A Multi-Market Bounded Prices Model Under Rational Expectations:
The Case of Corn and Soybeans in the U.S.

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Abstract:

This paper extends the bounded prices model under rational expectations to a multi-market setting. The resulting framework is used to estimate a supply-demand model for corn and soybeans. The estimated model is used to simulate the implications of removing price support and diversion programs over the sample period.

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I. Introduction

Analyzing market disequilibrium and its economic implications has been the focus of much research (Rosen and Quandt; Ziemer and White; Quandt and Rosen, 1986; Portes et al.). Although several types of disequilibrium models have been employed (e.g., Maddala and Nelson; Laffont and Garcia; Bowden), a version receiving recent attention is Maddala's bounded price variation model (BPVM). The BPVM differs from traditional disequilibrium models in that rationing occurs only upon occasion. That is, a market with bounded prices will be in equilibrium until price reaches an upper or lower limit, at which time rationing occurs and the market is in disequilibrium.

Although the BPVM is appropriate in a variety of settings, it seems well suited for analyzing agricultural markets where guaranteed price supports are offered to producers. Accordingly, empirical applications of the BPVM to agricultural markets have been reported by Shonkwiler and Maddala, Holt and Johnson, and Liu et al. The studies by Shonkwiler and Maddala and Holt and Johnson are also unique in that the basic BPVM was extended to include rational price expectations. The resulting model is more complicated than traditional linear rational expectations models since price supports truncate the equilibrium price distribution. Even though the resulting model is highly nonlinear, full information maximum likelihood (FIML) estimates can still be obtained using Fair and Taylor's iterative solution-estimation procedure.

While previous studies have highlighted the potential for modeling agricultural markets in a bounded prices framework, more work is required. Specifically, previous research has been conducted in a single-market context, thus ignoring potentially important cross-price effects. Inter-market linkages are important since agricultural supply decisions are often made jointly and because many agricultural commodities are related in consumption.

Any complete analysis of government intervention should incorporate relevant cross-price relationships.

Considering the above, the objective of this paper is to estimate a multi-market BPVM for the U.S. corn and soybean markets that (1) includes cross-price linkages in the supply and demand equations and (2) incorporates the truncation effects associated with government price support programs in a rational expectations framework. Previous research has shown that corn and soybean supply decisions are made jointly (Gallagher; Lee and Helmberger; Chavas and Holt); however, these joint decisions have not been modeled in a rational expectations context. Consequently, this paper goes beyond the recent studies by Shonkwiler and Maddala and Holt and Johnson, which focused only on the corn market, and provides the first known application of a multi-market bounded prices model under rational expectations.

II. A Bounded Prices Model with Rational Expectations

Consider the following multi-market supply-demand model for two commodities with exogenously set support prices $\overline{P}_{1t}$ and $\overline{P}_{2t}$:

$$D_{1t} = \underline{\alpha}_1' \underline{X}_{1t} + \alpha_2 P_{1t} + \alpha_3 P_{2t} + u_{1t} \tag{1}$$

$$D_{2t} = \underline{\beta}_1' \underline{X}_{2t} + \beta_2 P_{1t} + \beta_3 P_{2t} + u_{2t} \tag{2}$$

$$S_{1t} = \underline{\gamma}_1' \underline{X}_{3t} + \gamma_2 P^e_{1t} + \gamma_3 P^e_{2t} + u_{3t} \tag{3}$$

$$S_{2t} = \underline{\nu}_1' \underline{X}_{4t} + \nu_2 P^e_{1t} + \nu_3 P^e_{2t} + u_{4t} \tag{4}$$

$$Q_{1t} = D_{1t} = S_{1t} \quad \text{if } P_{1t} \geq \overline{P}_{1t} \tag{5}$$

