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A Micro-Economic Analysis of Farm Restructuring in Khorezm Region, Uzbekistan

Nodir DJANIBEKOV
nodir@uni-bonn.de
Centre for Development Research (ZEF)
University of Bonn
Walter-Flex-Str. 3, 53113 Bonn, Germany

Abstract. The paper analyses the response of the agricultural producers to introduction of new agricultural policies in Khorezm, a region of Uzbekistan. Ever since its independence several reforms in agriculture of Uzbekistan have been taken as part of a gradual transition process towards a market-based economy. These processes include market liberalization, reformation of land relations, structural changes, and creation of supporting market infrastructure. Furthermore, there has been considerable promotion of input market liberalization, abolishment of state procurement system, introduction of water charges and improvement of the livestock sector. The understanding of the effects of these reforms on the agricultural producers and consumers in Khorezm is very important for further decision making. In order to formalize the key aspects of sectoral decision making, the major task of this research is to develop a model for policy analysis which reflects the unique features of the agricultural sector of the study region. The model results show that the market liberalization may not lead to an increase in the regional production of cotton and may negatively affect the agricultural employment. Furthermore, the livestock sector may serves as a security tool in rural households for maintaining their income level when the markets are liberalized.

Keywords: Agricultural policy analysis, Sector model, Khorezm

1. Introduction

The Khorezm region is located in the north west of Uzbekistan in a lower Amu Darya river delta. The regional arable land comprises 6 percent of national land and produces about 7% of national agricultural product (MAWR 2004a). The agricultural sector produces two third of regional GDP and employs 40% of regional labour (OblStat 2004a). The distinct features of agricultural policies implemented in the Khorezm region include the maintenance of state control over cotton export as a part of policy for stabilizing the national export revenues (Guadagni et al 2005). Annually, state imposes a state order task to agricultural producers according to which they have to sell total raw cotton harvest to the state processing companies at the procurement prices lower than the possible international market price for raw cotton. As result of this policy, the area of cotton cultivation is maintained in the region (OblStat 2004b). In exchange for producing cotton, state provided the producers with input subsidies. Nevertheless, in 2003, cotton was still unattractive for agricultural producers in Khorezm. Next, a program was declared to obtain national self-sufficiency in wheat production (Guadagni et al 2005), according to which the winter wheat production was promoted at costs of fodder crop cultivation. Except for the drought period in 2000 and 2001 the total regional crop area has been increasing steadily (OblStat 2004b).

Next agricultural policy was to gradually substitute large scale state farms by smaller private farms, in other words farm restructuring. As result of the farm restructuring process, in 2003

the agricultural production in Khorezm consisted of three types of producers each distinguishable by their resource endowments, land use rights, production activities and individual policy environments such as large-scale state farms with average size of 1,200 ha; private farms with average size of 12 ha; and rural households with average size of 0.2 ha (OblZem 2004).
The motivation for the study was the discussion on the governmental level about further implementation of entirely new agricultural reforms in the region such as liberalization of cotton and input markets, accomplishment of farm restructuring process; introduction of water prices; and improvement of the livestock sector, which raise a question about how regional production and welfare will change when these policies are introduced. Therefore, an application of a tool for systematic policy analysis is required. This work is part of ZEF/UNESCO project in development research on the economic and ecological restructuring of land and water use in the Khorezm region.

2. Objectives and hypotheses

Based on forthcoming agricultural reforms, the main objectives of this study was to analyze the effects of different agricultural policies on regional production pattern and welfare. Based on this, a specific objective was to develop and apply a sector model using empirical and economic information available. Since a sector model is to be developed another specific objective of the study is to establish a calibration technique for selected model based on state of art.

3. Applied model

A sector model based on mathematical programming is the most appropriate for modeling the agricultural sector of Khorezm. Such models incorporating relationships between different production activities do not depend upon long-term historical data, and can be applied for analyzing effects of previously unobserved policies (Norton and Solis 1983, Hazell and Norton 1986). Using such a model, a modeler can introduce exogenous policy changes into the model and observe the simulated response. A regional agricultural sector model for Khorezm (called KhoRASM) was developed as a static partial equilibrium model reflecting the unique features of the agricultural sector of Khorezm for 2003 as a reference year.

The KhoRASM model consists of linear supply and non-linear demand modules. The supply module reflects the basic crop and animal production activities in the region in linear manner, such as no production functions were introduced and each production activity is defined by a single set of production technologies. The constraints are imposed due to limited supplies of resources and state order which implies that a pre-determined share of agricultural land is allocated under cotton. In regional sector model the prices should be defined endogenously to recognize the price-quantity interrelationships via introduction of demand function (McCarl and Spreen 1980). The influence of changes of agricultural income of rural population on demand is essential when demand structure is analyzed for a transition country such as Uzbekistan. Functional forms such as a Normalized Quadratic – Quadratic Expenditure System (NQ-QES) which introduces non-linear Engel curves on income effect on consumption are more in line with empirical evidence (Frohberg and Winter 2001). Therefore, this demand function was used for the demand side.

