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THE TURKISH AGRICULTURAL SECTOR MODEL: A POSITIVE QUADRATIC PROGRAMMING APPROACH TO CALIBRATION AND VALIDATION

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CONTENTS

I. INTRODUCTION

Agriculture plays a crucial role in the economic development of Turkey. In 1983, it contributed 20 percent to GDP and employed over 50 percent of the labor force. Turkish agriculture, due to the variety of soils and agro-climatic conditions is highly diversified. It produces continental products (such as wheat, corn, barley, cotton, tobacco, sugarbeet) as well as Mediterranean products (such as fruits, nuts and vegetables) on about 25 million hectares of land with over 10 million people. Since the 1940's Turkey has been a net exporter of many agricultural products, including cereals (wheat, rye, barley, millet), pulses (chick-peas, beans, lentil), industrial crops (cotton, tobacco), nuts (hazelnuts, pistachios), fresh and dried fruits (raisins, figs, citrus, apples), vegetables (tomatoes, potatoes, onions), oils and oilseeds (olive oil, poppy, cotton, sesame, peanuts), and, livestock products (live animals, wool, hides, meat). In 1980, nearly 60 percent of the value of exports were agricultural and livestock products, with another 20 percent (such as textiles, processed food and livestock products) having their origins in agriculture (Kasnakoglu, 1985).

The agricultural sector has been subjected for a long period of time to direct and indirect government intervention. Various instruments of agricultural policy such as output support prices, input subsidies, credits, quotas, tariffs, taxes, land distribution, infrastructural investments, extension services, have been employed. The objectives are many and include income and price stability, stimulation of output and income, satisfaction of domestic demand, improving balance of payments and changing sectoral terms of trade.

An obvious implication of the diversity of agricultural production, the multiplicity of targets and instruments available to achieve them; is that the consequences of policy measures on the intended and unintended variables cannot be ascertained by a partial analysis of individual policy instruments, targets or crops.

The Turkish Agricultural Sector Model (TASM) is developed to provide an internally consistent, quantitative framework of analysis to evaluate the effects of policy interventions.[1]

In this paper, we concentrate on the calibration and validation of the base solution, which is a prerequisite to the further policy simulations with the model. Policy makers and even many economists, have been reluctant to rely heavily on programming models for planning, due to the poor performance of these models at the disaggregated levels, and the lack of widely accepted validation procedures. A practical method developed by one of the authors, (Positive Quadratic Programming) is employed to calibrate and validate the model.[2] The performance of the positive quadratic programming approach is evaluated by projecting cropping patterns two years ahead of the base year.

II. THE BASIC STRUCTURE OF TASM

The model used to simulate the agricultural sector and the resource allocation effects of agricultural policies on production, consumption and trade patterns is a partial equilibrium, static, optimization model.

The objective function maximized in the model is the sum of the consumers' and producers' surplus, plus net export revenue, and minus the reservation wage of labor. Risk costs are included as part of the production costs within an E-V framework. Given the structure of consumer demands, production activities and trade possibilities, the optimal solution entails

equating supply to domestic plus foreign demand and prices to marginal costs for all commodities, making provisions for risk and allowing for the reservation wages for labor.

The core of the model consists of the production activities and resource constraints. The input and output coefficients for single crop production and rotations are specified for each unit of land. In addition to land, other input requirements for production are labor, tractor, fertilizer animal power, seed and * capital. Animal power is supplied by livestock production activities, and seed is supplied by the crop production activities.[3] Labor, tractor and animal power are divided into four calendar quarters. The model is given a choice of two production techniques, animal or mechanized. It can assign any combination of weights to these two techniques to produce a single crop, depending on the optimal allocation of resources.

The structure of the livestock subsector is similar to the crop subsector. The explicit production cost for animal husbandry is labor. Other inputs required are cereals, straws and forage, which are by-products of crops; and concentrates which are derived from crops processed for human consumption. Pasture land is also required for supplemental grazing, with the exception of poultry. In addition to meat, milk, hide, wool and eggs, the livestock production activities also provide animal power used in crop production activities.

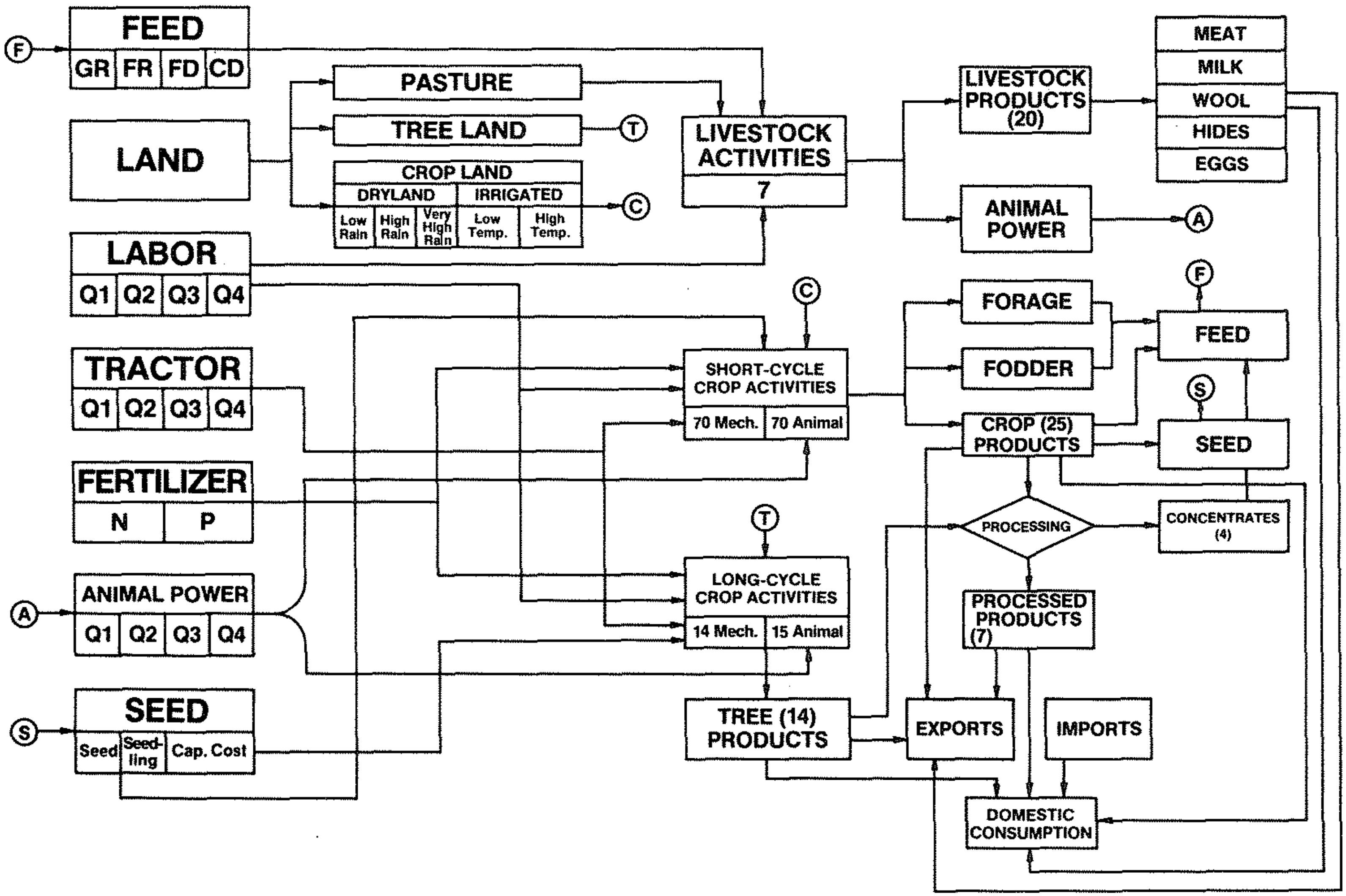
The commodities produced by the production activities are distributed between: (i) domestic demand generated through demand curves, (ii) demand for cereals used for feeding in the livestock sector, (iii) demand for seeds used in crop production activities, (iv) exports in raw form, (v) exports in processed form. On the supply side, besides the domestic production, some commodities are allowed to be imported at exogenous prices.

