AJAE APPENDIX: NONLINEAR DYNAMICS AND STRUCTURAL CHANGE IN THE U.S. HOG-CORN RATIO: A TIME-VARYING STAR APPROACH

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Unit Root Tests

As discussed in the main text several tests of the unit root hypothesis were performed. The standard augmented Dickey-Fuller (ADF) test, without and with trend, respectively, may be conducted by estimating regression equations of the form

(A.1) $$\Delta y_t = \mu + \eta y_{t-1} + \sum_{i=1}^{p} \delta_i \Delta y_{t-i} + \varepsilon_t ,$$

and

(A.2) $$\Delta y_t = \mu + \eta y_{t-1} + \beta t + \sum_{i=1}^{p} \delta_i \Delta y_{t-i} + \varepsilon_t ,$$

where $t = 1,\ldots,T$ and where p is the order of the autoregression, determined to render ε_t a white noise process. In either case the null hypothesis of a unit root may be tested by testing $\mathrm{H}_0^{\mathrm{ADF}} : \eta = 0$, which, in any event, is a non-standard test. As described by Li and Maddala (1996) and Park (2003), we use a recursive non-parametric bootstraps to test the unit root hypothesis in the (logarithm) of the hog-corn data, where p = 12. Specifically, a total of 999 bootstrap replications are used by drawing, with replacement, from the model's residuals. In both cases (i.e., with and without trend) the empirical p-value associated with $\mathrm{H}_0^{\mathrm{ADF}}$ was determined to be 0.001.

Of course the above tests are not necessarily of great value if a nonlinear model, and in particular a STAR-type model, is to be considered under the alternative. Suppose that an alternative model is given by

(A.3) $$\Delta y_t = \theta_0 + \eta y_{t-1} + \sum_{i=1}^{p} \theta_i \Delta y_{t-i} + \left(\phi_0 + \pi y_{t-1} + \sum_{i=1}^{p} \phi_i \Delta y_{t-i}\right) G\left(s_t, \gamma, c\right) + \varepsilon_t ,$$

where

$$G\left(\Delta_{12} y_{t-d}; \gamma, c\right) = \left[1 + \exp\left\{-\gamma\left(s_t - c\right)\right\}\right]^{-1},$$

an LSTAR model. In (A.3) when monthly data are used, as in the present application, s_t is typically taken to be $\Delta_{12} y_{t-d}$, $d \in [1, D_{\max}]$. Of course the same problems apply to (A.3) as to any STAR-type model when testing, namely unidentified nuisance parameters associated with ϕ_0, π, and $\phi_1, \ldots, \phi_p$ when $\gamma = 0$. Following Luukkonen, Saikkonen, and Teräsvirta (1988), this identification problem may be overcome by approximating $G(\Delta_{12} y_{t-d}; \gamma, c)$ with a first-order Taylor series. Doing so, and collecting terms, gives

$$\text{(A.4)} \qquad \Delta y_t = \theta_0 + \eta y_{t-1} + \sum\nolimits_{i=1}^{p} \theta_i \Delta y_{t-i} + \beta_0 s_t + \beta_1 y_{t-1} s_t + \sum\nolimits_{i=2}^{p} \beta_i \Delta y_{t-i+1} s_t + \varepsilon_t^* .$$

As Eklund (2003) observes, in the case of (A.4) a linear model that contains a unit root obtains when the restrictions $\eta = \beta_0 = \ldots = \beta_p = 0$ are imposed. It is a simple matter to also add a linear trend term to (A.4), if desired. Therefore, a test of the null hypothesis $\mathrm{H}_0^{ADF-STAR} : \eta = \beta_0 = \ldots = \beta_p = 0$ yields a test of the unit root hypothesis against an LSTAR alternative. As Eklund (2003) notes, the test in this case is also non-standard, and therefore the asymptotic F test is no longer valid. One possible way to proceed is, again, to use a non-parametric bootstrap. Eklund (2003) presents simulation results that show reasonable size and power properties for moderate sample sizes when the bootstrap is used to test $\mathrm{H}_0^{ADF-STAR}$.

