policy reform would make a net improvement to the environment, more attempts will need to be made to quantify the environmental changes associated with it. Therefore, the objective of this paper is a small start to that process in that it attempts to quantify, among others, the environmental changes likely to be associated with economic reforms in Tunisia. To achieve this end, we develop a multi-market model for the Tunisian agriculture (QUIZON and BINSWANGER, 1986 ; BRAVERMAN and HAMMER, 1986). The need for such a framework is justified on two grounds. First, agricultural markets are linked by substitution possibilities in production and consumption, and government intervention in one market maycreate spillover effects in other markets. Second, the multi-market analysis, although stops short of a Computable General Equilibrium (CGE) framework, provide a great deal of simplicity in operational work which balances the more complete set of information obtained with CGE models.

The rest of the paper is organized as follows. Section II reviews the literature on the multi-market modeling framework. In section III, the structure of the Tunisian multi-market model is presented. Data requirements and methodological issues are discussed in section IV. The different policy scenarios, simulation results and the conclusions of the study are presented in subsequent sections.

THE MULTI-MARKET MODELING FRAMEWORK

Numerous studies have used a multi-market framework to examine the impacts of market liberalization on production, consumption, trade of specific commodities and the further effects on household incomes, government revenues, and the trade balance for transition and developing countries. Empirical applications of this modeling framework are reported in BRAVERMAN *et al.*, (1987a) for Korea, BRAVERMAN *et al.*, (1987b) for Cyprus, BRAVERMAN *et al.*, (1987c) for Hungary. Other attempts at multi-market modeling include QUIZON and BINSWANGER (1986) for India, and BAUTISTA (1986) for the Philippines. In this section, we present the general framework of the multi-market modeling structure as described in SADOULET and DE JANVRY (1995).

The model structure incorporates four classes of agents. Producers distinguished by region and commodity, consumers distinguished by region and social group (urban versus rural), suppliers of factors (intermediate demand factor or inputs supplied by the rest of the economy) and the government. On the production side, the model assumes that producers are profit maximizers in that, their responses can be characterized by a well behaved profit function. The latter yields a system of regional output supply and factor demand equations, the parameters of which satisfy the set of symmetry and homogeneity restrictions established in production theory.

Regional output supply and factor demand equations are a function of commodity and factor prices (P, r). The specification also includes some exogenous shifters to be used as policy instruments in simulation experiments (z). Total output supply of each commodity (factor demand) is obtained by summing over the three regions (equations 1 and 2 below). Similarly, on the factor side, supply of factors of production (equation 3) is a function of commodity and factor prices.

Regional income, Y_k, (equation 4), is given as the sum of profits made from the agricultural income generating activities and some other exogenous incomes (e.g. remittances, services, etc...). However, this latter being held fixed, only profits will be affected by policy intervention. Final demand for each region is specified as a function of commodity prices at the consumer level, regional income and other exogenous shifters. Total demand for commodity i (equation 5) is obtained by summing over regional demand.

Equilibrium conditions on product (equation 6) and factor markets (equation 7) depend upon the tradability of each product and factor. For products/factors that are traded internationally, markets are assumed to clear through adjustments in net exports (NE = exports minus imports), which equilibrate supply and demand at exogenous border prices ($\overline{P}$). On the other hand, for products/factors not traded internationally, there exists an exogenous difference between domestic supply and demand ($\overline{NE}$, $\overline{NE}_0$) and markets clear through domestic prices moving to equate supply and demand. Finally, the balance of trade (equation 8) is a residual. It indicates the magnitude of the deficits or surpluses of the multi-market model equilibrium, with no feedback on the domestic price system.

Let *i*, *h*, and *k* denote the set of agricultural products, variable factors and the set of agro-ecological regions, respectively. q_i^s, q_i^d are the supply and final demand of commodity *i* ; X_h^s , X_h^d denote the supply and demand of production factor h ; Y_k, Π_k , $\overline{R}_k$ denote total income, agricultural profits and non agricultural income for region k, respectively. P_i, P_i^c, r denote commodity *i* producer price, consumer price and factor h price, respectively. z_s, z_d, denote shifters of product supplies and final demand functions, respectively. NE_i , NE_h, denote net exports of commodity *i* and net exports of factor *h*, respectively. Following the general structure as in SADOULET and DE JANVRY, the model is written as follows :

- The producer side

Supply of commodity i : $q_i^s = \Sigma_k\, q_{ik}^s(P, r, z^s)$ (1)
Demand of input h : $X_h^d = \Sigma_k\, X_{hk}^d(P, r)$ (2)

