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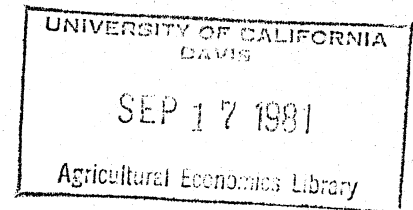
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A REGIONAL-NATIONAL MODEL FOR AGRICULTURAL POLICY ANALYSIS
WITH AN APPLICATION TO THE STATE OF IOWA

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Policies and programs

ABSTRACT

There is a growing tendency in the United States for decentralized public policymaking concerning agricultural production and resource use. The Regional-National Model can be used as a tool to estimate the regional effects of a national policy, and to evaluate the national implications of regional policy alternatives. A Regional-National Model of soil erosion in Iowa is presented as an illustration of this modeling technique.

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Introduction

There is a growing tendency in the United States for decentralized public policymaking concerning agricultural production and resource use. Regional differences in climate, soil characteristics, water resource development, and input factor costs present each region^{1/} with a unique situation. The general public is typically more interested in production, farm income, production costs, and resource use in their own region than in basing their decision making upon national averages estimated by the federal government. Hence, individual regions have an incentive to develop a framework for analyzing both the impacts of national farm policies upon their own area, and in formulating region-specific policy programs which take explicit account of important local problems. Regional programs are primarily directed towards land use, soil conservation, and water quality; however, such issues as farm size and structure and rural development are also being addressed by various state legislatures.

A comprehensive evaluation of agricultural policy programs from the perspective of an individual region thus necessitates the development of a regional model consistent within a national framework, which we refer to as a Regional-National (RN) model. The RN model can be used as a tool to estimate the regional effects of a national policy which applies to all regions, e.g., commodity programs; to evaluate the national implications of regional policy alternatives, such as a regulation affecting a

particular region, e.g., banning the use of certain cotton pesticides; and, to improve estimation of impacts of regional policies (resource development programs) upon the regions.^{2/}

The objectives of this paper are: 1) to provide some considerations in formulating a regional-national model, and 2) to present a case study which links one region (the State of Iowa) to a national model for evaluating the economic impacts of a regional policy aimed at controlling soil erosion.

Some Considerations in Formulating a Regional-National (RN) Model

There are three basic approaches to linking a regional model with a national model: top-down (Jaske, Mathematica, Heady and Srivastava), bottom-up (Schaller, Baum), and simultaneous methods (Meister, Chen, and Heady; Huang, Weisz, and Heady). Selection of a linkage method, model components, and linkage variables are needed to build a specific RN model. Some considerations in building a Regional-National (RN) model are presented in this section.

Selection of the linkage method for building a RN model depends upon the actual causal relationships among regional and national economic variables. The top-down approach is preferable for analyzing the impacts of agricultural policies which are implemented at the national level and apply to all regions. Examples of such policies are U.S. price and income supports and Section 208 of the Federal Water Pollution Control Act.

The bottom-up approach is preferable when analyzing the effects of policies implemented at the regional level which may not apply to all regions within the nation. An example of such a regional policy is legislation in the State of Iowa which imposes limits and practices on land use in order to alleviate the problem of soil loss. Another example of the bottom-up approach is in regards to the potential linkage of price and income supports with conservation practices (Benbrook). Compliance provisions could be developed which are targeted to ameliorate designated resource management problems in different geographical regions and cropping systems. The bottom-up approach would be useful in estimating the impact of these regional policy programs upon national price and production.

The simultaneous modeling approach is a preferable method when a compromise between national and regional decision processes is needed. The interrelationships between national commodity prices and regional grain stock holdings in the Farmer Owned Reserve is an example where this approach may provide useful information.

Various types of models can be selected for building a national and a regional component in a RN model. The national component can be a programming, an econometric, or an input-output (I-O) model. Similarly, a regional component can be either of the three. With proper use of an econometric (or I-O) and a programming modeling approach in building the national and regional components, a positive analysis with prior normative assumptions, or a normative preliminary analysis with prior positive assumptions can be performed through the RN model.

A regional-national model requires the specification of three sets of data: regional variables, national variables, and linkage variables. Regional variables incorporate information determined within the regional model (e.g., production levels, input factor use, environmental variables, etc.) and can be thought of as regional responses or contributions to the national agricultural economy. Region-specific variables determine the intraregional economic activity over which the region has primary control.

National variables are those which are exogenous to particular regions, but are endogenous to the national model (e.g., aggregate commodity demand and supply, commodity and input factor prices, etc.). The level of national variables typically shows little or no variation across regions; however, the impact of these variables upon regional economic activity often varies considerably.

