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Ethan Buck, Morgan Hinz, Yuxi Jiang, Xiuyun Wen, and Todd H. Kuethe

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The Rationality of USDA's Retail Food Price Inflation Forecasts

Ethan Buck, Morgan Hinz, Yuxi "Jimmy" Jiang, Xiuyun "Lisa" Wen, and Todd H. Kuethe*

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*This research was completed as part of the Purdue University Department of Agricultural Economics Undergraduate Honors Research Program. Senior authorship is assigned equally. Corresponding author: Prof. Todd H. Kuethe tkuethe@purdue.edu

Abstract

The USDA-Economic Research Service's "Food Price Outlook" forecast is an important source of information on U.S. retail food prices and widely used by researchers, policymakers, food industry professionals, and the media. Despite their widespread use, these forecasts have not been rigorously evaluated. This study examines the degree to which ERS's monthly retail food price forecasts are rational, in the sense that they are unbiased and incorporate all information available using the mode forecast rationality test developed by Dimitriadis et al. (2019). The tests were applied to all 22 retail food price series across 18 horizons for all years from 2004 through 2022 (19 years). The study finds that the forecasts are generally rational. Mode rationality cannot be rejected at any horizon for 8 of the 22 price series, rejected at only one horizon for 4 of the 22 price series, and rejected at two horizons for 3 of the 22 price series. There are only three price series for which mode rationality was rejected for a number of horizons: food at home; meats, poultry, and fish; and other foods. Despite the generally positive performance, the forecast methodology was recently retired by USDA-Economic Research Service.

1 Introduction

The rapid increase in retail food prices prices since the onset of the COVID-19 pandemic has emerged as a critical economic and policy concern. From November 2021 to November 2022, food prices increased by 10.6%, with grocery prices rising 12% and menu prices jumping 8.5% (US Bureau of Labor Statistics). The USDA Economic Research Service's (ERS) "Food Expenditure Series" suggests that U.S. consumers spent roughly $2.1 trillion on food in 2021, which accounted for approximately 10.3% of disposable personal income (USDA Economic Research Service, 2022). In developed countries, food inflation is often not considered in core inflation measures due to the low percentage of food in household expenses and the low volatility of food prices (Gómez et al., 2012). However, food price shocks were a large component of the high inflation of the 1970s (Blinder and Rudd, 2013), and food price rises help shape consumers' broader inflation expectations (Kikuchi and Nakazono, 2022). In the U.S., high food prices are associated with a higher probability of food insecurity (Gregory and Coleman-Jensen, 2013), and in developing countries, high food prices are associated with periods of social unrest (Bellemare, 2015).

ERS's food price inflation forecasts are important source of information on U.S. retail food prices. The forecasts are used by researchers and policymakers to anticipate necessary changes of food assistance programs; by food industry professionals to project costs, expenditures, and demand for products and services; and by the media to inform U.S. consumers about expected price changes (Kuhns et al., 2015). Despite their widespread use, these forecasts have not been rigorously evaluated.

This study examines the degree to which ERS's food price forecasts can be considered rational, in the sense that they are unbiased and efficiently incorporate all information available at the time the forecast was constructed. As documented by Kuhns et al. (2015), ERS produces monthly forecasts of annual price change for 22 food price series. The first forecast is released July preceding the reference year, eighteen months prior to the terminal event. This study examines historic forecasts and observed outcomes from 2004 through 2022 (19 years) across all 18 horizons.

ERS food price inflation forecasts differ from other USDA forecasts in important ways. The forecasts are reported as a fixed one percent interval, yet most interval forecasts are wider in volatile periods and narrower in tranquil periods. The rationality of interval forecasts that vary in this fashion can be evaluated by the frequency with the forecast interval contains the observed outcome relative to the *a priori* coverage probability and the degree to which misses are distributed independently (Christoffersen, 1998). This framework, for example, was employed by Isengildina et al. (2004) and Isengildina-Massa and Sharp (2012) to evaluate

WASDE price forecast intervals. However, because ERS's food price forecasts are reported as a fixed one percent interval, the forecasts are assumed to maximize the probability that this interval contains realized outcome. This construction is known as a "modal interval forecast" (Brehmer and Gneiting, 2021).

It is a well-known property that, in general, there is no loss function that is minimised by the mode, or alternatively the mode is not an "elicitable functional" (Heinrich, 2014). Dimitriadis et al. (2019), however, rely on the convergence of the midpoint of the modal interval to the mode by Gneiting (2011) to establish the *asymptotic elicitability* of the mode and derive a joint J-test of rationality the nests the mode a special case of the general loss function, in the spirit of Elliott et al. (2005). We apply this test to ERS' series of food price inflation forecasts to measure the degree to which the forecasts may be considered rational.