- The factor supply side

Supply of input h : $X_h^s = \Sigma_k\, X_{hk}^s(P, r)$ (3)

- The regional income and final demand side
Regional income : $Y_k = \Pi_k(P, r) + \overline{R}_k$ (4)

Demand of output i : $q_i^d = \Sigma_k\, q_{ik}^d(P^c, Y_k, z^d)$ (5)

- Market equilibrium conditions

Product markets : $\Sigma_k\, q_{ik}^s = \Sigma_k\, q_{ik}^d + NE_i$ (6)

Non-tradable : $NE_i = \overline{NE_i}$; (P_i, q_i endogenous)

If tradable : $P_i = \overline{P_i}$; (NE_i, q_i endogenous)

Factor markets : $\Sigma_k\, X_{hk}^s = \Sigma_k\, X_{hk}^d + NE_h$ (7)

Non-tradable : $NE_h = \overline{NE_h}$; (r_h, X_h endogenous)

Balance of trade : $BOT = \Sigma_i\, NE_i$ (8)

MULTI-MARKET MODEL APPLICATION

To tailor the above general framework to our specific objectives, the Tunisian multi-market model divides the country into three different agro-ecological regions. The choice of these regions is primarily based on the need to analyze the impacts and the likely consequences of government policies on crop and livestock production in Tunisia's low rainfall area. With this in mind, the country is divided into the following regions : the low rainfall area, the high rainfall area and the rest of the country[1].

Further, the model explicitly considers the supply and demand of four commodities, which we think are the most relevant to the country's low rainfall area. These are barley, sheep meat, pasture and lamb. The importance of these commodities to the low rainfall area's welfare is the main criterion on which the selection is based upon. However, to capture most of the substitution effects among the different commodities within and across regions, we further consider the supply and demand of wheat, beef meat, olive oil, and forage products. Each of these product markets has its specific characteristics and some of the products (i.e., barley, forage, pasture and lamb) are used as inputs in the production process of other products.

For instance, for wheat, barley, beef, and olive oil, which are traded internationally, the government sets production and consumption prices and the discrepancy between national supply and demand is met by net exports.

(1) - The low rainfall area, by its ecological nature, is defined based on the following criteria : (i) a region that receives less than 350 mm of rain per year (ii) has an advanced level of land degradation, and (iii) main observed activities are barley, lamb and pasture. The high rainfall region, by contrast to the first one, is a more favorable ecological area.

Both cereals, wheat and barley, have price controls, with producer, consumer and intermediate user prices fixed by the government. Producer prices for these commodities are guaranteed support prices as they are fixed above world levels. Wheat consumer price, on the other hand, is aligned to world level. For barley, intermediate users as well as final consumers are taxed as the intermediate demand and final consumption prices are above world levels.

Markets for beef meat and olive oil also have price controls. Beef meat producers are subsidized as the beef producer price is above world level. However, consumers are taxed as beef consumer price is above border price. Olive oil producers are taxed as producer price is below world level. Consumers, on the other hand, are subsidized as consumer price of olive oil is below border price. Finally, sheep meat imports are not significant and supply is assumed entirely domestic.

On the factor side, three inputs are included in Tunisia multi-market model. These are ammonium, labor, and machinery. Factor supply is assumed to be national and markets for these factors equilibrate through domestic prices moving, as no trade is assumed for these factors.

Finally, to capture the magnitude of the deficits or surpluses at equilibrium, the balance of trade is calculated in a straightforward manner. With no feed back on the domestic price system (i.e., residual), the balance of trade is equal the differential between imports and exports times the world price for each commodity. The different equations of the Tunisian multi-market model detailed in table 1 below are simultaneous and solved for all endogenous variables jointly.

Table 1 : The tunisian multi-market model equations

Wheat (wh) : $\Sigma q_i^s(P_i, r_k, z^s)+M_{wh}=q^d(P^c, Y, z_d)$

Barley (ba) : $\Sigma q_i^s(P_i, r_k, z^s)+M_{ba}=q^d(P^c, Y, z_d)+\Sigma q_i^d(P_{sm}, P_{be}, P^u, r_k)$

Beef (be) : $\Sigma q_i^s(P_i, r_k, z^s)+M_{be}=q^d(P^c, Y, z^d)$

Olive oil (oo) : $\Sigma q_i^s(P_i, r_k, z^s)=q^d(P^c, Y, z^d)+X_{oo}$

Sheep meat (sm) : $\Sigma q_i^s(P_i, r_k, z^s)=q^d(P^c, Y, z^d)$

Forage (fo) : $\Sigma q_i^s(P_i, r_k, z^s)=\Sigma q_i^d(P_{sm}, P_{be}, P^u, r_k)$