$$Q_{1t} = D_{1t} < S_{1t} \quad \text{if } P_{1t} < \overline{P}_{1t} \tag{6}$$

$$Q_{2t} = D_{2t} = S_{2t} \text{ if } P_{2t} \geq \bar{P}_{2t} \tag{7}$$

$$Q_{2t} = D_{2t} < S_{2t} \text{ if } P_{2t} < \bar{P}_{2t} \tag{8}$$

where D_{it} is quantity demanded, i=1,2, S_{it} is quantity supplied, i=1,2, P_{it} is the market clearing price, i=1,2, and P^e_{1t} and P^e_{2t} denote the expectations of prices P_{1t} and P_{2t}, respectively. Vectors $\underline{X}_{1t}$ and $\underline{X}_{2t}$ denote demand shifters and $\underline{X}_{3t}$ and $\underline{X}_{4t}$ are vectors of supply shifters. Likewise, $\underline{u}_t = (u_{1t}, u_{2t}, u_{3t}, u_{4t})'$ denotes a vector of joint normally distributed random variables with mean vector zero and variance-covariance matrix Σ.

With observations on P_{1t}, P_{2t}, $\bar{P}_{1t}$, and $\bar{P}_{2t}$, the data points belonging to equilibrium and those associated with excess supply can be identified. Unlike the single-market case, however, the model in (1)-(8) will be associated with four regimes. Let ψ_1 denote the set of observations where $\bar{P}_{1t} \geq P_{1t}$ and $\bar{P}_{2t} \geq P_{2t}$, ψ_2 the set of observations where $P_{1t} < \bar{P}_{1t}$ and $P_{2t} \geq \bar{P}_{2t}$, ψ_3 the set of observations for which $P_{1t} \geq \bar{P}_{1t}$ and $P_{2t} < \bar{P}_{2t}$, and ψ_4 the set of points where $P_{1t} < \bar{P}_{1t}$ and $P_{2t} < \bar{P}_{2t}$.

For observations belonging to ψ_1, both markets are in equilibrium and we have a simultaneous system given by (1)-(5), and (7). Alternatively, for observations belonging to ψ_2, the first market is in disequilibrium and the second market is not. In this case the market price for the first commodity is $\bar{P}_{1t}$ but we still observe both D_{1t} and S_{1t} since the amount produced and the amount purchased by the government under the price support program are known. At the same time, the market for the second good remains in equilibrium with the sub-system represented by equations (2), (4), and (7) determining D_{2t}, S_{2t}, and P_{2t} endogenously. Data points belonging to ψ_3 are defined in an analogous manner. Lastly, for data points belonging to ψ_4, both markets are in disequilibrium with prices set equal to their respective support rates and with quantities demanded and supplied determined from (1)-(4).

The model in (1)-(8) represents a market for a pair of commodities where price supports truncate the equilibrium price distribution. To close the model, it is necessary to specify the mechanism used by producers to form expectations about P_{1t} and P_{2t} when making supply decisions. In the present case, the expectations P^e_{it}, i=1,2, are assumed to be formed rationally.

The multi-market rational expectations model with price supports is obtained as follows. The expected market price equations obtained from (1)-(5) and (7) are:

$$\begin{aligned} P^*_{1t} = {} & (\alpha_2\beta_3 - \alpha_3\beta_2)^{-1}[\beta_3\underline{\gamma}_1'\underline{X}^e_{3t} - \alpha_3\underline{\nu}_1'\underline{X}^e_{4t} + (\beta_3\gamma_2 - \alpha_3\nu_2)P^e_{1t} \\ & + (\beta_3\gamma_3 - \alpha_3\nu_3)P^e_{2t} - \beta_3\underline{\alpha}_1'\underline{X}^e_{1t} + \alpha_3\underline{\beta}_1'\underline{X}^e_{2t}] \end{aligned} \tag{9}$$