In KhoRASM, supply and demand sides are linked via nonseparability conditions according to which producer decisions of rural household are affected by his consumer characteristics. First, rural households can produce/trade or consume an agricultural commodity, and their agricultural profit is equal to his total expenditure for commodity purchasing. Secondly, agricultural wages are equal to leisure price. Finally, available time for agricultural activities in

rural households is used for on-farm, off-farm production activities and leisure. Following a standard welfare analysis, total welfare of the study region consists of consumer surplus, i.e. money metric indirect utility function, and producer surplus, i.e. agricultural income.

In order to formalize the key aspects of sectoral decision making and for reasons of data availability and computational complications the model's demand and supply sides are aggregated over districts, producers, consumers and commodities. In the supply side, three groups of producers such as state farms, private farms and rural households. The demand side is presented by two types of consumers such as urban and rural households. Since producer decisions of rural households are affected by their consumer characteristics, they were introduced both as agricultural producers and consumers of agricultural products and, therefore, appear both in supply and demand sides of the model. Commodities which are consumed by rural and urban households are projected in the model as price-endogenous. Since rural households decides whether to allocate its time to on-farm, off-farm activities or leisure time, leisure is defined as a separate consumption commodity. All commodities are tradable between producers and consumers and can be exported to and imported from outside of the region, except for leisure.

The study uses large amount of data and information dealing with agricultural sector in Khorezm. Information about input-output coefficients of agricultural production, resource quality and quantity, input-output prices in each type of agricultural producer were collected via farm and household surveys. The aggregated data were collected from the official statistical reports. FAO and WATSIM databases were the sources for information on regional consumption and primary values for demand elasticities.

4. Model calibration

Usually, without calibration, the mathematical programming models cannot exactly replicate the observed situation (McCarl and Spreen 1980, Howitt 2002) and, therefore, the model needs to be calibrated such the variables of the demand and supply sides are equal to their values observed in 2003. To ensure that the base solution of the model fits the observed values of modelled activities and to ensure that the model simulations include the characteristics of regional demand and supply, the model the supply and demand sides were calibrated separately. The calibration of the supply side of KhoRASM is especially interesting because it contributes to the field of known calibration techniques for supply models based on mathematical programming. While a positive mathematical programming (PMP) is usually used (Howitt 1995, Heckelei 2002), an elegant alternative approach is developed in this study for calibration of the supply side of KhoRASM. In contrast to PMP, the developed technique calibrates the supply side via adjustments in the production technologies of supply side, such as fertilizer and water application rates, labor and diesel use rates per hectare of land. This approached calibrated the supply side of the model maintaining its original specification. The main assumption of the developed calibration approach is that the technology parameters collected via farm and household surveys are the least reliable information in the model.

In the calibration of the model's demand side the general idea was to derive parameters of the demand function such as prices and demanded quantities are equal to their observed values at the base run of the model. Usually, information on price and income elasticities does not fulfill the microeconomic theory requirements and, thus, prior to deriving the parameters for the demand function, the price and demand elasticities were adjusted in order to fulfill them (Frohberg and Winter 2001). After the demand elasticities are modified, their values used for deriving the parameters for demand side of the model. Being calibrated separately, demand and supply sides in the base run solution of the general model exactly replicate the observed values for 2003 and after this the model was used for the scenario simulations. The model was

programmed in GAMS, calibrated and solved as nonlinear programming problem using CONOPT3 solver.

5. Results of policy simulations

Five separate scenarios relevant to the forthcoming agricultural reforms were simulated in the model via exogenous changes in the parameters.

Scenario 1 assumes that the state invests into the improvement of irrigation and drainage system in the region. The model adaptation in this scenario was implemented as follows: firstly, it was assumed that the improvement of water efficiency is achieved through investment by the state and does not pose any direct cost to farmers. Secondly, water efficiency for each crop was improved by 10% over each water application month, i.e. water application rates decreased by 10%. Next, yields were increased by 10% for all crops; all other parameters remained fixed. Thus, the productivity of all other modeled factors, which are kept fixed in this scenario, e.g. nitrogen fertilizers, diesel and labor, will also improve.

Scenario 2 is related to the recently discusses introduction of water pricing mechanism in the region. The simulation is based on crop-area water pricing approach and the water prices are introduced into the production costs for crop growing activities. In the model, the improvement in water use efficiency is simulated by decreasing the original values of the technology coefficients of actual crop water requirements for crops which are charged by water price by 10%. It was also assumed that the producers will benefit from the improved managerial and institutional practices of operating the regional irrigation and drainage system by water user associations which can increase the crop yields by 10% via better quality and more timely supply of irrigation water to the farm fields.