We find that, over the period examined, the midpoint of ERS's modal interval forecast provides a rational prediction of observed retail food price changes. Mode rationality cannot be rejected at any horizon for 8 of the 22 price series, rejected at only one horizon for 4 of the 22 price series, and rejected at two horizons for 3 of the 22 price series. There are only three price series for which mode rationality was rejected for a number of horizons: food at home; meats, poultry, and fish; and other foods. These findings may assist USDA forecasters in improving forecasting methods and help forecast users understand the patterns in food price inflation forecast errors.

2 Data

USDA-Economic Research Service's "Food Price Outlook" forecast of retail food prices is released monthly, beginning in July preceding the reference year (with an 18 month forecast horizon). As shown in Figure **??**, the forecast is revised monthly until December of the reference year (with a 1 month horizon). Realized values are reported in January the year following the reference year by the Bureau of Labor Statistics' (BLS) Consumer Price Index (CPI). BLS-CPI reports the annual percentage change for 22 nested retail food price series. Table 1 reports the summary statistics for BLS-CPI reported retail food price changes across our observation period of 2004 – 2022.

As previously stated, ERS's food price forecasts are reported as a fixed one percent interval, which are assumed to maximize the probability that this interval contains the realized outcome, called the "modal interval forecast" (Brehmer and Gneiting, 2021). ERS's forecasting methods vary across the series, with exact documentation provided by Kuhns et al. (2015). Figure 1 plots the reported forecast interval for three headline series – all food, food away from home, and food at home – at four of the 18 forecast horizons (18, 12, 6, and

1). The dashed red line represents the realized percentage price changes for each series, as reported by BLS-CPI.

As demonstrated by Brehmer and Gneiting (2021), the only appropriate scoring function for modal interval forecasts is the proportion of times the forecast contain the observed value, known as the forecast "hit rate." The hit rate is calculated using the interval function:

$$I_{h,t} = \begin{cases} 1 & \text{if } A_t \in [l_{h,t}(\gamma), u_{h,t}(\gamma)] \\ 0 & \text{if } A_t \notin [l_{h,t}(\gamma), u_{h,t}(\gamma)] \end{cases} \tag{1}$$

where $[l_{h,t}(\gamma), u_{h,t}(\gamma)]$ are the lower and upper limits of the interval forecast for terminal value A_t made at horizon h with coverage probability γ. The hit rate is the expected value $\mathbb{E}(I_{h,t})$ or the average of observed hits: $(\sum_{t=1}^{T} I_{h,t})/T$.

The hit rate for each price series across all 18 forecast horizons is reported in Table 2. Forecast rationality implies that the forecast error should be weakly increasing function of the forecast horizon (Patton and Timmermann, 2007). In other words, the hit rate is expected to increase as the terminal event approaches or the horizon shrinks. As shown in Table 2, the hit rate generally increases as the terminal date approaches. In addition, Figure 2 plots the hit rate for the three headline series: all food, food away from home, and food at home. As suggested by food away from home, the hit rate for a number of the price series improve initially and then decline before improving again at the short horizons.

Table 1: Summary Statistics for Observed Food Price Changes, 2004 – 2022

	Mean	**Std. Dev.**	**Min.**	**Max.**
All food	2.84	2.14	0.30	9.90
Food away from home	3.19	1.33	1.30	7.70
Food at home	2.57	2.88	–1.30	11.40
Meats, poultry, and fish	3.37	3.34	–3.50	9.60
Meats	3.47	3.84	–4.40	9.20
Beef and veal	4.38	4.85	–6.30	12.10
Pork	2.64	4.20	–4.10	9.10
Other meats	2.76	3.43	–0.90	14.20
Poultry	3.04	3.98	–2.70	14.60
Fish and seafood	3.37	2.57	–0.90	9.10
Eggs	4.24	13.94	–21.10	32.20
Dairy products	2.39	4.37	–6.40	12.00
Fats and oils	3.29	5.45	–1.40	18.50
Fruits and vegetables	2.11	2.86	–4.80	7.50
Fresh fruits and vegetables	2.23	2.60	–2.10	8.50
Fresh fruits	2.05	3.37	–6.10	7.90
Fresh vegetables	2.17	3.16	–5.10	7.00
Processed fruits and vegetables	2.66	3.55	–1.60	12.00
Sugar and sweets	2.53	2.78	–1.70	10.40
Cereals and bakery products	2.65	3.50	–0.80	13.00
Nonalcoholic beverages	1.98	2.76	–1.00	11.00
Other foods	2.18	2.94	–0.50	12.70