Pasture (pa) : $\Sigma q_i^s(P_i, r_k, z^s)=\Sigma q_i^d(P_{sm}, P_{be}, P^u, r_k)$

Lamb (lm) : $\Sigma q_i^s(P_i, r_k, z^s)=\Sigma q_i^d(P_{sm}, P_{be}, P^u, r_k)$

Income (Y_k) : $Y_k = \Pi_k (P_i, r_k) + \bar{R}_k$

Balance of trade : $\Sigma P_i^w M_i - \Sigma P_i^w X_i$

Table notes : Where *i* denotes the set of agricultural products (wheat, barley, sheep meat, olive oil, forage, pasture, lamb) ; h the set of variable factors (fertilizer, labor, machinery) and k the set of the 3 agro-ecological regions (low rainfall area, high rainfall area and the rest of the country). M_i, X_i denote imports and exports of commodity i, respectively. P^u is the user price set of inputs to the livestock sector (barley) and P^w refers to world prices. Y denotes income and all other variables are as defined above.

DATA AND METHODOLOGICAL ISSUES

To implement the multi-market model specified above, data of the Tunisian agricultural sector are used. In particular, data on commodity supply, derived and final demand, commodity imports and exports, and commodity producer, user, consumer and border prices are required. On the supply side, commodity supply was computed as an average year from a time series production data spanning the period 1980-2000. On the demand side, commodity demand is computed as per capita consumption in 1999 times the estimated number of inhabitants in each region.

Sources of these data are various issues of the Annuaire des statistiques agricoles of the Ministry of Agriculture as well as issues of Annuaire Statistiques de la Tunisie and the Enquête nationale sur le Budget, la consommation et le niveau de vie des menages of the Institut National des Statistiques.

The resulting model structure is a system of 68 equations in the same number of unknowns. However, as we will only consider small

changes in the solution around the initial state, all the equations are log-linearized to yield a system of equations that are linear in the rates of change in both endogenous and exogenous variables with the coefficients transformed into elasticities. If we let A denote the matrix of coefficients associated with the endogenous variables, B the matrix of exogenous variable coefficients, u the vector of rates of change in endogenous variables and x the vector of rates of change in exogenous variables, the system can be simplified and written in matrix form as follows :

$$A.\ u = B.\ x$$

Solving the above system for the endogenous variable yields :

$$u = A^{-1}.\ B.\ x$$

Resolution of the model relies though on estimating / gathering a large set of elasticities that include the supply and derived demand elasticities as well as the final demand and income elasticities of the different commodities in the model. This large set of information has been collected from different research works carried both inside and outside the country. However ; given the incompleteness of the system, only the relevant theoretical restrictions implied by the production (symmetry constraint) and consumption (Slutsky condition) theories were. imposed[1].

SIMULATING THE EFFECTS OF DIFFERENT POLICY SCENARIOS

This section presents the rationale behind the different policy scenarios and a description of policy instruments used to carry out the simulations. Results from the different simulations are then contrasted to base year values and presented in the next section in the form of percentage changes from these values. Table 2 provides a summary of the different policy scenarios along with the corresponding instruments used.

1. The first scenario is one in which a multiple price changes on the producer side is assumed. The idea here is to remove some of the distortions that bias the incentive structure of production. The policy instrument used consists in the reduction of the guaranteed producer price of wheat, barley and beef by 10 % and an increase in the producer price of olive oil by 10 %.

2. The second policy scenario is similar to the first one, except that it intends to remove some of the price distortions on the consumer side by bringing consumer prices closer to world levels. This policy regime consists in the reduction of the consumer domestic prices of barley and beef by 10 % and an increase in the consumer price of olive oil by 5 % to align it with the world price level.

3. The third scenario is a market liberalization scenario and is a combination of the first and second one (S1+S2). This scenario is consistent with GATT support measures.

4. The fourth policy scenario analyses the effects of a drought policy that consists in a reduction in the user demand price of barley by 10 %. This policy has been used by the government to alleviate the effects of drought and help farmers during this period.

(1) -The symmetry constraint implies that the supply cross-price elasticities between commodities i and j are related by the following condition : $E_{ij}pj = E_{ji}pj\ (P_j\ q_j s / P_i\ .\ q_i s)$. The symmetry in substitution effects implies that the cross-price elasticities between commodities i and j are related by the following relation : $e_{ij}pj = (P_j / P_j)\ e_{ji}pj + P_j\ (e_{ji}y - e_{jj}y)$. Variables are as defined above.