Since generally the data available are most reliable at the farmgate level, prices and some quantities used in the model are incorporated at this level. Import price is the CIF price plus the transportation and marketing margins, export price is FOB minus the margins for all commodities in raw or processed forms. The domestic demand functions are also calculated at the farmgate level.

In addition to commodity and area balance equations, ~~in~~ trade, area, and production, limit equations may be used for model validation, as market absorption constraints or for different policy experiments. The basic structure of the model is illustrated in Figure 1.

FIGURE 1

BASIC STRUCTURE OF TASM



III. THE ALGEBRAIC STATEMENT OF TASM

A. INDICES

s_1 Basic Land Types

Dry Low Rainfall
Dry High Rainfall
Dry Very High Rainfall
Irrigated Low Temperature
Irrigated High Temperature
Tree Area
Pasture

s_2 Land Types Without Rainfall or Temperature Distinction

Dry High or Very High Rainfall
Dry Either Rainfall
Irrigated Either Temperature

l Labor (Divided into 4 quarters)

Labor 1Q
Labor 2Q
Labor 3Q
Labor 4Q

a Animal Power (Divided into 4 quarters)

Animal 1Q
Animal 2Q
Animal 3Q
Animal 4Q

m Tractor Power (Divided into 4 quarters)

Tractor 1Q
Tractor 2Q
Tractor 3Q
Tractor 4Q

f Fertilizer

Nitrogen
Phosphate

d Seeds

Wheat
Corn
Rye, Oats, Millet, etc.
Rice
Barley
Chick-pea
Dry Bean
Lentil
Potato
Onion
Green Pepper
Tomato
Cucumber
Sunflower
Groundnut
Cotton
Sugar Beet
Tobacco
Melon
Pistachio
Alfalfa
Fodder

o Output

Wheat	Corn
Rye, Oats, Millet, etc.	Rice
Barley	Chick-pea
Dry Bean	Lentil
Potato	Onion
Green Pepper	Tomato
Cucumber	Sunflower
Olive	Groundnut
Cotton	Sugar Beet
Tobacco	Tea
Citrus	Grape
Apple	Peach
Apricot	Cherry
Wild Cherry	Melon
Strawberry	Banana
Quince	Pistachio
Hazelnut	Soybean
Sesame	
Sheep Meat	Sheep Milk
Sheep Wool	Sheep Hide
Goat Meat	Goat Milk
Goat Wool	Goat Hide
Angora Meat	Angora Milk
Angora Wool	Angora Hide
Beef	Cow Milk
Cow Hide	Buffalo Meat
Buffalo Milk	Buffalo Hide
Poultry Meat	Eggs

g Livestock Inputs from Crop By-Products*

F - Wheat	F - Corn
F - Rye	F - Rice
F - Barley	F - Pulses
F - Alfalfa	F - Fodder
C - Rye	C - Wheat
C - Sugar Beet	C - Barley

t Production Technique

Animal	Mechanized

*F stands for straws and C stands for concentrates or pulps.

i Crop Production Activities

Single Crop Activities

Activity	Land Type**	Crop
SWHEATD	DRY.HRET	WHEAT
FWHEATD	DRY.ERET	WHEAT/FALLOW
SWHEATI	IRR.ERET	WHEAT
SCORN.D	DRY.VRET	CORN
FCORN.D	DRY.HRET	CORN/FALLOW
SCORN.I	IRR.ERET	CORN
SRYE..D	DRY.HRET	RYE-OATS-MILLET
FRYE..D	DRY.ERET	RYE-OATS-MILLET/FALLOW
SRICE.I	IRR.ERHT	RICE
FRICE.I	IRR.ERET	RICE/RICE/FALLOW
SBARLYD	DRY.HRET	BARLEY
FBARLYD	DRY.ERET	BARLEY/FALLOW
SCKPEAD	DRY.HRET	CHICKPEA
SCKPEAI	IRR.ERET	CHICKPEA
SDBEANI	IRR.ERET	DRYBEAN
SLENTLD	DRY.HRET	LENTIL
SPOTATI	IRR.ERET	POTATO
SONIOND	DRY.VRET	ONION
SONIONI	IRR.ERET	ONION
SGPEPPI	IRR.ERET	GREENPEPPER
STOMATI	IRR.ERET	TOMATO
SCUCUMI	IRR.ERET	CUCUMBER
SSUNFLD	DRY.VRET	SUNFLOWER
SSUNFLI	IRR.ERET	SUNFLOWER
SGRNUTI	IRR.ERHT	GROUNDNUT
SSBEANI	IRR.ERET	SOYBEANS
SSESAMI	IRR.ERET	SESAME
SCOTTNI	IRR.ERHT	COTTON
STOBACD	DRY.HRHT	TOBACCO
SMELOND	DRY.HRET	MELON
SMELONI	IRR.ERET	MELON
SALFALI	IRR.ERET	ALFALFA
SFODDRD	DRY.HRET	FODDER

Sugarbeet Rotation Activities

Activity	Land Type	Crop
RWHSR.I	IRR.ERET	WHEAT/SUGARBEET
RCRSR.I	IRR.ERET	CORN/SUGARBEET
RSFSR.I	IRR.ERET	SUNFLOWER/SUGARBEET
RAASR.I	IRR.ERET	ALFALFA/SUGARBEET
RWHSRAI	IRR.ERET	WHEAT/SUGARBEET/ALFALFA
RWHSRSD	DRY.VRET	WHEAT/SUGARBEET/SUNFLOWER
RWHSRDD	DRY.VRET	WHEAT/SUGARBEET/DRYBEAN
RWHSRFD	DRY.VRET	WHEAT/SUGARBEET/FALLOW

**R = Rainfall; T = Temperature; E = Either; V = Very High; H = High.

Sugarbeet Rotation Activities (continued.) *

Activity	Land Type	Crop
RWHSRLD	DRY.VRET	WHEAT/SUGARBEET/LENTIL
RWHSRWD	DRY.VRET	WHEAT/SUGARBEET/WHEAT
RWHSRCD	DRY.VRET	WHEAT/SUGARBEET/CORN
RWHSRMD	DRY.VRET	WHEAT/SUGARBEET/MELON

Multiple Crop Activities (3 Crops in 2 Years)

Activity	Land Type	Crop
MWC.C.I	IRR.ERHT	WHEAT-CORN/COTTON
MWC.G.I	IRR.ERHT	WHEAT-CORN/GROUNDNUT
MWC.R.I	IRR.ERHT	WHEAT-CORN/RICE
MWC.V.I	IRR.ERET	WHEAT-CORN/VEGETABLE
MWC.O.I	IRR.ERET	WHEAT-CORN/ONION
MWC.S.I	IRR.ERET	WHEAT-CORN/SESAME
MWS.C.I	IRR.ERHT	WHEAT-SOYBEAN/COTTON
MWS.V.I	IRR.ERET	WHEAT-SOYBEAN/VEGETABLE
MWS.O.I	IRR.ERET	WHEAT-SOYBEAN/ONION
MBC.C.I	IRR.ERHT	BARLEY-CORN/COTTON
MBC.R.I	IRR.ERHT	BARLEY-CORN/RICE
MBC.V.I	IRR.ERET	BARLEY-CORN/VEGETABLE
MBC.O.I	IRR.ERET	BARLEY-CORN/ONION
MBC.S.I	IRR.ERET	BARLEY-CORN/SESAME
MBS.C.I	IRR.ERHT	BARLEY-SOYBEAN/COTTON
MBS.R.I	IRR.ERHT	BARLEY-SOYBEAN/RICE
MBS.V.I	IRR.ERET	BARLEY-SOYBEAN/VEGETABLE
MBS.O.I	IRR.ERET	BARLEY-SOYBEAN/ONION
MRC.C.I	IRR.ERHT	RYE-CORN/COTTON