Figure 1: Forecast Intervals and Observed Values, 2004 – 2022

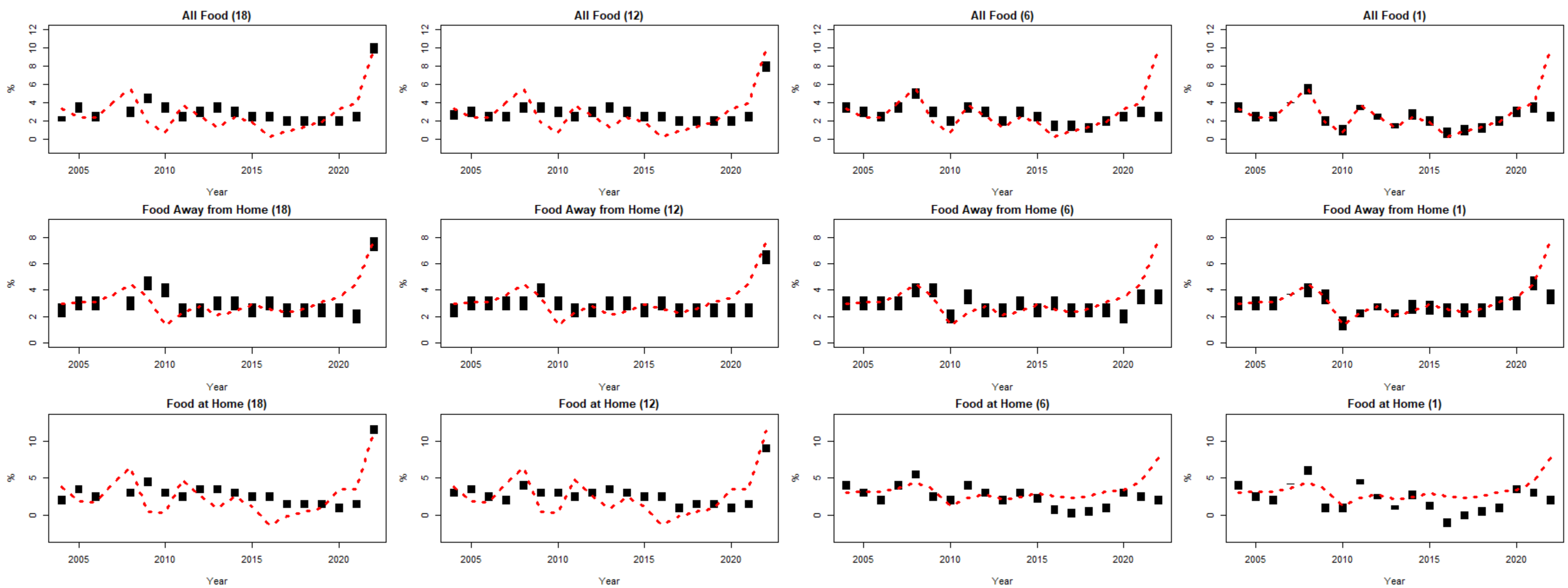
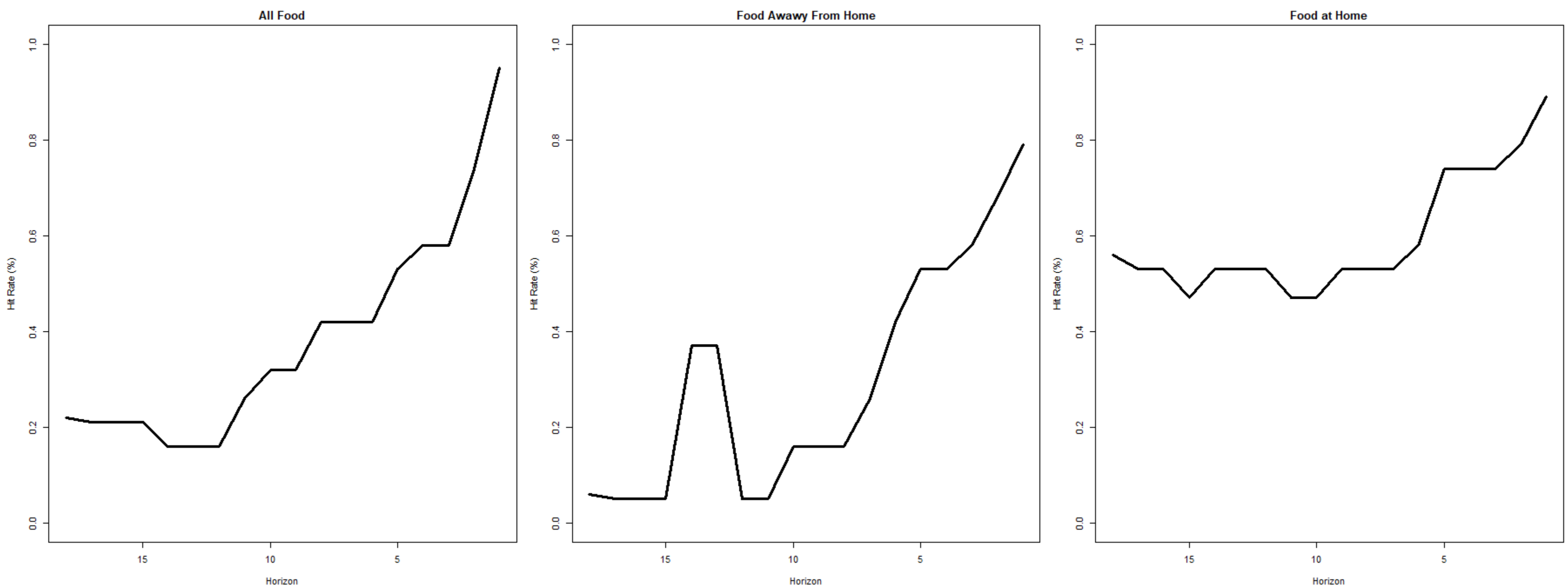