Table 2 : Description of alternative policy scenarios and corresponding instruments used.

N°	policy scenario	Desciption of policy instruments
S 1	Reduction in producer support	Reduction in the producer guaranteed price of wheat, barley and beef by 10 % and an increase in the producer pprice of olive oil by 10 %.
S 2	Reduction in consumer taxes	Reduction in the consumer domestic price of barley and beef by 10 % and an increase in the consumer price of olive oil by 5 %.
S 3	Market liberalization	S1 + S2
S 4	Drougtht policy	Reduction in the user demand price of barley by 10 %.

Discussion of simulation results

The differential impacts of alternative domestic price reforms discussed above are analyzed in this section. Accounting of all income and welfare changes resulting from these policy measures are presented next in tables 3 and 4.

Impacts on commodity supply, final demand and trade

Reduction in producer support (SI) tends to have a differential but mild negative impact on commodity supply of wheat, barley, and beef. Final demands for these commodities, however, tend through the income effect to decrease in larger proportions, reducing significantly their import bills by 41 %, 1 % and 53 %, respectively. Supply of olive oil increases significantly in all regions due to the increase in the producer price by 10 %. Final demand of this commodity does not change much and the overall effect is, therefore, an increase in olive oil exports by 16 %.

Reduction in the domestic consumer price distortions of barley, beef and olive oil (S2) would not affect much the incentive structure of supply in the three agro-ecological regions. Final demands for barley and beef, on the other hand, would increase and cause their imports to increase substantially.

The third scenario is a market liberalization one combining both price reforms of scenario one and two. Market liberalization reforms tend to reduce crop supplies in a similar manner than the first scenario. However, changes in final commodity demands tend to be the result of income effect of scenario one and the price effect of the second scenario. Imports of wheat and beef will significantly decrease by 87 % and 31 %, respectively. Olive oil exports will increase by around 20 %.

The drought policy scenario assumes a reduction in the intermediate demand price of barley by 10 %. This drought relief program is implemented to help farmers cope with the drought and reduce slaughtering of young animals. Simulation of this package shows no impact on the structure of production and consumption in the three agro-ecological regions. However, such policy measure would negatively impact agricultural budget revenue (-24 %) as well as the agricultural balance of trade (-2 %). Impacts of these different policy alternatives on commodity supply, final demand and trade are summarized in table 3 below.

Impacts on agricultural budget revenue, the balance of trade and incomes

The various policy scenarios analyzed in this paper seem to have differential impacts on key welfare and income measures. The effects of the selected policies on the agricultural budget revenue, the balance of trade, regional agricultural incomes and the net welfare effect are summarized in table 4 below.

The market liberalization scenario (S3) combines policy reforms of both scenario one and two. By removing some of the distortions of current policies (i.e., bringing producer/consumer prices closer to world levels), this scenario improves domestic resource allocation and positively impacts the welfare of agriculture on the whole.

The agricultural budget revenue, computed as total proceeds from taxes minus total producer and consumer subsidies, seems to be positively affected by this reform. The producer and consumer support declines and so would producer and consumer taxes. The net effect is a 6 % increase in the agricultural budget revenue. The change in the structure of demand and supply would affect trade with world markets. The import bills of wheat and beef would greatly improve. Export revenues from olive oil would increase and the overall effect is an increase of the agricultural balance of trade by around 42%.

Non-tradable commodity prices tend to decline and cause regional agricultural incomes to drop by up to 25 %. The net welfare effect of market liberalization, computed as the sum of the loss in agricultural incomes in the different agro-ecological regions and government savings from domestic support reduction, is positive (+56.4 MD).

The drought management policy is simulated in the fourth scenario. Tunisia has implemented several drought relief programs, which include a strong feed subsidy component with a high budgetary cost. The simulation of a 10 % reduction in the user price of barley would result in about 25 % decline in agricultural budget revenue. The net effect on the agricultural balance of trade is a decline of 2 %. The net welfare effect is a negative 1.2 MD.

Table 3 : Impacts of various policy regimes on selected commodity suppply, final demand and trade.