Multiple Crop Activities (4 Crops in 2 Years)

Activity	Land Type	Crop
MFC.WGI	IRR.ERHT	FODDER-COTTON/WHEAT-GROUNDNUT
MFC.WSI	IRR.ERHT	FODDER-COTTON/WHEAT-SOYBEAN
MFC.BSI	IRR.ERHT	FODDER-COTTON/BARLEY-SOYBEAN
MFC.RSI	IRR.ERHT	FODDER-COTTON/RYE-SOYBEAN
MAC.WSI	IRR.ERHT	ALFALFA-COTTON/WHEAT-SOYBEAN
MAC.BSI	IRR.ERHT	ALFALFA-COTTON/BARLEY-SOYBEAN

Tree Crop Activities

Activity	Land Type	Crop
OLIVE.D	TREE	OLIVE
TEA...D	TREE	TEA
CITRS.I	TREE	CITRUS
GRAPE.D	TREE	GRAPE
GRAPE.I	TREE	GRAPE
APPLE.I	TREE	APPLE
PEACH.I	TREE	PEACH
APRIC.I	TREE	APRICOT

Livestock Activities

SHEEP
GOAT
ANGORA
CATTLE
BUFFALO
MULE
POULTRY

Tree Crop Activities (continued)

Activity	Land Type	Crop
CHERR.I	TREE	CHERRY
WCHER.I	TREE	WILD CHERRY
STBER.I	TREE	STRAWBERRY
BANAN.I	TREE	BANANA
QUINC.I	TREE	QUINCE
PISTA.D	TREE	PISTACHIO
HAZEL.D	TREE	HAZELNUT

c Land Choices

Dry Low Rainfall
Dry High Rainfall
Dry Very High Rainfall
Irrigated Low Temperature
Irrigated High Temperature

j Livestock Production Activities

Sheep
Goat
Angora
Cattle
Buffalo
Mules, Camels, Horses, etc.
Poultry

y Year

1974 to 1979

b Area

Same as the 35 field and tree crops in o plus alfalfa and fodder

bc Cereal Area

Wheat
Corn
Rye
Rice
Barley

bf Fallow Area

FWHEATD
FCORND
FRYE..D
FRICE.D
FBARLYD
RWHSRFD

po Processed Products

Wheat Flour
Tomato Paste
Sunflower Oil
Olive Oil
Dry Tea
Raisin
Shelled Hazelnut

e Production Cost Structure

Labor	Tractor
Fertilizer	Seed
Capitals	

B. PARAMETERS (DATA)

P	Crop production coefficients
Q	Livestock production coefficients
I_{oc}	Land Matrix for Undifferentiated Land
P_{cost}	Crop production costs
Q_{cost}	Livestock production costs
Q_q	Crop used for feed index (1 = yes, 0 = no)
Proctrade	Conversion factor for processed products
Concentrate	Concentrate coefficients derived from crop processing
Exprice	Export prices at farmgate
Imprice	Import prices at farmgate
Ppprice	Trade prices of processed products at farmgate
Resav	Resource availability
Revar	Revenue variances of crop and livestock activities
α	Demand function intercept
β	Demand function slope
Φ	Risk aversion coefficient
Tech	Ratio of animal to tractor technology
Fallo	Ratio of fallow land to cereal land
PQPA	PQP term for animal technology
PQPT	PQP term for tractor technology
PQPb	PQP term for crop areas
PQPbc	PQP term for cereal area
PQPbf	PQP term for fallow area

C. ACTIVITIES (VARIABLES)

CROPS	Crop production activities
PRODUCT	Livestock production activities
LANDC	Land choice for different rainfall and temperature
PFERT	Fertilizer use
PRCOST	Production costs
TOTALPROD	Total production
TOTALCONS	Total consumption
IMPORT	Import
EXPORT	Export
PPTRADE	Processed product trade (- for imports, + for exports)
ANIMAL	Land cultivated with animal
TRACTOR	Land cultivated with tractor
TECHNOLOGY	Deviation from base year ANIMAL/TRACTOR ratio
AREA	Crop and tree areas
CERAREA	Cereal area
FALAREA	Fallow area
FALLOW	Deviation from base year FALAREA/CERAREA ratio

D. ALGEBRAIC STATEMENT OF TASM

Land Constraints

(1) $\sum_i \sum_t P_{s_1,i,t} * CROPS_{i,t} + \sum_j Q_{s_1,j} * PRODUCT_j + \sum_c Ioc_{s_1,c} * LANDC \leq Resav_{s_1}$ for all s_1

[Land use by crop and livestock production] [Undifferentiated land use] [Land availability]

(2) $\sum_i \sum_t P_{s_2,i,t} * CROPS_{i,t} = \sum_c Ioc_{s_2,c} * LANDC$ for all s_2

[Undifferentiated* land use by crop production] [Total undifferentiated land use]

Labor and Tractor Constraints

(3) $\sum_i \sum_t P_{l,i,t} * CROPS_{i,t} + \sum Q_{l,j} * PRODUCT_j \leq Resav_l$ for all l

[Labor use by crop and livestock production] [Labor availability]

Equation (3) with index m instead of l refers to tractor constraints.

Animal Constraints

(4) $\sum_i \sum_t P_{a,i,t} * CROPS_{i,t} \leq \sum Q_{a,j} * PRODUCT_j$ for all a

[Animal power required by crop production] [Animal power provided by livestock production]

(5) $PRODUCT_j \leq Resav_j$ for all j

[Livestock production] [Animal inventory]

Fertilizer Accounting

(6) $\sum_i \sum_t P_{f,i,t} * CROPS_{i,t} = PFERT_f$ for all f

[Fertilizer used by crop production] [Total fertilizer use]

Production Costs

(7) $\sum_i \sum_t Pcost_{e,i,t} * CROPS_{i,t} + \sum_j Qcost_{e,j} * PRODUCT_j = PRCOST_e$ for all e

[Cost of production by crop and livestock] [Total production cost]

Production Balances

(8) $\sum_i \sum_t P_{o,i,t} * CROPS_{i,t} + \sum_j (1-Qq_o) * Q_{o,j} * PRODUCT_j = TOTALPROD_o$ for all o

[Products produced by crop and livestock production] [Total production]

Commodity Balances

(9) $TOTALPROD_o + IMPORT_o = TOTALCONS_o + \sum_j Qq_o * Q_{o,j} * PRODUCT_j + EXPORT_o + \sum_{po} (1/Proctrade_o) * PPTRADE_o$ for all$_o$

[Total production] [Import] [Total consumption] [Crops used as livestock feed] [Export] [Trade of processed products]

Feed Balances

(10) $\sum_{i}\sum_{t} P_{g,i,t} * CROPS_{i,t} + \sum_{o} Concentrate_{g,o} * TOTALCONS_{o} \geq \sum Q_{g,j} * PRODUCT_{j}$ for all g

[Feed produced by crop production] [Concentrates derived from human consumption] [Feed required by livestock]

Total Area Balances

(11) $\sum_{i}\sum_{t} P_{b,i,t} * CROPS_{i,t} = AREA_{b}$ for all b

[Areas used by crop production activities] [Total crop area]

Technology Balances

(12) $\sum_{b}\sum_{i} P_{b,i,t} * CROPS_{i,t} = ANIMAL$ for t = animal

[Areas cultivated by animal technology] [Total animal cultivated area]

(13) $\sum_{b}\sum_{i} P_{b,i,t} * CROPS_{i,t} = TRACTOR$ for t = tractor

[Areas cultivated by tractor technology] [Total tractor cultivated area]