Table 2: Hit Rate, 2004 – 2022

	Horizon																	
	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1
All food	0.22	0.21	0.21	0.21	0.16	0.16	0.16	0.26	0.32	0.32	0.42	0.42	0.42	0.53	0.58	0.58	0.74	0.95
Food away from home	0.56	0.53	0.53	0.47	0.53	0.53	0.53	0.47	0.47	0.53	0.53	0.53	0.58	0.74	0.74	0.74	0.79	0.89
Food at home	0.06	0.05	0.05	0.05	0.37	0.37	0.05	0.05	0.16	0.16	0.16	0.26	0.42	0.53	0.53	0.58	0.68	0.79
Meats, poultry, and fish	0.22	0.26	0.26	0.26	0.26	0.26	0.21	0.32	0.32	0.32	0.37	0.37	0.42	0.47	0.47	0.58	0.58	0.68
Meats	0.28	0.26	0.26	0.26	0.16	0.16	0.11	0.11	0.16	0.16	0.16	0.16	0.26	0.32	0.32	0.53	0.68	0.74
Beef and veal	0.22	0.16	0.16	0.16	0.16	0.16	0.05	0.05	0.05	0.05	0.11	0.16	0.26	0.32	0.32	0.58	0.37	0.63
Pork	0.17	0.16	0.16	0.16	0.11	0.05	0.21	0.21	0.21	0.21	0.21	0.26	0.32	0.32	0.37	0.58	0.58	0.79
Other meats	0.11	0.11	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.11	0.11	0.11	0.21	0.21	0.53	0.68
Poultry	0.17	0.16	0.16	0.21	0.21	0.26	0.16	0.11	0.11	0.11	0.11	0.16	0.16	0.21	0.26	0.47	0.79	0.84
Fish and seafood	0.22	0.21	0.32	0.32	0.32	0.26	0.26	0.16	0.16	0.16	0.21	0.26	0.26	0.32	0.42	0.47	0.63	0.74
Eggs	0.17	0.16	0.11	0.16	0.16	0.16	0.05	0.05	0.05	0.05	0.11	0.11	0.11	0.05	0.11	0.21	0.32	0.53
Dairy products	0.06	0.05	0.05	0.11	0.05	0.05	0.05	0.05	0.05	0.05	0.11	0.26	0.42	0.42	0.58	0.63	0.74	0.84
Fats and oils	0.17	0.16	0.11	0.11	0.05	0.05	0.05	0.58	0.58	0.58	0.05	0.53	0.53	0.16	0.26	0.37	0.42	0.63
Fruits and vegetables	0.28	0.32	0.26	0.26	0.32	0.32	0.32	0.32	0.32	0.32	0.26	0.32	0.42	0.58	0.53	0.58	0.79	0.84
Fresh fruits and vegetables	0.22	0.26	0.26	0.21	0.26	0.26	0.26	0.21	0.26	0.32	0.32	0.32	0.37	0.42	0.47	0.53	0.58	0.84
Fresh fruits	0.17	0.21	0.11	0.11	0.11	0.11	0.11	0.16	0.21	0.16	0.16	0.16	0.37	0.42	0.53	0.58	0.63	0.89
Fresh vegetables	0.17	0.21	0.16	0.16	0.16	0.26	0.21	0.21	0.11	0.16	0.21	0.21	0.21	0.11	0.16	0.16	0.42	0.74
Processed fruits and vegetables	0.17	0.16	0.16	0.11	0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.21	0.32	0.32	0.53	0.63	0.74
Sugar and sweets	0.11	0.16	0.16	0.11	0.11	0.11	0.16	0.21	0.21	0.26	0.32	0.47	0.47	0.58	0.63	0.74	0.79	0.84
Cereals and bakery products	0.22	0.16	0.16	0.16	0.21	0.21	0.11	0.16	0.16	0.16	0.21	0.21	0.42	0.37	0.37	0.37	0.58	0.68
Nonalcoholic beverages	0.28	0.26	0.26	0.21	0.26	0.32	0.32	0.32	0.32	0.32	0.26	0.32	0.37	0.37	0.47	0.63	0.68	0.79
Other foods	0.28	0.26	0.26	0.26	0.26	0.32	0.21	0.16	0.26	0.32	0.37	0.37	0.42	0.37	0.42	0.42	0.53	0.63

