The Climate Change Impact on Cropping pattern

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1. Introduction

The impact of climate change is investigated using the Agricultural Sector Model frame work and Calibration Method of PMP.

The effects of climate change may be caused by change of temperature and rainfall pattern. Its effects of climate on yield levels and variances are investigated and used well following this procedure (Chen, McCarl and Schimmelpfennig 2000, Adams, McCarl and Mearns 2003). The former uses panel data in U.S. Agriculture with different climate change scenario. For this research, further field survey will be needed.

2. Agro-climate impact to the productivity by Province

For characterization of Adana province , the regional comparison of productivity might be helpful, so the Technical Inefficienct Effects model are applied using panel data and concluded that agro-climatic and other environment variables are critical (Demir and Mahmud 2002). So to see the regional variability to this impact, these variables are needed to be considered.

Model

In this framework aggregate provincial level, agricultural data as opposed to farm level data is used. Also assuming that agro-climatic variables may affect the productivity, we include these variables in the production function as well as in the inefficiency model.

We have set output(VA) as Lhs variable, and as Rhs variables 19 X variables and 16 Z variables are used . The 19 X variables include Land, Labor, Capital, Land-quality and Rainfall in linear form, and squared and cross terms since the production function is a Translog. Note that for the column Rainfall we do not have a square term because the variable is a dummy and the square of a dummy would cause linear dependence which would cause problem of matrix inversion.

The 16 Z variables are the environmental variables and their interactions with factor inputs-X variables. The environmental variables are, Z1: Land-ownership distribution (measured by GINI coefficient G), Z2: Land quality (measured by a land quality index Q), Z3: general crop-pattern (a dummy variable taking 1 for intensive cultivation, 0 for cereals and traditional livestock C) and Z4: Precipitation (rain+snow) (a dummy variable taking 1 for precipitation above the national average R). The remaining 12 Z variables are interactions Z*X (interactions with land, labor and capital 4x3 =12).

Data

Employed the data from 67 province, aggregate at provincial level, covering the 1993, 1994 and 1995. Panel data analysis is employed by Coelli and Battese (1998). This dataset was provided by Demir Nazmi and S. F. Mahmud (2002).

Result

The variation is different by agricultural region. Central region and eastern region have low score. Even Mediterranean region, where water resource abundant region, some have low score. Adana locates as relatively 0.61 -0.67. Focusing in Mediterranean region, only Adana province increases the technical efficiencies score in three years (Figure.1).

3. Irrigated area and crops

Ceyhan Plain Irrigation Project Area, our research field, is water abundant area and the irrigated crops are varied by water users association due to the infrastructure development and accessibility to water.

This project area has been extended in cotton, where the soil is suitable to maize suitable area as well. The irrigated crops has been changed from cotton to Maize as the water users association's record (Fig.3).

As the result, even now some areas have much crop variety, such as with citrus and vegetables (DSI, 2002) collected by Dr. Umetsu & Nagano in July 2003 (Fig.4)..

4. Data

The data can be grouped in three main clusters: (a) gross margin, (b) resource requirements for unit acrea, (c) resource availability. For (a) and (b) AERI(2001), Koral and ALTUN(2000) are used. Besides particularly for water requirements Ozgenc and Erdogan(1988) from DSI is useful. For (c)

Labor, capital, water availability are obtained from DSI(2002).

5. Regional Agricultural Production Model

The model is non-linear programming model. It maximizes the consumers' and producers' surplus.

Agricultural production in this region is highly diversified due to variety of soils and agro-climatic conditions. The structure of production presents a challenging diversity with the regions which have both common products and regional specialties. The techniques of production for the common products are quite different among regions because of the differences in climate and resource endowments. The diversity in production points out an unusually interdependent production structure on the supply side. Inter-subsectoral dependencies are as important as the intra-subsectoral dependencies. In addition, on the demand side, the regions compete with each other for access to the same national and foreign markets, on the one hand. On the other hand, demand for feed is in fierce competition with the demand for food.