and

$$\begin{aligned} P^*_{2t} = {} & (\alpha_2\beta_3 - \alpha_3\beta_2)^{-1}[\alpha_2\underline{\nu}_1'\underline{X}^e_{4t} - \beta_2\underline{\gamma}_1'\underline{X}^e_{3t} + (\alpha_2\nu_2 - \beta_2\gamma_2)P^e_{1t} \\ & + (\alpha_2\nu_3 - \beta_2\gamma_3)P^e_{2t} - \alpha_2\underline{\beta}_1'\underline{X}^e_{2t} + \beta_2\underline{\alpha}_1'\underline{X}^e_{2t}] \end{aligned} \tag{10}$$

where $[\underline{X}^e_{1t}, \underline{X}^e_{2t}]$and $[\underline{X}^e_{3t}, \underline{X}^e_{4t}]$ denote, respectively, expectations of the exogenous variables in the demand and supply equations. The rational expectations P^*_{1t} and P^*_{2t} are appropriate when price supports <u>do</u> <u>not</u> truncate producers' price expectations.

Using standard results for truncated normal distributions, it can be shown that the expectations in (9) and (10) are related to the price expectations after truncation as follows:

$$P^e_{1t} = \overline{P}_{1t}\Phi(K_{1t}) + \sigma_1(2\pi)^{-1/2}\exp(-K^2_{1t}/2) + P^*_{1t}[1 - \Phi(K_{1t})], \tag{11}$$

and

$$P^e_{2t} = \bar{P}_{2t}\Phi(K_{2t}) + \sigma_2(2\pi)^{-1/2}\exp(-K^2_{2t}/2) + P^*_{2t}[1 - \Phi(K_{2t})], \tag{12}$$

where,

$$\begin{aligned} K_{1t} = [\bar{P}_{1t} - (\alpha_2\beta_3 - \alpha_3\beta_2)^{-1}[\beta_3\underline{\gamma}_1'\underline{X}^e_{3t} - \alpha_3\underline{\nu}_1'\underline{X}^e_{4t} + (\beta_3\gamma_2 - \alpha_3\nu_2)P^e_{1t} \\ + (\beta_3\gamma_3 - \alpha_3\nu_3)P^e_{2t} - \beta_3\underline{\alpha}_1'\underline{X}^e_{1t} + \alpha_3\underline{\beta}_1'\underline{X}^e_{2t}]/\sigma_1, \end{aligned} \tag{13}$$

$$\begin{aligned} K_{2t} = [\bar{P}_{2t} - (\alpha_2\beta_3 - \alpha_3\beta_2)^{-1}[\alpha_2\underline{\nu}_1'\underline{X}^e_{4t} - \beta_2\underline{\gamma}_1'\underline{X}^e_{3t} + (\alpha_2\nu_2 - \beta_2\gamma_2)P^e_{1t} \\ + (\alpha_2\nu_3 - \beta_2\gamma_3)P^e_{2t} - \alpha_2\underline{\beta}_1'\underline{X}^e_{2t} + \beta_2\underline{\alpha}_1'\underline{X}^e_{2t}]/\sigma_2, \end{aligned} \tag{14}$$

where $\Phi(\bullet)$ denotes the distribution function of the standard normal and σ^2_1 and σ^2_2 denote respectively the variances of P_{1t} and P_{2t}. In the above formulation $1 - \Phi(K_{it})$ denotes the probability the ith support price is not effective.

With price supports, the rational price expectations P^e_{1t} and P^e_{2t} are obtained by simultaneously solving equations (9)–(14). This system of equations is highly nonlinear and closed form expressions for the rational price predictors cannot be obtained. To obtain estimates of the structural model that incorporate all information implied by rationality, the iterative simulation–estimation procedure described by Fair and Taylor is used.

III. The Model

A structural model is specified for the U.S. corn and soybean markets that consists of four behavioral equations: one each for aggregate corn and soybean demand, and one each for aggregate corn and soybean production. The model is closed by assuming that producers form price expectations rationally.