Tech

(14) ANIMAL-TECH * TRACTOR = TECHNOLOGY

[Deviations of the [ANIMAL - TRACTOR] technology use from the base year]

Fallow Balances

(15) $$\sum_{bc}\sum_{i}\sum_{t} P_{bc,i,t} * CROPS_{i,t} = CERAREA$$

[Areas under cereals] [Total cereal area]

(16) $$\sum_{bf}\sum_{i}\sum_{t} P_{bf,i,t} * CROPS_{i,t} = FALAREA$$

[Areas under fallow activities] [Total fallow area]

(17) $$FALAREA - Fallo * CERAREA = FALLOW$$

[Deviation of [FALAREA - CERAREA] from the base year]

Trade Restrictions for Base Runs*

(18) $IMPORT_o \leq IMPORT_{o,1979}$

(19) $EXPORT_o \leq EXPORT_{o,1979}$

(20) $PPTRADE_{po} \leq PPTRADE_{po,1979}$

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*Taken as = restrictions for PQP first stage runs, removed completely or replaced by demand functions or liberal upper bounds during policy simulations.

Restrictions for PQP First Stage Runs Only*

(21) $AREA_b \leq AREA_{b,1979} * 1.001$

(22) $TECHNOLOGY \leq 0$

(23) $FALLOW \leq 0$

Objective Function (for Stage 2)

(24) $\sum_o [\alpha_o * TOTALCONS_o - 0.5\beta * TOTALCONS_o{}^2] + \sum_o Exprice_o * EXPORT_o - \sum_o Imprice_o * IMPORT_o + \sum Ppprice_{po} * PPTRADE_{po}$

[Area under demand curves] [Export revenue] [Import costs] [Net revenue from processed product trade]

$-\sum_e PRCOST_e - \Phi[[\sum_i \sum_t \ Revar_i * CROPS_i{}^2] - [\sum Revar_j \ PRODUCT_j{}^2]]^{1/2}$

[Production costs] [Risk costs]

$-0.5 \sum_b PQPb_b * AREA_b{}^2 - 0.5[POPA * ANIMAL^2 + PQPT * TRACTOR^2] - 0.5[PQP_{bc} * CERAREA^2 + PQPbf * FALAREA^2]$

[Total area PQP terms] [Technology PQP terms] [Fallow PQP terms]

*These restrictions are employed to obtain the PQP terms, and replaced by the PQP terms, in the second stage.
**The objective function for stage 1 is the same, except the PQP terms at the end are not included.

IV. THE DATA

TASM is based on 15 types of orchards, 70 crop rotations and 7 livestock activities. Taking into account the two production techniques, namely mechanized and non-mechanized crop production, the total number of production activities specified in the model in 176.

The data used in the model are gathered mainly from SIS, SPO, FAO, TOPRAKSU and WORLD BANK sources. The lack of Turkish statistics suitable for this kind of modelling exercises forced the researchers to piece together the required data from different sources, and in many cases to employ unpublished raw data. In what follows we briefly state the nature of the data employed in this paper.[4]

Crop Production and Rotation Activities

In TASM there are 33 single annual crop and 15 perennial crop activities. In addition, 12 rotations for sugarbeet and 25 multiple cropping activities are incorporated as linear combinations of single crop activities with different land input requirements.[5] The input-output coefficients corresponding to these activities, with the exception of rice, hazelnuts, tea, soybean and sesame under mechanized technology are based on the ongoing "Production Inputs and Costs of Agricultural Crops in Turkey" research conducted by TOPRAKSU. The data collected by TOPRAKSU using daily bookkeeping method is the most reliable data of its kind currently available in Turkey despite its limits in coverage and bias towards mechanized technology. The non-mechanized activity coefficients are calculated using a conversion factor of 1/10 for tractor power and animal power, from the mechanized activity coefficients reported in TOPRAKSU data.

Livestock Activities

The seven livestock activities specified in TASM include sheep, ordinary goat, Angora goat, cattle (cow, oxen, bull, young cattle), buffalo, mule (horse, mule, donkey) and poultry (hens, cocks, turkey). On the input side, besides outputs and by-products from crop activities (feed grains, forage, fodder and concentrates), pasture land and labor are required. The output of the livestock activities include meat, milk, wool, hide and eggs in addition to animal power provided to crop production activities.[6]

Inputs

Six groups of inputs (land, labor, animal power, tractor, fertilizer and seeds) are incorporated in TASM. Labor, animal power and tractors are introduced on a quarterly basis. Land is classified into treeland, pastureland and cropland. The cropland is further divided into eight classes distinguishing between various combinations of irrigation, temperature and rainfall. The labor input is measured in man-hour equivalents and shows the actual time required for a given activity on the field. The tractor hours correspond to the usage of tractors in actual production and transportation related to these production activities. The two kinds of fertilizers, namely Nitrogen and Phosphate are measured in terms of nutrient contents. In the case of annual crops, amounts of seed or seedlings requirements are introduced as production costs. For non-annual or perennial crops fixed investment costs are assigned instead of production costs.

Crop Yields

Output from crop production activities is divided into: crop yield for human consumption, feed yield for animal consumption and forage yield or crop by-product for animal consumption. In addition, concentrates are derived from

the processing of raw materials for human consumption. The forage yield is imputed using (feed yield/total yield) and (forage yield/total yield) ratios. The historical yields for tree crops and vegetable crops are also imputed, since they are given per tree in the case of the former and for aggregate of vegetables in the case of the latter.

Livestock Yields

The outputs of the livestock activities include animal power, meat, milk, wool, hides and eggs. The animal power is estimated using the ratios of cattle, buffalo and mules employed as draft animals and assuming 500 working hours per year per pair. The meat yields for all animals and milk yields for cattle and buffalo are from the World Bank's Agricultural Sector Study Mission estimates. The remaining milk, wool and egg yields are based on SIS statistics. The hide yields are obtained by converting numbers of hides to Kg. using conversion factors 2.6 for sheep and goat and 20.5 for cattle and buffalo.

Output and Input Prices

Output prices used in TASM are farmgate prices, and are based on SIS figures. The costs of labor, tractor, fertilizer, seed for annual crops and fixed capital for perennial crops are based on TOPRAKSU estimates.

Resource Availability

The labor resource availability for the base year is computed by converting the agricultural labor force in 1979 to man-hour equivalents with the assumption that there are 294 working days in a year and 5 working hours in a day. Available tractor hours for 1979 are calculated by assuming 300 working days and 5 working hours a day for each tractor, and multiplying

these with the number of tractors in 1979. The livestock inventory is based on the numbers of livestock in 1979. The available land resources by type are calculated from TOPRAKSU data which distinguishes between irrigated and rainfed land but not by rainfall, and SIS data which distinguishes land by rainfall but not by irrigation. The stock of trees in 1979 covers both bearing and non-bearing areas.

Processing Factors, Costs and Concentrate Coefficients

Wheat, corn, rye, rice, sunflower, olive, soybean, sesame, sugarbeet and tea are processed for consumption, and concentrates for animal consumption are obtained as a by-product of this processing. The processing costs are computed using the following formula, with the assumption that the profit margin in processing is 20 percent for all crops:

Processing Cost = [(Export Price in Processed Form) - (Export Price in Raw Form)] * (0.80) (Processing Factor).