Figure 2: Hit Rate, 2004 – 2022



3 Methods

We want to test the degree to which ERS's food price inflation forecasts are rational, in the manner:

$$\mathbb{H}_0 : A_t = \text{Mode}[F_{t,t-h}|\Omega_{t-h}] \tag{2}$$

where A_t is the observed outcome at time t, $F_{t,t+h}$ the forecast of A_t at horizon $t-h$, and Ω_{t-h} the forecaster's information set at horizon $t-h$. However, there is no loss function that is minimised by the mode, or alternatively the mode is not an "elicitable functional" (Heinrich, 2014). Given that ERS's food price inflation forecasts are reported as a fixed-length modal interval, we can test for rationality using the approach developed by Dimitriadis et al. (2019). Dimitriadis et al. (2019) develop the *asymptotic elicitability* of modal interval forecast rationality tests based on the convergence of the midpoint of the modal interval to the mode, following Gneiting (2011). Gneiting (2011) demonstrate that the midpoint of the modal interval of length 2δ is the optimal point forecast under the loss function $L_\delta(x, Y) = 1_{|x-Y|\leq\delta}$ for some fixed $\delta > 0$.

Dimitriadis et al. (2019) construct a joint J-test of rationality (bias and efficiency) that nests the mode as a special case of the general loss function, in the spirit of Elliott et al. (2005). Elliott et al. (2005) similarly want to test rationality at the mean, in the manner:

$$\mathbb{H}_0 : A_t = \mathbb{E}[F_{t,t-h}|\Omega_{t-h}] \quad \text{a.s.} \tag{3}$$

Given that the forecast error $\varepsilon_t = A_t - F_{t,t-h}$ should be zero, on average, Elliott et al. (2005) derive the strict identification function $V_t^{\text{Mean}}(\varepsilon_t) = \varepsilon_t$. Their joint rationality test becomes:

$$\mathbb{H}_0 : \mathbb{E}[V_t^{\text{Mean}}(\varepsilon_t)\mathfrak{h}_t^T] = 0 \tag{4}$$

using the instrument set $\mathfrak{h}_t$.

Dimitriadis et al. (2019) similarly derive the joint mode rationality test for modal interval forecasts:

$$\mathbb{H}_0 : \mathbb{E}[V_t^{\text{Mode}}(\varepsilon_t)\mathfrak{h}_t^T] = 0 \tag{5}$$

using the asymptotic identification for the smoothed modal midpoint following Gneiting (2011):

$$V_{T,\delta_T}^{\text{Mode}}(\varepsilon_t) = \frac{1}{\delta_T^2} K' \left(\frac{-\varepsilon_t}{\delta_T} \right)$$

where δ_T converges "slowly" to 0 with sample size T.

4 Results

Table 3 reports the p-values of the joint mode rationality test for each price series across all 18 forecast horizons using three combinations of instruments, following the suggestions of Elliott et al. (2005): (1) a constant and the current forecast; (2) a constant, the current forecast, and lagged realized values; and (3) a constant, the current forecast, and lagged forecast errors. Forecast rationality is rejected when the reported p-value is less than or equal to the desired level of significance. Values less than or equal to 0.05 are presented in bold text. In addition, Figure 3 plots the p-values under each instrument set for the three headline series: all food, food away from home, and food at home.