Regarding the hog-corn data, the above methodology was applied to a model with twelve lags of the hog-corn ratio and with $s_t = \Delta_{12} y_{t-d}, d = 1, \ldots, 6$. As before, 999 bootstrap replications were formed assuming the model under the null hypothesis is true, that is, the linear unit root model is the true one. The tests were repeated both with and without a linear trend. In every instance the empirical p-value was determined to be 0.001 for all d, $d = 1, \ldots, 6$, implying that

$H_0^{ADF-STAR}$ is overwhelmingly rejected. Based on these results it is therefore reasonable to specify a nonlinear model of the hog-corn ratio in levels form as described in the main text.

AR and TVAR Model Results and Evaluation

As noted in the main text, parameter estimates for all of the estimated models are reported in the extended Appendix. Specifically, parameter estimates, along with heteroskedasticity consistent standard errors, for the (linear) AR and TVAR models are reported in table A.1. The estimated transition function for the TVAR is

$$G(t^*;\hat{\gamma}_2,\hat{c}_2) = [1+\exp\{-\underset{(1.345)}{2.513}\,(t^* - \underset{(0.069)}{0.443}\,)/\hat{\sigma}_t\}]^{-1}, \tag{A.5}$$

where heteroskedasticity consistent standard errors (HCSEs) are reported in parentheses. Of interest is that the estimated transition function in (A.5) for the TVAR model is nearly identical to that for the TV-STAR model, as reported in equation (13) in the main text. A plot of the transition function in (A.5) against time is presented in figure A.1. As noted in table A1, there is considerable change in the autoregressive parameters, as well as the coefficients associated with the seasonal dummy variables. Indeed, these parameters change rather markedly over time for the TVAR model, as well as with respect to the AR model, thereby confirming the importance of structural change in the hog and corn markets.

Diagnostic tests for remaining (MRSTAR) nonlinearity (d = 1,…,6) and for parameter constancy for the TVAR, notably LM_3^e and LM_1 tests, were obtained for the TVAR (e.g., van Dijk and Franses (1999) diagnostic tests). These results are reported in table A.2. They indicate that the TVAR is rejected against the TV-STAR for d = 1 and 6 (both for the standard and robust tests), a result that is consistent with the results of the Specific-to-General-to-Specific testing procedure presented in table 3 in the main text. Overall, a similar pattern holds when the same tests are applied to (1) monthly dummy variables only; and (2) lagged dependent variables only.

In other words, there is evidence of remaining nonlinearity for both the monthly dummy variables and the lagged dependent variables. Also, in this case there is some discrepancy between the standard and robust tests, suggesting that some of the detected nonlinearity may be due to heteroskedasticity. The results in table A.2 also show there is mo evidence of remaining parameter non-constancy under any scenario considered. Based on these results and the evidence in table 3 in the main text, we proceed by fitting a TV-STAR to the hog-corn data.

TV-STAR Model Results and Evaluation

Parameter estimates, along with HCSEs, for the TV-STAR model are reported in table A.3. The qualitative properties of the estimates are discussed in detail in the main text, and therefore will not be considered further here. The results of diagnostic LM tests for remaining (additive) nonlinearity (d = 1,…,6) and parameter constancy, that is, the diagnostic tests of Eitrheim and Teräsvirta (1996), for the TV-STAR model are recorded in table A.4. Again, standard and robust tests are reported. The results confirm a lack of remaining nonlinearity and parameter nonconstancy for the estimated TV-STAR that uses $\Delta_{12} y_{t-1}$ as a transition variable for the nonlinear component. Indeed, this conclusion holds when the LM tests are applied to (1) all regressors; (2) monthly dummy variables only; and (3) lagged dependent variables only. As well, standard and robust versions of the respective tests are in much sharper agreement, as contrasted with the results in table A.2. Based on the residual diagnostics in table A.4., as well as those recorded in table 1 in the main text, we conclude that the estimated TV-STAR does a satisfactory job of capturing key features of the hog-corn sereis.