Crop and Livestock Production

The crop and livestock production data used in the validation of TASM are taken mainly from official statistic reported by SIS. However, production data for wheat, barley, rye-oat-millet, dry beans and tobacco were deflated. The data for lentils and chick-peas, sunflower and corn were inflated slightly due to biases discovered in these statistics, when compared to the results of various other studies and censuses and in the light of calibration runs to be discussed later.[7] For meat and milk output of the livestock activities, estimated figures are based on SPO figures rather than SIS figures, which are underestimates since they only cover meat produced from animals processed in municipal slaughterhouses.[8]

Foreign Trade

The data related to foreign trade involves trade and prices in unprocessed as well as processed products. The quantity of exports and imports of unprocessed products, with the exception of livestock meat are based on official statistics. The trade prices are FOB and CIF at farmgate, adjusted for marketing and transportation costs. Foreign trade is allowed for the following processed products; wheat flour, tomato paste, sunflower oil, olive oil, dry tea, raisins and shelled hazelnuts.[9]

Consumption and Demand

The domestic consumption is defined as: Production + Imports - Exports - Feed ± Processed Trade. Wheat, corn, rye, paddy, sunflower, olive, soybean, sesame, sugarbeet and tea are processed for human consumption. The domestic demand functions relate observed consumption quantities to observed prices at the farmgate, and were estimated by fitting a linear function through the observed base year consumptions and farmgate prices with the given price elasticities. The price elasticities are estimated from FAO (1971) income elasticities using the Frisch (1959) method.

Risk

The E-V risk formulation employed in the model uses the per hectare revenue variances for different crop, rotation and livestock activities. The revenue variances for activities are calculated from time series data on deflated farmgate prices (with 1979 = 100) and adjusted yields (for discrepancies between model yields and official yields). The risk aversion coefficient Φ is taken to be 1 in this version of the model.[10]

The Exchange Rate

During 1979 two official exchange rates are observed in the Turkish economy, due to the devaluation of the currency. In the base solution simulations, the simple arithmetic average of the two exchange rates, (35 TL/$ and 47 TL/$) 41 TL/$ was used to convert domestic prices into dollars.

V. PQP APPROACH TO VALIDATION AND CALIBRATION

The rapid development of computers and efficient solution algorithms have made the extensive use of large-scale programming models possible. Using them, economists can simulate the impacts of farm programs upon the agricultural sector. Policy makers and even many economists, on the other hand, have been reluctant to rely heavily on programming models for planning, due to the poor performance of these models at the disaggregated levels, and due to the lack of widely accepted validation procedures. Regional programming models often show far greater specialization of production by region than actually occurs. The sectoral programming models on the other hand with more detailed specification of production activities than regional models, have shown much greater specialization in production technology, rotational activities, and resource mixes than is observed.

Considerable attention has been devoted in the last decade to methods which attempt to alleviate this undesirable outcome of programming models. These methods basically involve incorporating additional constraints, as in flexibility constraints, rotations instead of single crop activities, or other ad hoc constraints. Alternatively, negative nonlinear terms are added to the objective function in the form of risk coefficients, penalty functions, downward sloping demand functions. While each of the above methods may have sound theoretical and empirical justification for being incorporated into

programming models, they have in practice been employed as calibration tools. Although not always reported, most researchers in the field will admit experimenting with different risk aversion coefficients, Frisch parameters for estimating demand elasticities, specification of rotational activities, and as a final resort the progressive or regressive incorporation of flexibility constraints. It is likely that the reported base solutions, in general, represent the best parameter fits and constraint combinations.

The Positive Quadratic Programming (PQP) approach is based on the discrepancy between the linear cost function implied by Leontief technology and the nonlinear cost function implied by the farmers' unconstrained profit maximizing actions.

In short, the farmer's aggregate crop allocation decisions in a region are used to calculate additional nonlinear cost terms that would cause the observed allocations, rather than adding constraints on the linear system that would force the allocations.

Using this positive approach, the linear model can be exactly calibrated to observed outputs for a single year or calibrated with a least-squares criterion if actual crop acreages for several years are known. The resulting optimization problem incorporates a quadratic cost term for each regional crop grown and is constrained only by those constraints that can be empirically justified. The problem is solved as a quadratic programming problem.

The additional PQP cost component is termed the implicit cost since it is implied in a positive sense by the farmer's crop allocations.

Empirical implementation of positive programming is achieved in two stages. The first stage starts with the data and specification of a conventional LP (or QP) problem. The actual regional crop acreages ($\tilde{x}$) are

increased by a small perturbation ε consistent with (Howitt and Méan [1985]) Theorem I, say (.001) $\tilde{x}$, and are formulated as upper bound inequality constraints. The constrained LP problem is now run to obtain the dual values on the calibration constraints for the n-m crops at interior optima. The ε perturbation of the calibration constraint right hand side ensures that relevant resource constraints will be binding for those crops in the basis that are constrained by resources.

Although it would be preferable to estimate the quadratic production function coefficients for the constrained crops, they are neither required nor possible for the single time period case.

The vector of (k-m) dual values from the first stage problem for the interior crops is multiplied by the negative reciprocal of the observed acreages $\tilde{x}_i$ i=1 . . . k-m and used as the diagonal coefficients of the quadratic cost function in the second stage problem. The second stage problem is then solved for the optimal base period solution. The principal steps are:

a Given a standard LP or QP and the vector of actual acreage grown $\tilde{x}$. Perturb $\tilde{x}$ by ε and add the calibration constraints.

b Run the first stage problem. The observed crop vector, $\tilde{x}$ is kx1 (k>m), therefore the first stage will result in m binding resource constraints, and k-m dual values corresponding to the binding calibration constraints.

c If the production function is quadratic in land and separable, the implicit cost function is quadratic in x, and has the form $1/2\tilde{x}^T E\tilde{x}$ where E is a (k-m)x(k-m) positive semidefinite matrix. By the PQP theorem II (Howitt and Méan):

$$-\lambda^* = E\tilde{x}.$$

Given the minimal data set $\tilde{x}$, cross cost effects are restricted to zero, and thus for the single period calibration case considered here E is a diagonal matrix with nonzero elements e_{ii} where:

$$e_{ii} = -\lambda_i^*/\tilde{x}_i$$

corresponding to the interior cropping activities.

$\underline{\underline{d}}$ Using the values e_{ii}, the second stage problem is specified as

$$\text{Max} \quad f(x) + 1/2x'Ex$$

$$\text{Subject to} \quad Ax \leq b \quad x \geq 0.$$

The second stage problem calibrates exactly with the base year vector $\tilde{x}$ without additional constraints, and is available for policy analysis in the knowledge that the model response will be determined by economic comparative advantage and resource constraints that have a clearly demonstrated empirical basis.

Since the base solution obtained from the second stage calibrates exactly with the base year vector of actual acreages (or other variables for which the cost functions are updated with PQP terms), the conventional validation procedure of comparing the observed and simulated base year quantities becomes irrelevant in this case. At this point it is necessary to define the terms "calibration" and "validation" as used in this paper. By calibration with the PQP approach, we understand the ability of the model to reproduce the actual base year quantities and prices, and informally test the internal consistency of the model data and structure.

The first stage run described above, not only provides duals to be employed in the second stage, but also identifies possible inconsistencies that might be inherent in the model specification. This is very important in sector models, where interrelated quantities which enter the model such as area, production, consumption and trade, have different data sources.

Therefore, exact calibration with respect to acreages does not guarantee exact calibration with respect to production or consumption. Before one can proceed with the second stage based on the results of the first stage, it may be necessary to perform minor consistency or calibration adjustments in the model data and specification. This should not be confused, however, with the calibration adjustments for both structural inconsistencies and base year errors in conventional validation approaches.

We define validation as the ability of the model to be systematically updated and hence employed as a short-run policy tool in the years beyond the base year. In other words, one should be able to predict with the model in the short-run after systematically updating resource constraints and PQP coefficients. To this end, the 1979 base solution to TASM, augmented with PQP terms is employed to project 1981 values which are then compared with the observed values to assess the reliability of the model.