6. Calibration Method

According to Cakmak H. E, and H Kasnakoglu, 2001, the implementation of calibration methodology can also provide information about the general structure of the model. The first step of the model can be written in simple matrix notation as follows:

$$\text{Max} \quad Z = f(D) \tag{1}$$

$$Ax \leq b \tag{2}$$

$$Ix = \tilde{x} + \varepsilon \tag{3}$$

$$x \geq 0 \tag{4}$$

where Z is the objective function. Domestic and foreign demand, import costs of the products, and the variable costs of all production activities are included in the objective function. The vector x and the matrix A denote the activities and input-output coefficients. Vector b shows the RHS of the equations.

Equation (3) is called calibration constraint. $\tilde{x}$ is formed by the base period levels of the activities, and ε is the perturbation factor (equals 0.001) to prevent degenerate solution. The dual values of the calibration constraints provide the missing information about the marginal costs of the activities. The intercept and slope terms of the activity specific marginal cost functions are estimated by using the prevailing product pattern in the base period. The slope terms are dependent on the gross revenue and the level of activities.

$$\gamma_{r,a,t} = -1/SE_a \cdot \sum_o (P_o \cdot Y_{r,a,t,o}) / BPA_{r,a,t} \tag{5}$$

where λ is the slope term, SE and P represent supply elasticity and price, respectively; Y is the yield, and BPA denotes base period activity level. The indices are defined as follows: r, region; a, production activity; t, technology; and o, output.

The intercept terms are found by using the dual values of the calibration constraints and the slope terms:

$$\alpha_{r,a,t} = -DVC_{r,a,t} - \gamma_{r,a,t} \cdot BPA_{r,a,t} \tag{6}$$

where α is the intercept term of the cost function, and DVC denotes the dual value of the calibration constraint in (3).

Hence, the cost functions are obtained

from the production decisions of the farmers in the base period. In the second step the cost functions are incorporated in the model shown in equations from (1) to (4), and calibration constraints (3) are removed. The model used for policy experiments is shown below:

Max Z=

$$f(D)+\sum_{r,a,t} x_{r,a,t}\left(\alpha_{r,a,t}+0.5\gamma_{r,a,t}\cdot x_{r,a,t}\right) \quad (7)$$

$$Ax \le b \quad (8)$$

$$x \ge 0 \quad (9)$$

The model, is consistent with the microeconomic theory(Howitt1995a,b), and it replicates the base year production and prices without the calibration constraints.

7. Remarks

In this research the regional level production model will be developed by calibration procedure. Although the impact of climate change is not obvious, the reason for this may be that little empirical evidence is available on sources of agricultural output variability. In Chen, McCarl and Schimmelpfennig(2000) precipitation and temperature individually have opposite effects on corn yield level and variability. The further research is needed crop by crop.

Using our regional production model, the policy issues are also can be discussed, due to the recent policy instrumental change from price support to direct-income payment, it will give the farmers more decision making choice so that cropping pattern may be cased by this policy change rather than climate change.

8. References

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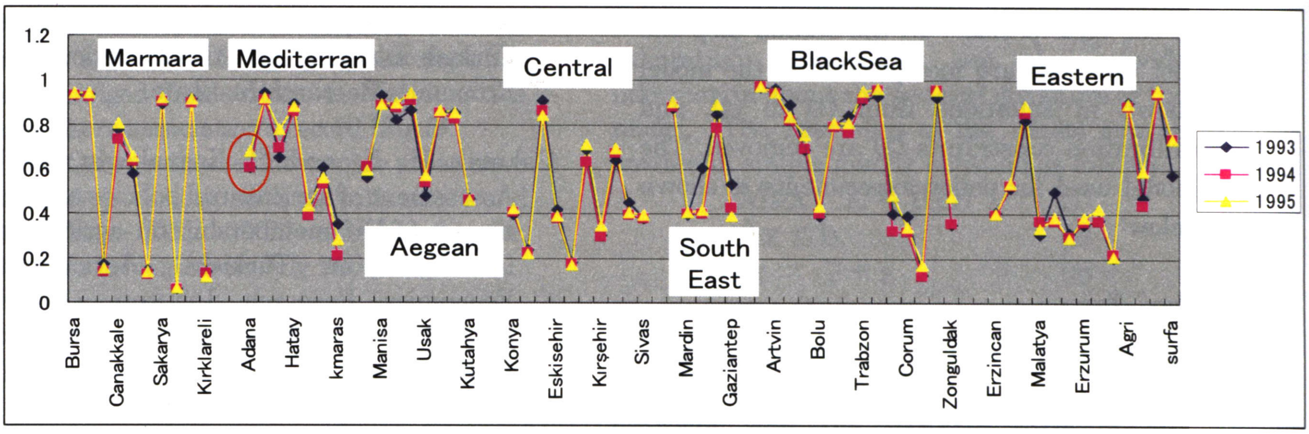