Forecast Performance

As an additional form of model validation, a post-sample forecast evaluation was also performed. This was accomplished in the following manner. The models were re-specified and re-estimated using data through 1989.12, saving back the remaining fourteen years (168 observations) for forecasting purposes. Although not shown here, it is of interest that the same specifications (i.e., lag lengths, choice of *d* in the transition variable $\Delta_{12} y_{t-d}$, etc.) were maintained as for each of the models discussed in the main text (i.e., the AR, TVAR, and TV-STAR models). Following Lundbergh, Teräsvirta, and van Dijk (2003), we also estimate and report forecast evaluations for an LSTAR model. In this case the transition variable was chosen to be $\Delta_{12} y_{t-1}$, the same transition variable employed in the TV-STAR model.

The forecast exercise was conducted as follows. Each of the AR, TVAR, LSTAR, and TV-STAR models was estimated recursively on a rolling window of data, starting with February, 1913 to December, 1989 and ending with August, 1926 through June, 2004. For each window, 1-step-ahead to 18-step-ahead forecasts for the level of the series are obtained, resulting in a total of 139 forecasts at each horizon. Moreover, because there is no closed form expression for forecasts generated from the LSTAR and TV-STAR for all h-step-ahead forecasts, $h > 2$, we follow Clements and Smith (1997) and use 1000 bootstrap simulations to obtain forecasts in this case. Results, in terms of root mean square forecast errors (RMSFEs), are plotted in figure A.2.

For the first two horizons all models perform equally well in terms of forecast performance. Beyond $h = 2$, however, both the AR and LSTAR models have consistently higher RMSFEs than do either the TVAR or TV-STAR models. Therefore, the incorporation of structural change has important implications for forecasting the hog-corn ratio over intermediate and longer-term horizons. Through about the nine-month forecast horizon the estimated TVAR and TV-STAR models perform equally well. But starting with the ten-month forecast horizon the TV-STAR model shows somewhat better performance than the TVAR model, and consistently so through the eighteen-month-ahead forecast horizon. This result is in keeping with those reported elsewhere in the literature (e.g., Lundbergh, Teräsvirta, and van Dijk, 2003), wherein a properly specified STAR-type model will perform better than its counterparts at intermediate and longer-term forecast horizons. This is certainly the case here with respect to the TV-STAR model.

Generalized Impulse Response Functions

Here we describe how Generalized Impulse (GI) response functions are computed for a two-regime STAR model that occurs when $G_2(t^*) = 0$, 0.5, or 1. The GI is useful for assessing the properties of nonlinear models because it may be used to average over 'histories,' 'shocks,' and 'futures.' Let $\varepsilon_t = \delta$ denote a specific shock and $\Omega_{t-1} = \omega_{t-1}$ a particular history. The GI is then defined as

(A.6) $$\mathrm{GI}_{\Delta y}\left(h, \delta, \omega_{t-1}\right) = \mathrm{E}\left[\Delta y_{t+h} \,\middle|\, \varepsilon_t = \delta, \omega_{t-1}\right] - \mathrm{E}\left[\Delta y_{t+h} \,\middle|\, \omega_{t-1}\right], \quad h = 0, 1, 2, \ldots .$$

In (A.6) the expectation of Δy_t is conditional only with respect to the shock and the history—all shocks that might occur in intermediate periods (futures) are, in effect, averaged out. The GI is therefore a function of δ and ω_{t-1}, which in turn are realizations of the random variables ε_t and Ω_{t-1}. The implication is that $\mathrm{GI}_{\Delta y}\left(h, \delta, \omega_{t-1}\right)$, defined as,