The Demand Equations

Relatively simple demand equations are used to keep the model tractable. Each demand equation is hypothesized to be a function of corn and soybean prices, the price of livestock, exports, and a time trend.

The following demand equations are specified:

$$QCD_t = \alpha_0 + \alpha_1 PC_t + \alpha_2 PS_t + \alpha_3 LP_t + \alpha_4 CXP_t + \alpha_5 t + u_{1t} \tag{15}$$

and

$$QSD_t = \beta_0 + \beta_1 PC_t + \beta_2 PS_t + \beta_3 LP_t + \beta_4 SXP_t + \beta_5 t + u_{2t}. \tag{16}$$

where QCD_t is annual disappearance of corn, QSD_t is annual disappearance of soybeans, PC_t is the farm price of corn, PS_t is the farm price of soybeans, LP_t is a livestock price index, CXP_t denotes corn exports, SXP_t represents soybean exports, t is a time trend, and u_{1t} and u_{2t} are random error terms.

The Supply Equations

Corn and soybean supply decisions are interrelated since corn and soybeans are produced using many of the same resources (Gallagher; Lee and Helmberger; Chavas and Holt). Government price support programs have also been implemented for both commodities, thus creating the potential for cross-market price and quantity reactions induced by government intervention.

The supply equations are specified as:

$$QCS_t = \gamma_0 + \gamma_1 PC_t^e + \gamma_2 PS_t^e + \gamma_3 CWI_t + \gamma_4 DA_t + \gamma_5 D83_t + \gamma_6 t + u_{3t} \tag{17}$$

and

$$QSS_t = \nu_0 + \nu_1 PC_t^e + \nu_2 PS_t^e + \nu_3 SWI_t + \nu_4 D83_t + \nu_5 t + u_{4t} \tag{18}$$

where QCS_t is total corn production, QSS_t is total soybean production, PC_t^e is the rational expectation of the producer price for corn, PS_t^e is similarly for soybeans, DA_t is corn acres set-aside, CWI_t and SWI_t are indices of seasonal growing conditions for respectively corn and soybeans, $D83_t$ is a binary variable equaling 1 during 1983, and $u_{3t}$and u_{4t} are random error terms.

IV. Estimation Results

FIML estimates for the rational expectations model of the corn and soybean markets were obtained using annual data from 1950-85. The truncation effects associated with the corn and soybean price support programs were incorporated by embedding Fair and Taylor's algorithm to solve equations (9)-(14). An AR(1) error processes was also included for each of these equations with the autocorrelation parameters denoted by ρ_1, ρ_2, ρ_3, and ρ_4. The FIML estimates of the model are reported in table 1.

In the corn demand equation, the estimated value for α_1 implies an own-price elasticity of demand of -0.696, an estimate similar to the one reported by Shonkwiler and Maddala. The cross-price elasticity of corn demand with respect to soybean price is small and negative (-0.057) and the cross-price coefficient, α_2, is not statistically significant. Turning to the soybean demand equation, the estimated value for β_2 is negative and significant, implying an own-price elasticity of -1.015. Interestingly, the cross-price coefficient with respect to the corn price, β_1, is positive and significant with an associated elasticity of 0.719. Hence, it appears that corn is a substitute for soybean consumption.

The results for the supply equations also appear satisfactory. The estimated value for γ_1 is positive and significant and implies a short-run supply elasticity of 0.223. Similarly, the estimate of γ_2 is negative and where QCS_t is total corn production, QSS_t is total soybean production, PC_t^e is the rational expectation of the producer price for corn, PS_t^e is similarly for soybeans, DA_t is corn acres set-aside, CWI_t and SWI_t are indices of seasonal growing conditions for respectively corn and soybeans, $D83_t$ is a binary variable equaling 1 during 1983, and $u_{3t}$and u_{4t} are random error terms.