Data: Demir N. and S. F. Mahmud(2002)

Fig. 1 Product Efficiency Coefficients by Province in Turkey

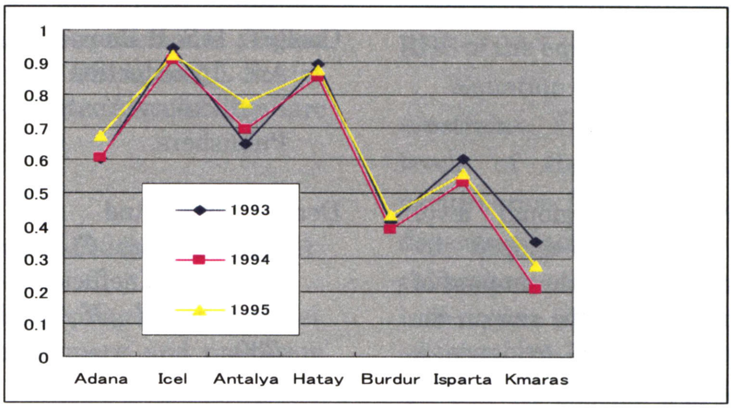

Fig. 2 Product Efficiency Coefficients by Province in Mediterranean region

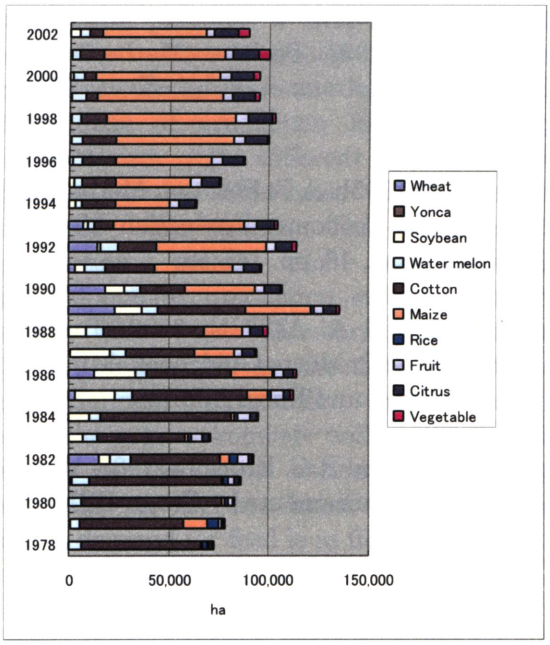

Fig. 3 Irrigation area by crop in Lower Ceyhan Plain Irrigation Project Area

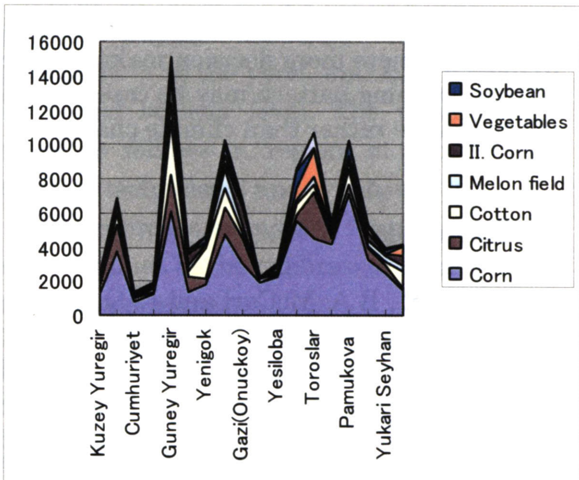

Fig.4 Major Irrigated Crops by Water Users Association