(A.7) $$\mathrm{GI}_{\Delta y}\left(h, \delta, \omega_{t-1}\right) = \mathrm{E}\left[\Delta y_{t+h} \,\middle|\, \varepsilon_t = \delta, \Omega_{t-1}\right] - \mathrm{E}\left[\Delta y_{t+h} \,\middle|\, \Omega_{t-1}\right],$$

is itself a random variable. The GI defined in (A.7) also has several conditional versions of potential interest. For example, only a particular history ω_{t-1} might be considered, and the GI taken as a random variable only in the shock ε_t. Alternatively, the shock might be fixed at $\varepsilon_t = \delta$ and the GI treated as a random variable with respect to the history Ω_{t-1}. Finally, it is possible to consider some subset of shocks and/or histories, defined as S and H, respectively, so that the conditional GI is given by $\mathrm{GI}_{\Delta y}(h, S, H)$. In the case of the TV-STAR model this later property is useful for considering all histories in a particular regime associated with, say, either a positive or negative shock.

Regarding the TV-STAR model considered here, we compute the GI in (A.6) in the following manner. First, we draw a random sample of 276 'histories', that is, initialization values, from the data used to estimate the model. Note that the number of histories is close to 25-percent of the total number of observations (histories) available. Values of the normalized initial shock are set equal to $\delta/\hat{\sigma}_\varepsilon = \pm 3, \pm 2.8, \ldots, \pm 0.2$, where $\hat{\sigma}_\varepsilon$ is the estimated standard deviation of the residuals from the TV-STAR model. The maximum forecast horizon is set at 40, that is, $h = 0,\ldots,40$. Therefore for each combination of history and initial shock, we compute $\mathrm{GI}_{\Delta y}(h, \delta, \omega_{t-1})$ for $h = 0,\ldots,40$. An analytical expression for the conditional expectation in (A.6) is not available for $h > 0$ for the TV-STAR model. Here the expectations are evaluated numerically by using 800 bootstrap simulations and taking the sample means. To summarize, the conditional expectation in (A.6) is estimated as the means over 800 realizations of Δy_{t+h}, obtained by iterating the TV-STAR model, with and without the initial shock used in the calculation of Δy_t, and by using 800 TV-STAR residuals sampled with replacement. With 30 shocks and 276 histories, this implies that 8,280 GI response vectors of length 40 are calculated. Impulse responses for the level of the hog-corn ratio are constructed by totaling the impulse responses for the first differences, that is, $\mathrm{GI}_y\left(h,\delta,\omega_{t-1}\right)=\sum_{j=0}^{h}\mathrm{GI}_{\Delta y}\left(j,\delta,\omega_{t-1}\right)$.

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Table A1. AR and TVAR Parameter Estimates for the Monthly U.S. Hog-Corn Ratio

	AR Model		TVAR Model			
			$\left(1-G\left(t^{*};\gamma,c\right)\right)$		$G\left(t^{*};\gamma,c\right)$	
Variable	Coef	HCSE	Coef	HCSE	Coef	HCSE
Constant	0.143	0.239	0.423	0.939	0.385	0.895
Δy_{t-1}	0.199	0.045	0.135	0.076	0.296	0.087
Δy_{t-2}	0.022	0.051	0.093	0.080	0.043	0.100
Δy_{t-3}	0.000	0.037	0.039	0.074	0.117	0.059
Δy_{t-4}	0.058	0.037	0.195	0.068	0.034	0.065
Δy_{t-5}	-0.030	0.035	0.028	0.066	0.045	0.061
Δy_{t-6}	0.011	0.036	0.110	0.063	0.019	0.062
Δy_{t-7}	-0.003	0.036	0.066	0.067	0.048	0.060
Δy_{t-8}	0.043	0.039	0.097	0.072	0.110	0.068
Δy_{t-9}	-0.004	0.036	0.108	0.068	0.043	0.059
Δy_{t-10}	-0.003	0.035	0.073	0.072	0.037	0.056
Δy_{t-11}	0.167	0.033	0.260	0.067	0.144	0.056
y_{t-1}	-0.053	0.086	-0.179	0.401	-0.130	0.292
D1	0.020	0.012	0.022	0.020	0.011	0.023
D2	0.025	0.010	0.021	0.020	0.031	0.017
D3	-0.010	0.010	0.047	0.026	-0.056	0.019
D4	-0.031	0.010	-0.027	0.020	-0.028	0.017
D5	0.005	0.012	-0.068	0.029	0.055	0.022
D6	-0.006	0.011	-0.048	0.024	0.021	0.020
D7	0.023	0.013	-0.008	0.032	0.039	0.020
D8	0.016	0.012	0.004	0.024	0.023	0.021
D9	-0.017	0.011	0.021	0.025	-0.042	0.019
D10	0.034	0.013	0.065	0.029	0.012	0.020
D11	-0.025	0.012	0.029	0.028	-0.058	0.022