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V. Policy Simulation Results

To illustrate the potential of the estimated model for policy analysis, the model is simulated over the historical sample period after removing price support and acreage diversion effects. It is thus possible to predict time-paths for the endogenous variables in the absence of government intervention. This sort of question is often raised in policy debates and the model presented here provides a natural framework within which to address this issue. Unlike models based on naive producer response, the simulations reported here are obtained by allowing all expectational variables to adjust to their new equilibrium levels.

Stochastic simulation results for selected years are reported in table 2. As expected, the impacts of removing support prices are larger for the corn market than for the soybean market. For example, during 29 of the 35 sample periods the simulated market price for corn was below the observed market price, and during 12 of these periods the fraction of simulated prices falling below the observed price exceeded 0.90. The results show that corn prices would have been well below observed market prices during most of the mid and late 1950s, throughout most of the 1960s and early 1970s, and again during part of the early 1980s. Simulated average corn prices were also lower for all thirteen periods in which the corn market was effectively in that average soybean prices are below observed prices during 27 periods. During nine of these 27 periods, the fraction of simulated soybean prices falling below observed soybean prices exceeded 0.90. Interestingly, of these nine years, seven coincided with periods in which the fraction of simulated corn prices falling below actual corn prices exceeded 90%. Among other things, this result highlights the importance of viewing the corn and soybean markets as a multi-market system for purposes of policy analysis.

VI. Conclusions

Previous applications of the BPVM to agricultural markets have not been conducted in a multi-market framework. A major focus of this study then was to model government price support operations in the U.S. corn and soybean markets using a multi-market endogenous switching model. The model was closed by assuming that producers form price expectations rationally. While previous studies have estimated corn and soybean supply decisions in a systems framework, this is the first attempt to do so using the rational expectations hypothesis. The resulting parameter estimates appeared reasonable and the estimated model provides a good fit to the data.

The estimated model also provides a rich framework within which to conduct policy analysis. One question addressed was the possible outcome of eliminating price support and acreage diversion programs. The results showed that corn prices would have been lower and, due to set-aside programs, corn production would have been higher over much of the 1950-85 sample period. The effects on the soybean market were less pronounced, although there were apparent "spillovers" from the corn market to the soybean market. Consequently, the analysis of government intervention in the corn and soybean markets is better served by the model presented here than by those that ignore cross-market linkages.

Table 1. Maximum Likelihood Estimates of U.S. Corn and Soybean Supply-Demand Parameters, 1950-85.

	Coefficients	t-values		Coefficients	t-values
α_0	26.5966	19.1426	ϕ_{30}	3.9498	3.7140
α_1	-22.8639	21.4614	ϕ_{31}	0.3258	2.8309
α_2	-0.8530	0.4586	ϕ_{32}	0.5045	1.7784
α_3	4.0786	7.5866	ϕ_{33}	0.5227	5.6309
α_4	0.5807	1.2676	ϕ_{34}	-0.0856	1.1762
α_5	0.6222	2.2101	ρ_1	0.2749	1.5505
β_0	1.4384	0.4006	ρ_2	0.2404	1.1903
β_1	4.8876	5.0941	ρ_3	0.3817	1.7788
β_2	-3.1210	4.5218	ρ_4	0.3467	1.6556
β_3	0.1224	0.7853	σ_{11}	20.8667	4.8463
β_4	3.2440	1.9998	σ_{12}	0.2004	0.1343
β_5	0.0067	0.0188	σ_{13}	-0.6704	0.4970
γ_0	-39.3769	18.2143	σ_{14}	0.4323	0.4390
γ_1	5.8814	4.2022	σ_{15}	-0.8529	0.6796
γ_2	-0.9492	1.6617	σ_{16}	-0.0403	0.0661
γ_3	5.8164	17.1739	σ_{17}	-1.8716	1.7973
γ_4	-0.4094	6.3389	σ_{22}	2.8381	0.9233
γ_5	-0.9903	3.3564	σ_{23}	-0.8958	1.4739
γ_6	1.4508	13.4619	σ_{24}	-1.0851	1.2193
ν_0	-9.1320	6.0552	σ_{25}	-0.0293	0.3043
ν_2	1.0658	2.8890	σ_{26}	-0.7908	1.2347
ν_3	0.8708	6.4694	σ_{27}	-0.3385	0.8234
ν_4	-0.2482	1.9539	σ_{33}	3.7233	3.7582
ν_5	0.4800	5.9683	σ_{34}	0.5510	0.9938
ϕ_{10}	3.7476	2.3954	σ_{35}	-0.9540	1.3262
ϕ_{11}	0.9623	6.1767	σ_{36}	0.4514	1.5026
ϕ_{12}	1.0742	1.7706	σ_{37}	-0.1333	0.2719
ϕ_{13}	-0.3916	2.6586	σ_{44}	0.9580	3.7873
ϕ_{14}	-0.0786	0.6267	σ_{45}	0.2671	0.6329
ϕ_{20}	0.6136	0.7124	σ_{46}	0.4100	2.8168
ϕ_{21}	0.1591	2.9523	σ_{47}	0.6031	2.2613
ϕ_{22}	0.4852	2.6167	σ_{55}	3.2151	3.4930
ϕ_{23}	-0.1046	1.7212	σ_{56}	0.2271	1.5445
ϕ_{24}	0.0777	1.5255	σ_{57}	0.4899	1.0094
			σ_{66}	0.3793	4.2599
			σ_{67}	0.1989	1.4161
			σ_{77}	1.2886	3.6509