VI. 1979 BASE RUNS AND CALIBRATIONS

The 1979 base solution is performed in two stages (as described in the previous section). In the first stage, the model is run employing equations 1-21 and 24 (with the PQP terms excluded). The first stage solution serves the dual purpose of providing the implicit costs for second stage and providing capacity and consistency checks on the model data and specification. Below, we briefly summarize our experience with the base solutions:

In TASM, the production activities are incorporated in three consecutive stages: area planted, production, and consumption which are interrelated via yields, processing, animal feed, and trade. With consistent data and a well

performing livestock sector, one would expect perfect calibration in the production and consumption with the introduction of area upper bounds in equation 21. This was not the case in the first runs of TASM.

While the production-consumption linkage has been satisfactory, due mainly to the introduction of foreign trade with equality constraints, and well behaved livestock activities, the area planted-production linkage has been less satisfactory and needed attention.[11] The discrepancy between the simulated and observed production in the base year, can be attributed to the data errors. As noted in section IV, while the Leontief matrix, including the yields was based on very detailed farm level information, the area cultivated and production data employed to derive consumption and demand functions and finally to judge the performance of the base solution were based on official SIS statistics.

To solve this problem of inconsistency, a decision had to be made as to whether to adjust yields, area or production. We decided to trust the vital technical coefficients of the model, which in our opinion are the most reliable data of their kind, and consequently adjust the official statistics, which have recently been re-examined in the light of 1980 Agricultural Census data. Furthermore, we decided to adjust the area data rather than the production data, except in the cases of the cereals and pulses which are generally acknowledged to be biased.[12] The official data on area cultivated is likely to be biased and unreliable for the following reasons:
(i) Reliable land ownership registration has not been completed in Turkey.
(ii) There is tendency for incorrect land size reporting and consecutive adjustments in official statistics. (iii) There has not been a comprehensive land size survey in the past, hence yearly adjustments are on an incorrect base. (iv) The fruit tree areas are not reported in the official statistics

and the ones used in the model are estimated from the numbers of fruit trees and tree/hectare estimates. (v) The official statistics report total vegetable area, rather than area for individual vegetables, hence the area under specific vegetables is an estimate.

The exact nature of the adjustments in area and production data for 1979 are shown in Appendix II. Basically, in the light of the preliminary results of the 1980 Agricultural Census, and the World Bank study conducted by Gencaga (1983), the cereal, drybean, and tobacco productions are adjusted downwards, and sunflower, chick-pea, and lentil productions are adjusted upwards. On the area data, most adjustments are in the downward direction, except for potato, lentil, sunflower, and tea.

Based on the adjusted production data, of course, the base consumption and consumer demand functions are also modified, and an updated first stage base solution is obtained with updated areas as the new constraints. The solution calibrated exactly with respect to area and very closely with respect to production, consumption, and prices which are endogenously determined. At this stage the base year solution presented two other problems related to technology which are seldom reported in the sector model literature.

In TASM two sets of production technology are specified for each production activity, namely mechanized and nonmechanized. The model chooses one or the other or a combination of the two. Similarly, certain crops, especially cereals, can be produced as single crop activities or in rotation with other crops and/or with fallow. While the updated model with modified data performed satisfactorily with respect to aggregates, its performance in simulating the techniques of production was not satisfactory. The base solution underestimated the mechanized production and overestimated the fallow rotations when compared to 1979 data.

Again these problems could be handled using conventional methods. Mechanized technology could be increased by adjusting the exogenous tractor rental rate, or changing the assumption of tractor-power and animal-power conversion rate. Excessive fallow rotations could be modified by respecifying the rotational activities and adjusting the activities with fallow to be less profitable. Having no reason to doubt the data or specification related to these problems, we rejected an arbitrary approach. As an alternative, PQP terms for mechanization and fallow practices were incorporated in an attempt to capture implicit costs or benefits associated with mechanization and fallow. The first stage base year run including equations 22 and 23 was used. In this run Tech is taken to be .33 in equation 14 and fallow to be .5 in equation 17 corresponding to 25 percent of the total and 50 percent of the total cereal area cultivated, respectively.[13]

The first stage base solutions incorporating area, technology, and fallow constraints formed the basis of the second stage base runs. The implicit costs, obtained via duals of the first stage runs were transformed into PQP terms as described in part V and included into the objective function, and equations 21-23 were removed for the final base year run. In this run the base year area, production, consumption, and technology calibrated very closely without adding additional constraints.

VII. PROJECTIONS INTO 1981 AND VALIDATION TESTS

Data Requirements for Projection

Projections with the sector model requires on the one hand updating the model parameters such as exchange rate, elasticities, factor costs; resource constraints such as land, labor, tractor availability; technical

specifications such as yields, and on the other hand updating the PQP coefficients and risk costs.[14]

The success with TASM projections depends therefore as much on the success of projections exogenous to the model as on the model performance. The purpose of this paper is to test the performance of PQP coefficients in a year other than the one in which they are estimated, rather than to conduct an exercise in forward projection with the model. Therefore, it is desirable to distinguish between the effects of exogenous projections and PQP terms on the projected values, and not to judge the performance of the PQP approach with the performance of the exogenous projections. In otherwords we pose the following questions in this section: How well TASM would have projected into 1981, if its exogenous parameters were projected with reasonable accuracy? Do the PQP coefficients estimated from the base solution reflect implicit costs and benefits that are stable enough in the short-run to allow for policy simulations, or do they only capture the data and model specification errors in the base solutions?

The nature of the exogenous projections and ex-post information incorporated into the model is summarized in Table 1. Notice that, basically three kinds of additional information is introduced for 1981 projections. The first set of information incorporated is related to inflation, which could be avoided if the projections were carried out in real terms and hence validated against deflated 1981 nominal values. The second set of information concerns the technical and structural changes in the economy or changes in policy variables.[15] The final piece of information involves the consumer demand functions, which need to be shifted due to population and income growth.

TABLE 1

DATA AND PARAMETER MODIFICATIONS FOR 1981 SIMULATIONS

General Area	Specific Area	Nature of Change
Resource Constraints	Land, Tractor, Labor, Animal Stock Availability	Those observed in 1981
Foreign Trade	Exchange Rate	Average of the three exchange rates in 1981
	Imports & Exports	Those observed in 1981
Resource Costs	Reservation Wage, Tractor Rent, Fertilizer Costs, Seed Costs, Investment Costs	Those observed in 1981
		Estimated from Input-Output Prices in 1981
Leontief Matrix	Yields	1979 modified yields updated with change in SIS yields in 1979 and 1981
Demand Functions	Price Elasticities	Based on repositioned demand functions obtained by imposing income and population growth and 1981 consumption and price information on the 1979 demand functions
Risk Costs		Inflated by percent change in producer's prices from 1979-1981
PQP Terms	Area, Technology, Fallow	Inflated by percent change in average factor costs from 1979-1981

The Results of 1981 Simulations

The results of the 1981 projections are given in Appendix III. To test how well the model projected changes in area, production, and consumption, we compare the ratios of observed and simulated changes from 1979 to 1981. The results as summarized in Tables 2-4 are very encouraging.

The model has been very successful in projecting the directions of changes in area, production, and consumption, with an error of less than 11 percent in all cases. The performance of the model in predicting absolute magnitudes of changes has also been very satisfactory. Absolute changes in over 75 percent of the crops or products are predicted with an error less than five percentage points. Only for about 10 percent of the crops or products the prediction error has been more than 10 percent.

TASM's performance in simulating absolute changes is unsatisfactory for soybeans and tea. In the case of soybeans, the model has been slower in responding to government incentives than the producers. Although the model's response has been in the right direction, it did not capture the full change which was a very high percentage, given the low acreage planted in this crop in the base year.