$$G(t^{*};\hat{\gamma}_2,\hat{c}_2)=[1+\exp\{-\underset{(1.345)}{2.513}\,(t^{*}-\underset{(0.069)}{0.443}\,)/\hat{\sigma}_t\}]^{-1}$$

Note: The table presents AR and TVAR model estimates for the hog-corn ratio model, 1913:02-2004:12. HCSE denotes heteroskedasticity robust standard errors and D1-D11 denote seasonal dummy variables.

Table A2. Results of Standard and Heteroskedasticity Robust LM-type Diagnostic Tests for TVAR Model Estimated for Monthly Hog-Corn Ratio.

	All Regressors				Monthly Dummies				Lagged Dependent Variables			
	Standard Tests		Robust Tests		Standard Tests		Robust Tests		Standard Tests		Robust Tests	
Transition Variable, s_t	LM_3^e	LM_1	LM_3^e	LM_1	LM_3^e	LM_1	LM_3^e	LM_1	LM_3^e	LM_1	LM_3^e	LM_1
$\Delta_{12} y_{t-1}$	4.51E-07	1.31E-06	0.080	0.050	6.02E-04	3.37E-03	0.128	0.159	9.33E-08	1.66E-07	0.107	0.057
$\Delta_{12} y_{t-2}$	5.11E-06	2.02E-06	0.215	0.120	3.15E-02	0.021	0.254	0.291	2.97E-07	1.86E-07	0.088	0.048
$\Delta_{12} y_{t-3}$	2.20E-05	8.05E-06	0.073	0.062	3.34E-03	3.21E-03	0.094	0.083	2.39E-05	3.81E-05	0.008	0.013
$\Delta_{12} y_{t-4}$	5.81E-04	6.43E-04	0.132	0.215	1.01E-03	5.03E-04	0.027	0.017	1.28E-03	5.49E-03	0.031	0.080
$\Delta_{12} y_{t-5}$	8.91E-04	7.72E-04	0.041	0.104	4.17E-04	8.08E-05	0.014	0.005	6.76E-03	0.011	0.048	0.150
$\Delta_{12} y_{t-6}$	4.51E-07	1.38E-05	0.030	0.027	4.82E-05	2.03E-05	0.006	0.002	2.63E-04	1.31E-03	0.014	0.046
t^*	0.282	0.265	0.529	0.571	0.380	0.277	0.422	0.273	0.347	0.232	0.606	0.485

Note: Numbers are p-values of LM-type tests for model misspecification of LSTAR-type models described by Eitrheim and Teräsvirta (1996) and van Dijk and Franses (2003) and applied to the U.S. hog-corn ratio, 1913:02-2004:12. The first six rows denote tests for remaining nonlinearity and the final row reports tests for parameter constancy. LM_3^e denotes an economy version of the LM_3 test (i.e., a third-order Taylor series expansion with interactions omitted for second- and third-order terms) for remaining nonlinearity (parameter non-constancy). LM_1 is analogously defined but for a first-order Taylor series expansion.