Simulation R^2 Values for Equations[a/]:

QCD_t: 0.976 QSD_t: 0.968 CXP_t: 0.943

QCS_t: 0.985 QSS_t: 0.975 SXP_t: 0.951

PC_t: 0.862 PS_t: 0.922 LP_t: 0.967

Likelihood Value = -64.7620

Note: Parameters ϕ_{ij} denote the parameters of a first-order vector autoregressive process used to obtain expectational values for corn exports (i=1), soybean exports (i=2), and livestock prices (i=3). Parameters ϕ_{i4}, i=1,2,3, denote trend coefficients. The parameters associated with the first-order VAR process were estimated simultaneously with the structural equations of the model. Also, σ_{ij} terms denote the elements of the variance-covariance matrix.

[a/] The R^2 values denote the square of the simple correlation coefficient between observed and simulated values.

Table 2. Simulated Effects of Removing Government Price Supports and Acreage Diversions on the U.S. Corn and Soybean Markets for Selected Years.

	Corn Market									Soybean Market								
	Price			Production			Disappearance			Price			Production			Disappearance		
Year	Actual	Simulated	Frac.	Actual	Simulated	Frac.	Actual	Simulated	Frac.	Actual	Simulated	Frac.	Actual	Simulated	Frac.	Actual	Simulated	Frac.
1951	1.66	1.49	0.76	2.63	2.48	0.18	3.37	3.22	0.18	2.73	2.43	0.73	0.28	0.21	0.16	0.30	0.22	0.16
1955	1.58	1.27	0.86	2.87	2.59	0.08	3.09	3.63	0.99	2.22	2.27	0.51	0.37	0.31	0.31	0.40	0.34	0.31
1957	1.40	1.00	0.88	3.05	3.08	0.56	3.36	4.50	1.00	2.97	1.82	0.97	0.48	0.50	0.50	0.52	0.54	0.50
1959	1.12	0.98	0.74	3.83	3.45	0.08	4.06	4.97	1.00	1.96	1.69	0.63	0.53	0.53	0.48	0.62	0.62	0.48
1961	1.20	0.53	0.98	3.60	4.10	1.00	4.73	6.11	1.00	2.30	1.16	0.99	0.68	0.68	0.54	0.65	0.71	0.72
1963	1.11	0.75	0.93	4.02	4.57	1.00	5.38	5.94	1.00	2.51	1.79	0.87	0.70	0.76	0.73	0.75	0.80	0.73
1965	1.16	0.75	0.95	4.10	5.02	1.00	5.25	6.17	1.00	2.54	2.12	0.75	0.85	0.89	0.60	0.88	0.92	0.60
1967	1.05	0.88	0.78	4.86	5.47	1.00	5.21	6.30	1.00	2.50	2.14	0.77	0.98	0.92	0.32	0.93	1.01	0.79