The aggregate series "food at home" yielded the highest number of rejections. Rationality was rejected at a 5% significance level for at least two instrument sets across nine horizons ($h = 18, 17, 16, 15, 13, 12, 11, 8, 5$). Rationality was similarly rejected across seven horizons for the aggregate series "meats, poultry, and fish" ($h = 17, 16, 15, 14, 13, 9, 8$) and across six series for the residual category "other foods" ($h = 18, 17, 16, 15, 14, 13, 8$). In addition, rationality was rejected at five horizons for two series: the aggregate "all food" ($h = 18, 12, 9, 8, 7$) and the individual series "beef and veal" ($h = 18, 17, 16, 7, 6$). Thus, rationality was only rejected in several cases for 5 of the 22 price series.

There were nine series for which rationality was not rejected at any horizon: food away from home, meats, poultry, dairy products, fruits and vegetables, fresh fruits and vegetables, fresh fruits, fresh vegetables, and sugar and sweets. There are an additional four series for which rationality was rejected at just one horizon: fish and seafood ($h = 17$), fats and oils ($h = 15$), processed fruits and vegetables ($h = 9$), cereals and bakery products ($h = 18$). Finally, rationality was rejected at two horizons for four series: pork ($h = 6, 5$), other meats ($h = 4, 3$), eggs ($h = 10, 8$), and nonalcoholic beverages ($h = 17, 5$). Thus, for the majority of series the forecasts are generally rational.

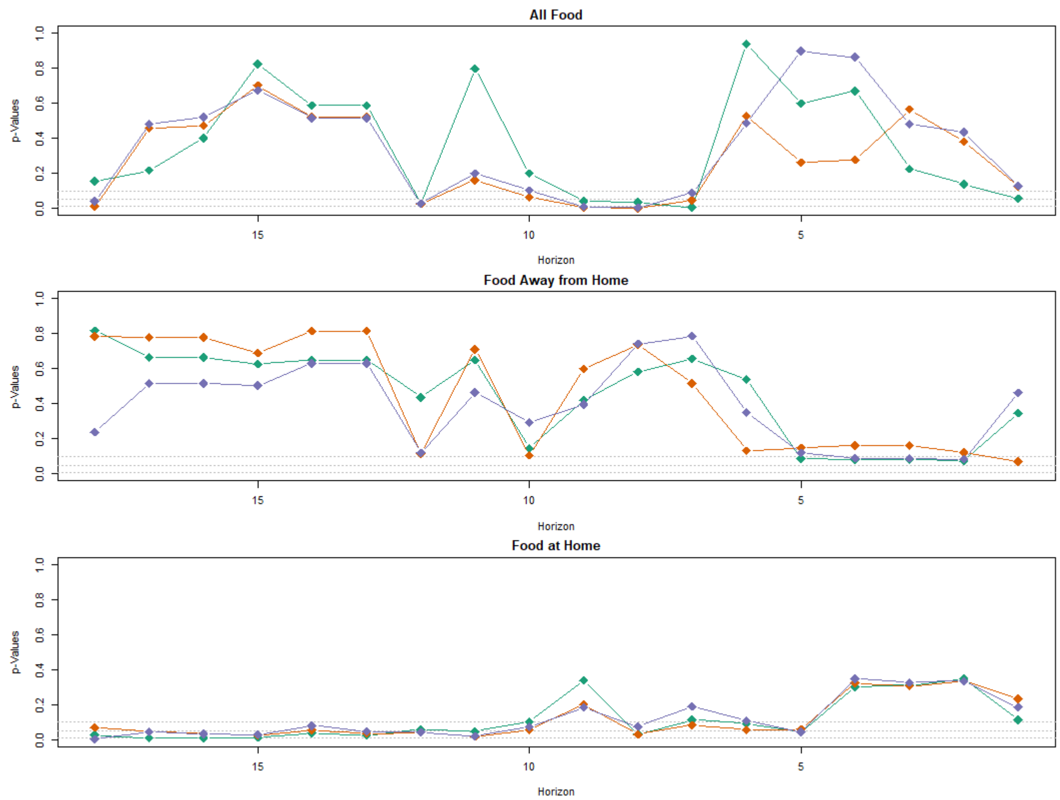
The high volume of rejections early in the forecasting cycle ($h > 12$) is not surprising given the high degree of uncertainty. The forecasts for which rejected at shorter horizons ($h < 7$), however, may warrant further investigation. The breakdown in rationality may be related to seasonal fluctuations in commodity and retail prices of certain food items which could be better captured with alternative modeling approaches.