Table A3. TV-STAR Estimates for the Monthly U.S. Hog-Corn Ratio

	$(1-G_1)(1-G_2)$		$G_1(1-G_2)$		$(1-G_1)G_2$		G_1G_2	
Variable	Coef	HCSE	Coef	HCSE	Coef	HCSE	Coef	HCSE
Constant	0.510	1.256	0.284	1.067	0.526	1.549	0.292	0.923
Δy_{t-1}	0.193	0.125	0.116	0.103	0.234	0.148	0.328	0.090
Δy_{t-2}	0.136	0.168	0.121	0.100	-0.127	0.209	0.079	0.069
Δy_{t-3}	-0.199	0.126	0.229	0.102	0.146	0.139	0.020	0.065
Δy_{t-4}	0.303	0.133	0.157	0.076	-0.078	0.128	0.025	0.080
Δy_{t-5}	-0.021	0.150	0.059	0.077	0.159	0.118	-0.101	0.070
Δy_{t-6}	0.225	0.140	0.084	0.077	-0.171	0.137	0.083	0.073
Δy_{t-7}	0.000	0.123	0.063	0.085	0.013	0.129	0.040	0.068
Δy_{t-8}	0.157	0.155	0.091	0.084	0.066	0.190	0.065	0.067
Δy_{t-9}	0.165	0.135	0.130	0.093	-0.057	0.156	-0.011	0.067
Δy_{t-10}	-0.030	0.130	0.145	0.086	0.100	0.163	-0.014	0.061
Δy_{t-11}	0.281	0.115	0.323	0.089	0.041	0.171	0.108	0.063
y_{t-1}	-0.216	0.506	-0.127	0.452	-0.190	0.488	-0.096	0.323
D1	0.030	0.042	0.018	0.025	0.029	0.044	-0.002	0.020
D2	-0.024	0.041	0.042	0.022	0.039	0.033	0.029	0.018
D3	-0.012	0.039	0.089	0.035	-0.057	0.034	-0.059	0.025
D4	-0.021	0.038	-0.032	0.026	-0.010	0.035	-0.035	0.020
D5	-0.059	0.041	-0.076	0.033	0.065	0.039	0.052	0.023
D6	-0.061	0.042	-0.042	0.026	-0.002	0.043	0.032	0.019
D7	0.033	0.049	-0.036	0.037	0.031	0.042	0.043	0.022
D8	0.040	0.039	-0.016	0.028	0.024	0.047	0.015	0.021
D9	0.077	0.041	-0.010	0.027	-0.058	0.046	-0.035	0.019
D10	0.077	0.047	0.053	0.034	0.017	0.038	0.019	0.023
D11	-0.007	0.043	0.052	0.035	-0.067	0.047	-0.055	0.023

$$G_1(\Delta_{12} y_{t-1};\hat{\gamma}_1,\hat{c}_1) = [1+\exp\{-500.0(\Delta_{12} y_{t-1} + \underset{(0.003)}{0.081}) / \hat{\sigma}_{\Delta_{12} y_{t-1}}\}]^{-1}$$

$$G_2(t^*;\hat{\gamma}_2,\hat{c}_2) = [1+\exp\{-\underset{(1.342)}{2.364}\,(t^* - \underset{(0.069)}{0.449}) / \hat{\sigma}_t\}]^{-1}$$

Note: The table presents TV-STAR estimates for the hog-corn ratio model, 1913:02-2004:12. HCSE denotes heteroskedasticity robust standard errors and D1-D11 denote seasonal dummy variables. The estimated TV-STAR is based on (11) in the main text.