In the case of tea, on the other hand, the model's reaction to the major policy change in tea of forcing the producers to harvest tea leaves by hand (and only 2.5 leaves from the top) in 1981 as opposed to by shears in 1979 (which substantially reduced the yield) was more dramatic than the reaction of the producers for this perennial crop. Again, although the direction was correctly predicted, the change in absolute magnitudes was underestimated. The production and consumption of Angora wool and hide were wrong both in direction and absolute changes. The errors most likely result from the

TABLE 2

PERFORMANCE OF TASM IN PREDICTING DIRECTIONS'

Direction Predicted	Area Number	Area Percent	Production Number	Production Percent	Consumption Number	Consumption Percent
Correct	31	.89	50	.91	53	.96
Incorrect	4	.11	5	.09	2	.04

TABLE 3

PERFORMANCE OF TASM IN PREDICTING ABSOLUTE CHANGES

Percent Error	Area Number	Area Percent	Production Number	Production Percent	Consumption Number	Consumption Percent
< 2	12	.343	25	.456	24	.436
2-4.9	15	.429	17	.309	18	.327
5-10	5	.143	7	.127	7	.127
> 10	3	.086	6	.109	6	.109
Total	35		55		55	

TABLE 4

REGRESSIONS OF ACTUAL PROPORTIONAL CHANGE ON SIMULATED PROPORTIONAL CHANGE

	With All Observations				Without Extreme Observations			
	Intercept	Slope	R	N	Intercept	Slope	R	N
AREA	-.616 (-1.1)	1.725 (3.21)	.24	35	.235 (4.69)	.767 (15.87)	.89	33
	--	1.438 (10.98)	.21	35	--	.991 (118.3)	.81	33
PRODUCTION	.108 (.40)	.992 (4.14)	.24	55	.136 (.90)	.904 (6.79)	.48	51
	--	1.086 (18.10)	.24	55	--	1.021 (35.21)	.47	51
CONSUMPTION	.063 (1.42)	.980 (41.20)	.97	55	.056 (1.24)	.982 (40.49)	.97	53
	--	1.002 (55.11)	.97	55	--	1.002 (54.24)	.97	53

Notes: Soybean and tea are excluded in regressions with 33 and 53 observations, and soybean, tea, Angora wool, and Angora hide are excluded in regressions with 51 observations.

conversion factors employed to estimate the wool and hide production from Angora goats.

In Table 4, the regression of simulated changes in area, production, and consumption on actual changes are presented. When the two problem crops or products discussed above are excluded, the simulated changes explain .89, .48, and .97 percent of the observed changes. Furthermore, the coefficients of the regressions without the intercept term suggest that there is no significant over or underestimation of the observed changes. Finally, the domestic prices which are endogenously determined by the model are almost perfectly simulated as suggested by the consumption regressions.

VIII. CONCLUSION

In this paper, the Turkish Agricultural Sector Model is updated using a Positive Quadratic Programming approach. The PQP approach is incorporated into the model through the area cultivated, production technology, and fallow activities. The PQP version of the model calibrates extremely closely. The validation performance of the PQP approach is then tested by projecting the model into 1981 and comparing the simulated changes in area, production and consumption of 55 products with actual changes between 1979 and 1981. The results as shown in the previous sections were very encouraging. The model in most commodities was not only able to predict correctly the directions of changes, but also the absolute magnitudes of changes.

Certainly, an ideal test of the PQP approach should involve more than one point in time. Furthermore, it would be desirable with the availability of further observation points in time of PQP estimates to develop more sophisticated econometric projections of PQP terms for future policy

simulations. Nevertheless, despite its limitations, we believe that TASM, augmented with PQP terms, is now a more reliable tool for policy analysis, when one considers the less satisfactory experiences with the older, more conventional versions.

IX. FOOTNOTES

[1]An earlier linear programming version of TASM has been developed in Le-Si, Scandizzo, Kasnakoglu (1983). The basic differences between the two versions are summarized in Appendix I.

[2]Howitt and Méan (1985).

[3]In this version of the model, seed is treated as an exogenous input.

[4]Further details on the data can be found in Le-Si, Scandizzo, Kasnakoglu (1983) and Kasnakoglu (1983).

[5]See the algebraic statement of TASM for the crops and activities incorporated in TASM. Also note that 5 fallow activities for cereals are included in the 33 single annual crop activities.

[6]See Le-Si, Scandizzo, Kasnakoglu (1983) and Evans, Le-Si (1983) for an Alternative Livestock Version of TASM.

[7]See for example World Bank (1983) and Gencaga (1983).

[8]A more detailed discussion on the nature of biases in SIS data and methods of adjusting employed can be found in Le-Si, Scandizzo, Kasnakoglu (1983) and Kasnakoglu (1983).

[9]Livestock meat exports are based on World Bank estimates, which incorporate exports of live animals which are underestimated in official statistics, due to non-coverage of illegal exports.

[10]See Hazell and Scandizzo (1974) for the theoretical discussions on the risk formulation.

[11]Foreign trade is introduced with equality constraints for this study, to concentrate on the internal dynamics of the sector, and to defer the discussion of existing trade barriers and controls to a future study.

[12]Further discussions on this issue can be found in Le-Si, Scandizzo, Kasnakoglu (1983); World Bank (1983); and Gencaga (1983).

[13]It should be pointed out that the reductions in fallow area has an effect especially on cereal area. Different cultivated area estimates exist for different fallow estimates. The cereal area is adjusted in this study according to fallow specifications and constraints introduced into the model.

[14]The risk costs are assigned to activities, whereas the PQP terms are assigned to areas cultivated. This, on the one hand, avoids the problem of identification between the PQP terms and risk terms and on the other hand, contributes to a more balanced output mix as well as technology mix.

[15]Foreign trade is again treated as exogenous in the simulated runs.

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APPENDIX I

DIFFERENCES BETWEEN THE EARLIER AND RECENT VERSIONS OF TASM

	EARLIER	RECENT
Objective Function	Linearized Area under Demand Absolute Mean Deviation Risk Linear Cost Functions	Quadratic area under demand Quadratic risk Quadratic cost functions
Technology	Rotations only	Single crop activities and rotations
Resources	Dry-Irrigated-Rain Combinations for cropland	Dry-Irrigated-Rain-Temperature combinations for cropland
ANIMAL VS. TRACTOR technology	Not restricted	PQP costs introduced
Fallow Activity	Not restricted	PQP costs introduced
Calibration	Via data, elasticities	Via PQP terms
Data	Minor adjustments for calibration	Minor adjustments for consistency

APPENDIX II

BASE YEAR DATA CORRECTIONS IN OFFICIAL AREA AND PRODUCTION STATISTICS

PRODUCTION	
CROPS	PERCENT CORRECTION
Wheat	-20
Corn	+ 1
Rye, Oats, etc.	-16
Barley	- 5
Chick-pea	+27
Drybean	-58
Lentil	+56
Sunflower	+25
Tobacco	- 4

AREA	
CROPS	PERCENT CORRECTION
Wheat	-28
Corn	-50
Rye, Oats, etc.	-28
Rice	-42
Barley	-38
Chick-pea	-21
Drybean	-58
Lentil	+63
Potato	+22
Onion	-22
Sunflower	+45
Olive	-42
Soybean	-34
Sesame	-56
Cotton	-16
Sugarbeet	-19
Tea	+63
Citrus	-11
Grape	- 6
Melon	-22
Pistachio	-79
Hazelnut	-13