Scenario 3 simulates the abolishment of state order for cotton and removal of state subsidies for inputs. The cotton market liberalization is defined in the KhoRASM model via elimination of the state procurement constraint and increase in the price for raw cotton to its hypothetical border price. The input market liberalization is defined as removal of producer constraints for a specific inputs and increase of prices for these inputs.

Scenario 4 is related to the accomplishment of farm restructuring when state farms are entirely substituted by the private farms. In this scenario, the values of input endowments and state procurement policy constraints imposed on state farms were transferred to private farms. Also, the input-output parameters of state farms were set to zero, and the ones of private farms and rural households remained unchanged.

Scenario 5 assumes the improvement of livestock keeping technologies. In this scenario, the values of milk and meat yield per cattle were increased by 10%. Next, the values of livestock feeding technologies were increased by 10% above their modeled values. Additionally, the land constraint imposed for livestock keeping activities in terms of area of sheds and buildings was increased by 10% in each producer aggregate.

The results of the policy simulations depend on assumptions of the model which were mandatory in order to reduce the complexity of the situation and to be able to represent in the model using sufficient amounts of primary and secondary data. Although, the simulation results should be treated with caution, it is believed that they are reliable and can contribute to the discussion on how the simulated policy can affect the regional income, production pattern and land and water use in Khorezm.
The policy simulation results eventually show that, despite higher input prices and water pricing being introduced into the agricultural sector of the study region, positive effects of water use efficiency and market liberalization may dominate. Furthermore, if water pricing is

introduced, the livestock sector may function as a security tool in rural households for maintaining their income level. Moreover, the improvement in livestock productivity shows the potential to decrease water consumption in the agricultural sector of the region.

The simulation of cotton and input market liberalization policy shows that under assumed changes of factor prices, this policy will not necessarily lead to an increase in the regional production of cotton. In general, the market liberalization has a positive effect on the regional rice sector which can be cultivated on land released from the procurement quotas in case of course the land is suitable for rice cultivation. Furthermore, despite the absence of a functioning land market, the completion of the farm restructuring process may increase the efficiency of land and water use and allow the producers to achieve a higher income level. Concerning the policy effect with regards to the location of producers and consumers, the market liberalization and farm restructuring reforms are more beneficial for districts with abundant water, while the water scarce districts will have a higher positive effect under improved water efficiency and increased productivity of the livestock sector.

Conclusion and policy messages

- The policy effects are different with respect to the district location to the river. Consequently, support programs and policies would be ill-advised if they ignore the locations of agricultural producers to the river.
- Substitution of state farm by private farms allows achieving higher regional welfare using less land and water. However, agricultural employment will decrease as result of policies which can improve land and water use such as farm restructuring and abolishment of state order for cotton. Hence, it should be taken into consideration that impact of liberalization programs would be limited unless additional programmes join such efforts such as increased opportunities of employment in non-agricultural sectors and development of processing sectors.
- Liberalization of cotton and input markets without incorporating the development in cotton processing sector does not make cotton attractive to agricultural producers. And under market liberalization, future growth in cotton production will still depend on regional exports. Therefore, there is much attention should be paid for development of the cotton processing industry in the region. In fact, as the simulation results showed, the agricultural production in Khorezm region is very sensitive to a reduction in state order for cotton. Vegetable production becomes more attractive for agricultural producers when state order for cotton is removed. To revitalize the vegetable production the regional policy makers could also pay more attention to promote on-farm processing technologies.
- Introduction of water prices shifts the regional agricultural production towards livestock sector production. Furthermore, irrespective of the scenarios analyzed, the regional livestock sector showed its potential to maintain and increase the rural income. Since most rural households keep livestock in their backyards, an implementation of programs for improving livestock productivity will generally imply an increase in income for the majority of the rural population and can be used by rural households as a shield against income decreases when factor markets are liberalized or water prices are introduced. The improvement of livestock husbandry should receive particular attention for instance via disease management and adequate fodder production. Furthermore, investment into the processing industry of dairy and meat products can support the improvement of the livestock sector.
- However, at present, access to sufficient and high quality feed in Khorezm is in short supply and the regional livestock highly depends on the cultivated fodder crops and the grain byproducts. Therefore, in case of further development of the livestock sector, the regional producers might not be able to supply enough forage and the regional livestock sector may become highly sensitive to the fodder supplies from outside of the region. Consequently,

emphasis should be given to the promotion of new varieties of fodder crops, intercropping systems and the production of crops with a high feed value.

- The introduction of water prices will have a negative impact on the incomes of agricultural producers and thus, it should be introduced gradually over a period of time to allow water users to adjust to higher production costs. After input subsidies are removed, the problem of possible crop yield declines can be offset and overcome via programmes that aim at increasing the productivity of inputs such as high-yielding crop varieties, better fertilizers, and plant protection. The development of low till or no till technologies for cotton and wheat will reduce production costs while maintaining present crop yields.

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