Table A4. Results of Standard and Heteroskedasticity Robust LM-type Diagnostic Tests for TV-STAR Model Estimated for Monthly Hog-Corn Ratio

	All Regressors				Monthly Dummies				Lagged Dependent Variables			
	Standard Tests		Robust Tests		Standard Tests		Robust Tests		Standard Tests		Robust Tests	
Transition Variable, s_t	LM_3^e	LM_1	LM_3^e	LM_1	LM_3^e	LM_1	LM_3^e	LM_1	LM_3^e	LM_1	LM_3^e	LM_1
$\Delta_{12} y_{t-1}$	0.240	0.202	0.300	0.259	0.208	0.138	0.167	0.199	0.209	0.190	0.501	0.419
$\Delta_{12} y_{t-2}$	0.232	0.174	0.580	0.470	0.314	0.214	0.348	0.313	0.256	0.243	0.450	0.387
$\Delta_{12} y_{t-3}$	0.193	0.334	0.355	0.566	0.631	0.489	0.796	0.667	0.453	0.729	0.591	0.770
$\Delta_{12} y_{t-4}$	0.232	0.570	0.397	0.718	0.490	0.499	0.830	0.774	0.205	0.853	0.299	0.846
$\Delta_{12} y_{t-5}$	0.338	0.380	0.617	0.699	0.223	0.176	0.650	0.495	0.409	0.541	0.360	0.535
$\Delta_{12} y_{t-6}$	0.049	0.060	0.281	0.258	0.087	0.076	0.400	0.254	0.128	0.305	0.223	0.381
t^*	0.418	0.321	0.725	0.627	0.577	0.496	0.689	0.578	0.198	0.192	0.423	0.419

Note: Numbers are p-values of LM-type tests for model misspecification in the form of remaining additive nonlinearity described by Eitrheim and Teräsvirta (1996) applied to the U.S. hog-corn ratio, 1913:02-2004:12. The first eight rows denote tests for remaining nonlinearity and the final row reports tests for parameter constancy. LM_3^e denotes an economy version of the LM_3 test (i.e., a third-order Taylor series expansion with interactions omitted for second- and third-order terms) similar to (5) for remaining nonlinearity (parameter non-constancy). LM_1 is analogously defined but for a first-order Taylor series expansion. The auxiliary regressions are based on (8), but with interaction terms involving $\hat{G}_1(.)$ excluded.

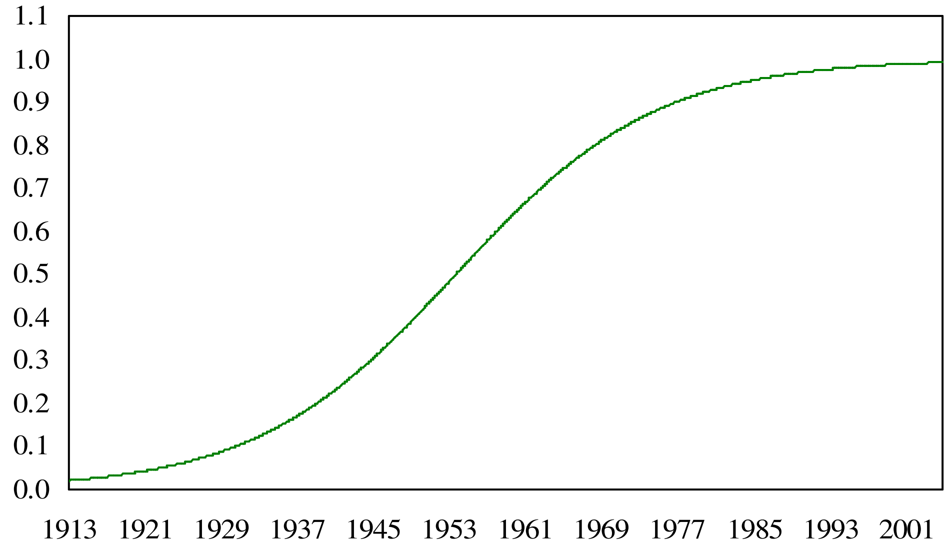

Figure A1. $G\left(t^*;\gamma,c\right)$ **Over Time for the Estimated TVAR Model of the U.S. Hog-Corn Ratio**