Linkage variables^{3/} are the variables transferring information from the national model to the regional model, and vice versa. Linkage variables are selected from both regional and national variables. Regional variables frequently used for linkage are regional production and resource use, which transfers all regional production and resource use information to the national model to determine the national commodity and input factor prices. National commodity and input factor prices are frequently used as linkage variables to determine adjustment functions for regional input factor use, production response, production costs, and farm incomes.

A Case Example

The Iowa Regional-National Recursive Model (Iowa-RN) is presented as an illustrative modeling example. This formulation, which links an Iowa regional programming model with a national econometric model, is used to investigate crop production activity in the State of Iowa. A base run with no restrictions on soil loss at either the state or PA level is presented here. This solution indicates the profit maximizing level of production of 7 endogenous crops and the resulting soil loss for each of 12 Iowa sub-regions when no restrictions are placed on the amount of soil leaving a field via water erosion.

The Iowa-RN model includes two primary components: a regional LP model of Iowa (English, Short, Heady, and Johnson) and a dynamic national simulation model of U.S. agriculture (Schatzer, Roberts, and Heady). The regional LP model has an analytical structure for simulating the technical interrelationships between factor inputs and outputs. The dynamic simulation model includes an econometric component to simulate the complex U.S. market structure which provides aggregate estimates of the demand and supply of commodities and input factor.

Figure 1 illustrates the linkages between the Iowa regional model and the U.S. simulation model. The bottom-up approach is used here. Any regional policy change can be translated into cost and yield changes (A), or resource institutional restraints (B). Production costs and yields are adjusted (C) and used to determine the profitability of production (D). The net profit from crops is then used in determining the range of the regional production response through a flexibility