APPENDIX III

RATIOS OF ACTUAL AND SIMULATED CHANGES BETWEEN 1979 AND 1981

	AREA		
obs	ARAF	ARSAF	PEA
Wheat	0.9840	0.9595	-0.0244
Corn	0.9913	1.0347	0.0434
Rye, etc.	0.8470	0.8720	0.0250
Rice	0.9745	0.9699	-0.0046
Barley	1.0589	1.0618	0.0028
Chick-pea	1.0000	0.9249	-0.0750
Drybean	0.9565	0.8782	-0.0782
Lentil	1.2856	1.4668	0.1812
Potato	1.0648	1.0261	-0.0387
Onion	1.0873	1.1282	0.0408
Greenpepper	0.9178	0.9530	0.0351
Tomato	0.9204	0.9518	0.0314
Cucumber	0.9166	0.9400	0.0233
Sunflower	1.1236	1.1471	0.0234
Olive	1.0271	0.9415	-0.0855
Groundnut	1.0000	1.0375	0.0375
Soybean	5.2380	1.4761	-3.7619
Sesame	0.8894	0.8125	-0.0769
Cotton	1.0681	1.0745	0.0064
Sugarbeet	1.3354	1.3800	0.0445
Tobacco	0.7362	0.7504	0.0141
Tea	0.9909	0.2727	-0.7181
Citrus	1.0615	1.0972	0.0357
Grape	0.9411	0.9537	0.0125
Apple	1.0718	1.0350	-0.0368
Peach	1.0580	1.0625	0.0044
Apricot	1.0842	1.0952	0.0109
Cherry	1.0459	1.0510	0.0051
Wildcherry	1.1913	1.2000	0.0086
Melon	0.9204	0.9056	-0.0147
Strawberry	1.0000	1.0000	0.0000
Banana	1.0666	1.0666	0.0000
Quince	1.0958	1.0684	-0.0273
Pistachio	1.0821	1.1555	0.0734
Hazelnut	1.0015	0.9556	-0.0458

Note: ARAF: Actual Area in 1981/Actual Area in 1979; ARSAF: Simulated Area in 1981/Actual Area in 1979; PEA: ARSAF-ARAF.

APPENDIX III (continued)

PRODUCTION							
obs	PRAF	PRSAF	PEP	obs	PRAF	PRSAF	PEP
Wheat	0.9714	1.0218	0.0503	Wildcherry	1.2000	1.2100	0.0100
Corn	0.8888	0.9272	0.0384	Melon	0.8620	0.8485	-0.0134
Rye, etc.	0.8486	0.9981	0.1495	Strawberry	1.0454	1.0545	0.0090
Rice	0.8800	0.8786	-0.0013	Banana	1.2703	1.2918	0.0214
Barley	1.1259	1.1283	0.0023	Quince	1.2444	1.2266	-0.0177
Chick-pea	1.0445	0.9670	-0.0775	Pistachio	1.2500	1.3550	0.1050
Drybean	0.9695	0.8898	-0.0797	Hazelnut	1.1666	1.1150	-0.0516
Lentil	1.5301	1.5417	0.0115	S-Mutton	1.8360	1.8372	0.0011
Potato	1.0452	1.0079	-0.0373	S-Milk	1.0667	1.0700	0.0032
Onion	1.0900	1.1351	0.0451	S-Wool	1.0505	1.0539	0.0033
Greenpepper	1.1009	1.1444	0.0434	S-Hide	1.6424	1.6368	-0.0055
Tomato	1.0285	1.0648	0.0363	G-Mutton	1.5971	1.5971	0.0000
Cucumber	1.0200	1.0456	0.0256	G-Milk	0.9753	0.9749	-0.0003
Sunflower	0.9745	0.9990	0.0244	G-Wool	0.9782	0.9782	0.0000
Olive	0.9302	0.8534	-0.0767	G-Hide	1.3333	1.3571	0.0238
Groundnut	0.9913	1.0313	0.0400	A-Mutton	2.0000	2.0307	0.0307
Soybean	4.5454	1.2727	-3.2727	A-Milk	1.0072	1.0091	0.0018
Sesame	0.9615	0.8769	-0.0846	A-Wool	1.0517	0.6724	-0.3793
Cotton	1.0247	1.0325	0.0077	A-Hide	2.6666	1.0000	-1.6666
Sugarbeet	1.2745	1.3169	0.0424	Beef	1.0667	1.0317	-0.0350
Tobacco	0.7757	0.7671	-0.0086	C-Milk	1.0447	1.0101	-0.0346
Tea	0.3464	0.0951	-0.2513	C-Hide	1.0387	1.0038	-0.0348
Citrus	1.0200	0.9515	-0.0685	B-Meat	0.8470	0.8470	0.0000
Grape	1.0571	1.0588	0.0017	B-Milk	0.9504	0.9501	-0.0003
Apple	1.0740	1.0374	-0.0366	B-Hide	0.8387	0.8709	0.0322
Peach	1.2045	1.2090	0.0045	P-Meat	1.0000	0.9984	-0.0015
Apricot	0.9545	0.9618	0.0072	Eggs	1.0596	1.0599	0.0002
Cherry	1.0326	1.0380	0.0054				

Note: PRAF: Actual Production in 1981/Actual Production in 1979; PRSAF: Simulated Production in 1981/Actual Production in 1979; PEP: PRSAF-PRAF.

APPENDIX III (continued)

CONSUMPTION							
obs	CRAF	CRSAF	PEC	obs	CRAF	CRSAF	PEC
Wheat	1.0182	1.0745	0.0562	Wildcherry	1.1963	1.2064	0.0101
Corn	0.7434	0.8291	0.0857	Melon	0.8632	0.8497	-0.0135
Rye, etc.	0.7001	1.0258	0.3256	Strawberry	1.0454	1.0545	0.0090
Rice	0.9173	0.9161	-0.0011	Banana	1.2660	1.2875	0.0214
Barley	1.2112	1.2556	0.0444	Quince	1.2249	1.2071	-0.0178
Chick-pea	0.5134	0.4205	-0.0929	Pistachio	1.1413	1.2608	0.1195
Drybean	0.5676	0.4876	-0.0800	Hazelnut	1.1105	1.1182	0.0769
Lentil	1.1071	1.1247	0.0175	S-Mutton	1.7904	1.7917	0.0012
Potato	1.0438	1.0063	-0.0374	S-Milk	1.0667	1.0700	0.0032
Onion	1.0734	1.1222	0.0488	S-Wool	1.0540	1.0571	0.0030
Greenpepper	1.1006	1.1441	0.0435	S-Hide	1.6904	1.6845	-0.0059
Tomato	1.0039	1.0414	0.3075	G-Mutton	1.6318	1.6318	0.0000
Cucumber	1.0200	1.0456	0.0256	G-Milk	0.9753	0.9749	-0.0003
Sunflower	0.9604	0.9142	-0.0461	G-Wool	0.7469	0.7469	0.0000
Olive	0.6547	0.5354	-0.1193	G-Hide	1.3333	1.3571	0.0238
Groundnut	0.9230	0.9642	0.0411	A-Mutton	2.0666	2.1000	0.0333
Soybean	1.6959	1.6719	-0.0239	A-Milk	1.0072	1.0091	0.0018
Sesame	0.9341	0.8488	-0.0852	A-Wool	0.8461	0.2820	-0.5641
Cotton	0.7054	0.7219	0.0165	A-Hide	2.6666	1.0000	-1.6666
Sugarbeet	1.3448	1.3873	0.0424	Beef	1.0625	1.0271	-0.0354
Tobacco	0.2221	0.2092	-0.0129	C-Milk	1.0446	1.0101	-0.0345
Tea	0.3331	0.0674	-0.2657	C-Hide	1.0692	1.0346	-0.0346
Citrus	0.8771	0.7996	-0.0774	B-Meat	0.8000	0.8000	0.0000
Grape	1.0328	1.0347	0.0019	B-Milk	0.9504	0.9501	-0.0003
Apple	1.0015	0.9640	-0.0374	B-Hide	1.1428	1.1714	0.0285
Peach	1.1843	1.1889	0.0045	P-Meat	0.9924	0.9909	-0.0015
Apricot	0.9261	0.9373	0.0111	Eggs	1.0459	1.0461	0.0002
Cherry	1.0326	1.0391	0.0065				

Note: CRAF: Actual Consumption in 1981/Actual Consumption in 1979; CRSAF: Simulated Consumption in 1981/Actual Consumption in 1979; PEC: CRSAF-CRAF.