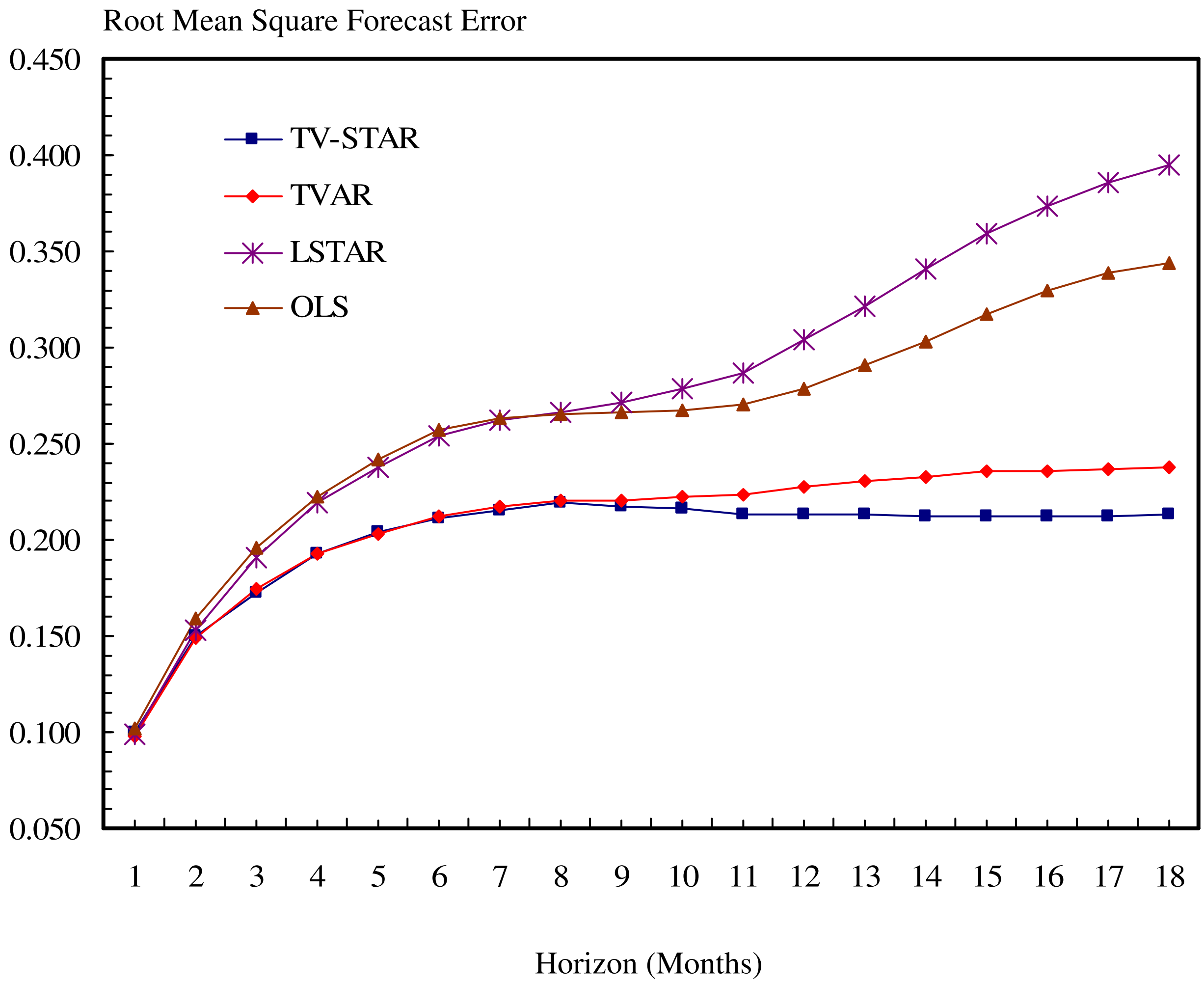

Figure A.2. Root Mean Square Forecast Errors for the AR, TVAR, LSTAR, and TV-STAR Models at One-to-Eighteen Month Forecast Horizons, 1990.01-2004.12