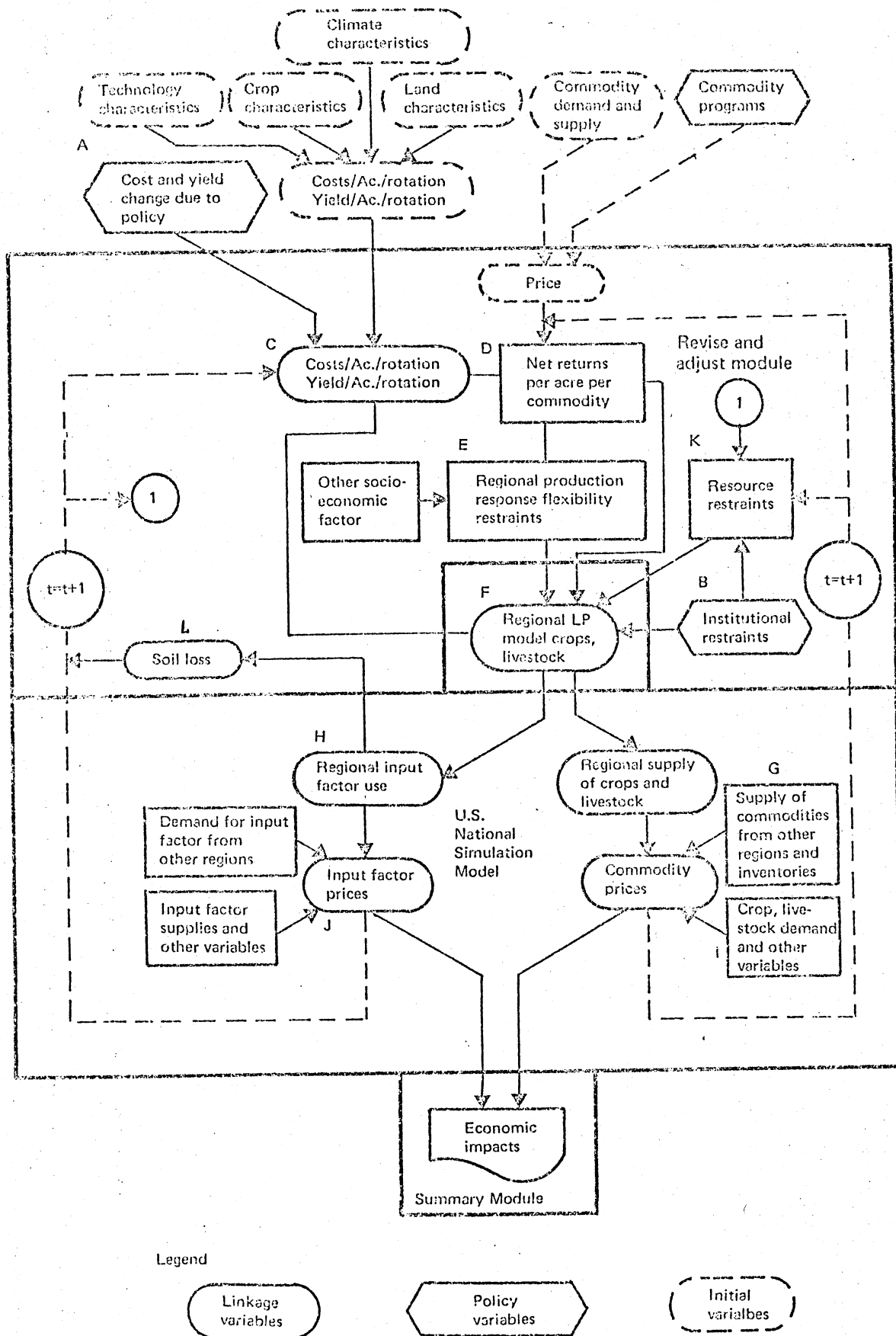


Figure 1. Structure of the Regional-National Model

restraint formulation (E), and to adjust the coefficients in the objective function of the regional LP model (F). The LP model then determines the regional production supply (G) and input factor demands (H). Soil loss is determined as a function of regional input factor use (L). The production supply factor demand subsequently determine the prices of commodities (I) and input factors (J). These prices are then used to determine production costs, yields, and net profits for the next time period (C) and resource restraint adjustments (K). The cost and yield simulators use the ratio $R_{it} = (S_{it-1} - S_{it})/S_{it-1}$ for adjusting yields, cost of production, and fertilizer inputs in region i in period t , where S_{it-1} and S_{it} are the soil depth at periods $t-1$ and t , respectively.^{4/} Details about individual model components may be obtained from the authors.

A test run of the Iowa-RN for years 1975-85 was conducted, with the LP component being solved at 5-year intervals and econometric component solved annually. Table 1 presents the acreage and production of the endogenous crops for 1975, 1980, and 1985. These results indicate a general trend towards increased corn and wheat production and decreased soybean and oat production. Changes within the individual producing areas (PA's) vary depending upon the relative profitability of the endogenous set of crops.

Total soil loss and average soil loss per acre are also indicated in Table 1. Average soil loss per acre, which ranges from a three-year average of 2.62 tons/acre in PA 2 up to 15.19 tons/acre in PA 10, appears to be falling over time in most producing areas. Selection of crop

Table 1. Acreage and production for endogenous crops and level of soil loss for Iowa

PA	Year	Corn		Oats		Sorghum		Soybeans		Wheat		Total Soil Loss (1000 Tons)	Average Soil Loss/Acre (Tons/Acre)	Inches of Topsoil Lost (Inches)
		Acreage (1000 Ac)	Production (1000 Bu)	Acreage (1000 Ac)	Production (1000 Bu)	Acreage (1000 Ac)	Production (1000 Bu)	Acreage (1000 Ac)	Production (1000 Bu)	Acreage (1000 Ac)	Production (1000 Bu)			
1	1975	1,074	108,550	172	13,088	1	110	519	19,646	3	114	4,838	2.74	0.0135
	1980	1,107	110,625	161	13,368	2	110	547	20,224	3	113	6,058	3.25	0.0169
	1985	1,188	113,478	180	13,670	2	110	587	20,949	3	114	9,842	4.91	0.0274
2	1975	1,468	154,608	4	144	0	0	493	16,404	0	0	5,899	3.00	0.0200
	1980	1,540	157,564	11	718	0	0	380	12,421	2	62	5,039	2.58	0.0171
	1985	1,627	161,628	81	5,318	0	0	223	7,162	2	62	4,495	2.30	0.0152
3	1975	1,175	126,381	110	6,655	0	0	973	32,079	5	186	8,180	3.55	0.0228
	1980	1,238	128,797	111	6,465	0	0	997	32,079	5	185	8,438	3.54	0.0235
	1985	1,307	132,119	123	6,951	0	0	916	28,725	5	186	7,880	3.30	0.0219
4	1975	1,104	114,740	278	14,670	0	0	402	11,816	3	100	6,367	3.28	0.0176
	1980	1,205	116,934	303	14,983	0	0	426	11,816	3	99	6,469	3.11	0.0179
	1985	1,330	119,950	334	15,322	0	0	452	11,816	3	100	6,777	2.98	0.0187
5	1975	873	77,916	73	3,625	7	285	415	12,845	17	407	25,529	17.86	0.1166
	1980	1,253	79,406	8	297	6	285	0	0	20	404	19,960	15.45	0.0912
	1985	710	33,127	0	0	7	285	0	0	21	406	1,962	2.66	0.0090
6	1975	717	75,216	37	2,165	0	0	553	18,935	2	63	7,299	5.42	0.0357
	1980	763	76,654	7	393	0	0	549	17,997	2	63	7,301	5.42	0.0357
	1985	818	78,631	19	956	0	0	474	14,894	2	63	6,917	5.14	0.0338
7	1975	1,165	127,033	119	6,161	0	0	791	27,022	15	472	12,671	5.84	0.0363
	1980	1,270	129,462	58	2,728	0	0	848	27,022	17	469	14,018	6.18	0.0401
	1985	1,396	132,801	28	1,202	0	0	747	22,065	18	471	13,472	5.94	0.0386
8	1975	1,864	206,020	233	12,648	0	0	1,062	37,617	12	372	19,473	5.94	0.0381
	1980	2,008	209,958	43	2,091	0	0	1,126	37,617	12	370	19,020	5.78	0.0372
	1985	2,185	215,374	44	2,050	0	0	945	29,802	12	372	17,716	5.39	0.0346
9	1975	589	60,752	54	2,680	0	0	159	5,498	1	39	3,877	4.96	0.0284
	1980	636	61,913	12	526	0	0	164	5,396	1	39	3,922	4.62	0.0287
	1985	694	63,510	20	849	0	0	91	2,833	1	39	3,528	4.15	0.0258
10	1975	575	53,743	103	5,029	3	230	285	9,619	4	172	13,915	13.56	0.0682
	1980	726	54,770	132	5,073	4	231	265	6,993	5	171	18,118	15.14	0.0888
	1985	1,059	56,183	0	0	5	231	268	8,845	10	172	18,135	16.88	0.0889
11	1975	380	38,590	51	3,297	0	0	293	8,845	8	267	5,648	6.25	0.0355
	1980	451	39,328	83	3,291	0	0	316	8,845	9	265	5,966	6.08	0.0375
	1985	505	40,342	51	1,790	0	0	344	10,620	10	266	6,387	6.51	0.0401
12	1975	606	57,242	93	4,258	4	292	293	9,959	12	520	8,840	7.53	0.0327
	1980	667	58,336	107	4,349	4	292	323	10,251	12	516	11,989	9.39	0.0443
	1985	754	59,841	127	4,448	5	292	366	10,620	13	519	16,468	11.42	0.0609
1A	1975	10,486	1,200,792	1,327	74,418	15	917	6,238	210,285	81	2,713	122,537	6.28	0.0357
	1980	12,865	1,223,748	1,036	54,282	16	917	5,942	190,662	90	2,755	126,300	6.08	0.0368
	1985	13,572	1,206,983	1,007	52,557	18	917	5,414	157,714	101	2,771	113,579	5.51	0.0331