Commodity / area	Base year value (000T)	Price reforms drought policy scenarios			
		S1	S2	S3	S4
Regional supply					
Low rainfall area :					
Wheat	350.5	0.0	0.2	0.2	-0.1
Barley	159.13	-3.6	0.2	-3.8	0.1
Beef	21.47	0.4	0.3	0.8	-0.2
Olive oil	11.27	4.9	0.2	5.0	-0.7
High rainfall area :					
Wheat	455	-0.7	0.1	-0.5	-0.0
Barley	81.15	-4.4	-0.1	-4.6	0.1
Beef	10.70	0.0	0.2	0.3	-0.1
Olive oil	33.25	4.2	0.0	4.2	-0.1
Rest of the country:					
Wheat	62.4	-1.0	0.2	-0.8	-0.1
Barley	52.54	-3.8	-0.2	-4.0	0.1
Beef	17.68	-1.0	0.4	-0.5	-0.2
Olive oil	5.95	8.1	0.7	8.8	-0.3
Final demand					
Wheat	938.76	-3.5	-3.3	-6.9	0.3
Barley	37.91	-3.0	2.9	-0.1	0.2
Sheep meat	50.21	-2.7	-0.6	-3.3	0.3
Beef	56.62	-5.8	2.7	-3.1	0.5
Olive oil	74.16	-1.8	-1.9	-3.7	0.1
Derived demand					
Low rainfall area :					
Pasture	199.82	-2.3	-0.3	-2.7	0.2
Lamb	0.47	-1.2	-0.2	-1.4	0.0
High rainfall area :					
Pasture	113.22	-2.0	-0.2	-2.2	0.1
Lamb	1.15	0.5	0.0	1.0	0.0
Rest of the country:					
Pasture	214.64	-4.5	-0.6	-5.1	0.3
Lamb	1.18	-1.0	-0.2	-1.2	0.0
Derived demand					
Wheat (imports)	70.86	-41.6	-46.3	-87.9	4.6
Barley (imports)	98.16	-1.1	1.1	0.5	0.8
Beef (imports)	6.15	-53.6	22.5	-31.0	5.3
Olive oil (exports)	60.72	16.8	3.4	20.2	-0.6

Table notes : All entries are percentage changes from base year levels.

Table 4 : Impacts on agricultural budget, the balance of trade and agricultural incomes.

Economic variables	Base year values (MD)	Price reform anddrought effect scenarios			
		S1	S2	S3	S4
Agricultural budget revenue	18,77	92,2	-94,3	6,4	-24,7
Agricultural balance of trade	109,25	33,7	7,9	41,7	-2,0
Agricultural incomes					
LRA	223,96	-16,8	-1,0	-17,8	1,4
HRA	249,76	-17,5	-0,3	-17,8	0,8
ROC	74,82	-22,5	-2,6	-25,1	3,9
Net welfare effect (MD)		44,4	14,0	56,4	-1,2

Table notes : All entries are percentage changes from base year levels, except for the net welfare effect computed in millions Dinars (MD).

CONCLUSION

In this paper a multi market model for the agricultural sector in Tunisia is developed to address a variety of key policy questions raised in the context of a new era of trade liberalization and economic reforms. The rationale for these reforms is to improve resources allocation and remove some of the price distortions supported by current price policies. Policy options investigated within this framework include, among others, the reduction in the producer support, market liberalization and a drought policy. The model is designed mainly to analyze the effects of these policy options on the low rainfall area. However, due to the inter-regional linkage, the high rainfall area and the rest of the country are also included to capture the possible transfers of feed and livestock resources across the three agro-ecological regions.

The main results of this paper are summarized along two main conclusions. The first one relates to the multi-market framework used to carry on this research. The modeling framework used here provides a simple and operational tool to assess the impacts of alternative policy regimes. Further, it allows capturing the complex-second round effects in all markets which are not predictable in a single market model framework.

The second conclusion is that market liberalization has important implications in terms of efficiency, equity and environmental sustainability. First, in terms of efficiency, market liberalization is efficient as the net welfare is positively affected. Second, neutral liberalization as it is simulated is equitable in that, no major differential impact on agricultural incomes is noted. Further, by reducing price distortions and improving resources allocation and thus productivity, market liberalization would improve the agricultural budget through domestic support reductions. This suggests that the decline in the agricultural incomes could largely be compensated by some kind of income support through transfers from the savings made with support reductions. Further, the agricultural balance of trade would significantly improve through the reduction of wheat and beef import bills and the increase in the export revenues from olive oil.

Last, market liberalization has potential benefits on the environment. Indeed, this policy could alleviate the increasing pressure on the low rainfall area's fragile environment and attenuate range degradation through the reduction in the derived demand for pasture (-2.7 %). Further, liberalization could provide incentives to move lamb fattening to the high rainfall area (+1.0 %), thus decreasing the pressure on the low rainfall area's resource base.

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