Table 3: Mode Rationality Test, 2004 – 2021

		Horizon																	
	Inst	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1
All food	1	0.15	0.22	0.40	0.82	0.59	0.59	**0.03**	0.80	0.20	**0.04**	**0.03**	**0.01**	0.94	0.60	0.67	0.23	0.14	0.06
	2	**0.01**	0.46	0.47	0.70	0.52	0.52	**0.03**	0.16	0.06	**0.01**	**0.00**	**0.05**	0.53	0.26	0.28	0.56	0.38	0.13
	3	**0.04**	0.48	0.52	0.67	0.51	0.51	**0.03**	0.20	0.10	**0.01**	**0.01**	0.09	0.49	0.90	0.86	0.48	0.43	0.13
Food away from home	1	0.82	0.67	0.67	0.63	0.65	0.65	0.44	0.65	0.15	0.42	0.58	0.66	0.54	0.09	0.08	0.08	0.07	0.35
	2	0.79	0.78	0.78	0.69	0.82	0.82	0.12	0.71	0.11	0.60	0.74	0.52	0.13	0.15	0.16	0.16	0.12	0.07
	3	0.24	0.52	0.52	0.51	0.63	0.63	0.12	0.47	0.29	0.40	0.74	0.79	0.35	0.12	0.09	0.09	0.08	0.46
Food at home	1	**0.03**	**0.01**	**0.01**	**0.01**	**0.04**	**0.02**	0.06	**0.05**	0.10	0.34	**0.03**	0.11	0.09	**0.04**	0.30	0.31	0.35	0.11
	2	0.07	**0.05**	**0.04**	**0.03**	0.05	**0.04**	**0.04**	**0.02**	0.06	0.20	**0.03**	0.08	0.06	0.06	0.32	0.31	0.33	0.23
	3	**0.00**	**0.04**	**0.03**	**0.03**	0.08	**0.05**	**0.04**	**0.02**	0.07	0.18	0.08	0.19	0.11	**0.04**	0.35	0.33	0.33	0.19
Meats, poultry, and fish	1	**0.04**	**0.03**	**0.03**	**0.03**	**0.04**	0.09	0.23	0.28	0.58	0.44	0.69	0.66	0.88	0.32	0.30	0.13	0.09	0.55
	2	0.09	0.06	0.06	0.06	**0.05**	**0.04**	0.21	0.24	**0.03**	**0.03**	**0.03**	0.25	0.07	**0.03**	**0.03**	0.24	**0.04**	0.77
	3	0.10	**0.05**	**0.05**	**0.05**	**0.05**	**0.04**	0.19	0.21	0.06	**0.05**	**0.05**	0.14	0.39	0.19	0.17	0.15	0.29	0.29
Meats	1	0.30	0.21	0.19	0.20	0.21	0.82	0.62	0.66	0.37	0.27	0.11	0.16	0.29	0.55	**0.05**	0.15	0.27	0.62
	2	0.20	0.14	0.14	0.14	0.25	0.14	0.71	0.68	0.28	0.17	0.10	0.24	0.40	0.54	0.07	0.46	0.88	0.10
	3	0.11	0.11	0.12	0.12	0.27	0.17	0.66	0.74	0.31	0.34	0.11	0.26	0.38	0.36	0.04	0.44	0.18	0.09
Beef and veal	1	0.08	0.47	0.21	0.49	0.24	0.12	0.12	0.24	0.17	0.28	0.24	**0.01**	**0.04**	0.31	0.23	0.93	0.10	0.83
	2	**0.02**	**0.01**	**0.01**	**0.02**	0.16	0.10	0.20	0.14	0.14	0.23	0.19	**0.00**	**0.03**	0.21	0.82	0.75	0.55	0.33
	3	**0.03**	**0.04**	**0.05**	0.13	0.26	0.11	0.35	0.17	0.17	0.19	0.18	**0.01**	**0.03**	0.24	0.79	0.95	0.18	0.33
Pork	1	**0.04**	**0.03**	**0.03**	0.13	0.18	0.82	0.55	0.52	0.39	0.50	0.06	0.19	**0.01**	**0.00**	0.48	0.26	0.42	0.49
	2	0.07	0.12	0.14	0.32	0.36	0.59	0.74	0.68	0.65	0.64	0.12	0.08	**0.00**	**0.00**	0.56	0.21	0.34	0.58
	3	0.10	0.12	0.12	0.27	0.36	0.87	0.79	0.72	0.61	0.62	0.15	0.30	**0.02**	**0.00**	0.18	0.42	0.34	0.51
Other meats	1	0.68	0.65	0.58	0.58	0.56	0.31	0.32	0.19	0.15	0.14	0.31	0.38	0.26	0.15	**0.04**	**0.02**	0.21	0.77
	2	0.85	0.39	0.34	0.34	0.34	0.41	0.36	0.33	0.33	0.30	0.83	0.75	0.58	0.32	**0.05**	**0.02**	0.19	0.26
	3	0.67	0.29	0.14	0.14	0.13	0.49	0.13	0.33	0.29	0.26	0.76	0.69	0.49	0.32	0.06	0.05	0.21	0.61
Poultry	1	0.18	0.71	0.67	0.76	0.63	0.69	0.81	0.35	—	0.35	0.35	0.34	0.35	0.17	0.19	0.13	0.24	0.20
	2	0.33	0.32	0.32	0.27	0.30	0.44	0.49	0.33	—	—	—	0.33	0.33	0.31	0.32	0.30	0.32	0.35
	3	0.33	0.32	0.31	0.18	0.31	0.48	0.20	0.33	—	—	—	0.33	0.33	0.31	0.32	0.11	0.13	0.35
Fish and seafood	1	**0.01**	0.37	0.12	0.13	**0.02**	**0.05**	0.93	0.81	0.37	0.39	0.37	0.99	1.00	0.82	0.68	0.88	0.59	0.78
	2	0.28	**0.04**	0.15	0.13	0.25	0.21	0.86	0.34	0.50	0.39	0.23	0.92	0.83	0.67	0.91	0.69	0.33	0.65
	3	0.08	**0.05**	0.07	0.08	0.20	0.16	0.30	0.21	0.34	0.44	0.35	0.98	0.93	0.86	0.17	0.74	0.36	0.20
Eggs	1	0.18	0.64	0.18	0.41	**0.02**	**0.05**	0.13	**0.02**	**0.00**	0.19	**0.03**	0.15	0.42	0.61	0.17	0.30	0.19	0.85
	2	0.39	0.35	0.47	0.14	0.10	0.28	0.14	0.09	**0.00**	**0.05**	**0.02**	0.06	0.12	0.33	0.24	0.11	0.19	0.36
	3	0.25	0.35	0.50	0.11	0.10	0.28	0.15	0.09	**0.00**	0.06	**0.02**	0.06	0.12	0.23	0.20	0.13	0.23	0.52