1969	1.16	0.75	0.95	4.69	5.78	1.00	5.81	6.90	1.00	2.35	1.26	0.97	1.13	1.04	0.22	1.46	1.37	0.22
1970	1.33	1.54	0.23	4.15	4.78	1.00	5.16	5.78	1.00	2.85	3.23	0.22	1.13	1.15	0.58	1.36	1.38	0.58
1971	1.08	1.06	0.54	5.65	6.04	0.95	6.31	6.71	0.95	3.03	2.54	0.79	1.18	1.23	0.72	1.28	1.33	0.72
1972	1.57	0.91	1.00	5.58	6.51	1.00	6.71	7.63	1.00	4.37	2.69	1.00	1.27	1.30	0.59	1.34	1.37	0.59
1973	2.55	1.72	1.00	5.67	6.26	0.98	6.38	6.97	0.98	5.68	4.54	0.99	1.55	1.46	0.21	1.61	1.52	0.21
1974	3.02	2.67	0.91	4.70	5.23	1.00	5.19	5.72	1.00	6.64	6.00	0.90	1.22	1.34	0.88	1.39	1.51	0.88
1975	2.54	1.93	0.97	5.84	6.20	0.94	6.40	6.76	0.94	4.92	3.71	1.00	1.55	1.50	0.37	1.74	1.68	0.37
1976	2.15	2.41	0.21	6.29	6.42	0.69	6.92	7.05	0.69	6.81	5.78	0.98	1.29	1.56	0.99	1.53	1.80	0.99
1977	2.02	2.25	0.21	6.51	6.47	0.43	7.64	7.61	0.43	5.88	5.20	0.88	1.77	1.81	0.66	1.87	1.91	0.66
1978	2.25	2.11	0.70	7.27	7.08	0.15	8.70	8.51	0.15	6.66	5.97	0.88	1.87	1.82	0.30	2.03	1.98	0.30
1979	2.48	2.29	0.75	7.93	7.73	0.17	9.64	9.44	0.17	6.28	6.10	0.57	2.26	1.96	0.00	2.44	2.14	0.00
1980	3.12	3.23	0.35	6.64	6.82	0.82	8.67	8.86	0.82	7.57	8.39	0.10	1.80	1.84	0.63	2.16	2.20	0.63
1981	2.47	2.88	0.06	8.12	7.99	0.28	9.51	9.38	0.28	6.04	6.92	0.04	1.99	1.97	0.48	2.30	2.29	0.48
1982	2.55	2.33	0.83	8.24	7.91	0.07	10.77	10.45	0.07	5.69	6.31	0.17	2.19	2.06	0.04	2.44	2.31	0.04
1983	3.21	2.92	0.85	4.18	5.13	1.00	7.70	8.65	1.00	7.91	7.89	0.53	1.64	1.66	0.56	1.98	2.01	0.56
1984	2.63	2.71	0.39	7.67	7.87	0.80	8.68	8.88	0.80	5.85	6.47	0.15	1.86	1.99	0.85	2.04	2.16	0.85
1985	2.55	2.15	0.93	8.88	8.44	0.02	9.42	10.08	1.00	5.19	4.12	0.97	2.10	2.07	0.39	2.42	2.39	0.39

Note: In the case of Price, Frac. denotes the fraction of times the simulated price was at or below the observed price. Similarly for Production and Disappearance, Frac. denotes the fraction of times the simulated values were equal to or above the observed values.

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