management practices has a direct effect upon the level of soil loss, and our base solution indicates that more soil-conserving tillage methods become economically feasible as relative input and output prices change. Average gross soil loss per acre can be translated into inches of topsoil lost by $ISL_{it} = TSL_{it} / (SBD_{it} * TACRES_{it})$, where ISL_{it} is estimated inches of topsoil lost, TSL_{it} is total soil loss (tons), SBD_{it} is soil bulk density, and $TACRES_{it}$ is total cropland acres, all for PA i in time period t .

Summary

A regional-national model (RN) with an application to the State of Iowa has been developed for evaluating impacts of national programs upon a region, and for evaluating regional programs upon national economic variables.

The model was applied to study soil erosion in Iowa. The results of a base run are presented. These results show changes in regional cropping patterns, an increase in nitrogen used and a decline in yield over a 10-year period because of soil loss.

An improved soil loss simulator is being developed. This simulator uses the crop rotations and management practices in the LP solution to adjust the soil profile in each of 12 producing areas (PA) within Iowa. The soil mapping unit (SMU) is selected as the basic soil element to build an Iowa soil file. In this file, total land in Iowa is divided into 12 PAs, and then further divided according to its land-capability classification. Each classification is divided into several groups of

SMUs. Each SMU contains data including soil depth of the A and B horizon, bulk density, RKLS factors for the Universal Soil Loss Equation, and crop acres. Some of these data are updated for each LP solution obtained. The rotation and conservation-tillage practices in each LP solution are used to determine C and P values. Soil loss for this SMU is computed from the R, K, LS, C, and P values. Once soil loss is computed, the soil depths and composition of the soil in each SMU are adjusted.

Alternative regional policies which seek to achieve a goal of limiting soil loss are currently in progress, including limits on erosive crop management systems, subsidies for constructing soil-conserving facilities, taxing soil loss, and others. The Regional-National Model is capable of estimating the national impacts of these regional policies upon commodity supply, price, and other pertinent economic factors.

FOOTNOTES

1/ A "region" may be defined either by political boundaries (state, county, etc.), or by commodity or resource boundaries (Corn Belt, Water Resource Districts, etc.). However, in the accompanying case study, "region" is defined in terms of the State of Iowa.

2/ Of course, the smaller the region and/or the less significant the effect of the regional policy, the more negligible we would expect the impact upon the nation to be.

3/ Only the top-down or the bottom-up RN model have linkage variables. The simultaneous RN model has no linkage variables, since all the variables in the model are simultaneously determined.

4/ This adjustment procedure is used for the test run. A more complete procedure is being developed.

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