	Inst	Horizon																	
		18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1
Dairy products	1	0.44	0.35	0.26	0.22	0.31	0.35	—	—	0.35	0.35	0.36	0.81	0.26	0.17	0.74	0.74	0.74	0.74
	2	0.24	0.41	0.41	0.50	0.34	—	—	—	0.38	—	0.34	0.85	0.45	0.36	0.33	0.33	0.40	0.34
	3	0.16	0.40	0.45	0.50	0.34	—	—	—	0.38	—	0.34	0.80	0.43	0.30	0.33	0.33	0.34	0.33
Fats and oils	1	0.89	0.54	0.09	**0.02**	0.85	0.86	0.38	0.93	0.64	0.92	0.79	0.80	0.72	0.35	0.74	0.70	0.26	0.06
	2	0.96	0.68	0.10	**0.02**	0.98	0.92	0.87	0.44	0.71	0.80	0.70	0.56	0.44	0.29	0.57	0.64	0.81	0.17
	3	0.97	0.13	0.10	**0.02**	0.59	0.65	0.67	0.29	0.64	0.97	0.79	0.43	0.31	0.07	0.25	0.54	0.85	0.19
Fruits and vegetables	1	0.71	0.48	0.96	0.56	0.24	0.77	0.86	0.69	0.05	0.81	0.77	0.95	0.25	0.98	0.98	0.91	0.37	0.74
	2	0.69	0.93	0.94	0.94	0.76	0.76	0.97	0.75	0.04	0.80	0.83	0.61	0.16	0.99	1.00	0.99	0.31	0.42
	3	0.76	0.68	0.83	0.84	0.63	0.70	0.94	0.89	0.07	0.97	0.92	0.91	0.25	0.99	0.99	0.97	0.41	0.40
Fresh fruits and vegetables	1	0.91	0.67	0.50	0.62	0.31	0.59	0.66	0.93	0.28	0.49	0.61	0.78	0.37	0.66	0.41	0.75	0.86	0.15
	2	0.37	0.34	0.33	0.36	0.19	0.25	0.26	0.18	0.10	0.44	0.34	0.23	0.76	0.70	0.46	0.80	0.93	0.26
	3	0.81	0.34	0.33	0.34	0.19	0.31	0.37	0.37	0.15	0.94	0.50	0.56	0.90	0.62	0.46	0.30	0.19	0.27
Fresh fruits	1	0.30	0.47	0.62	0.81	0.69	0.72	0.64	0.52	0.17	0.40	0.76	0.88	0.34	0.28	0.22	0.36	0.39	0.40
	2	0.11	0.14	0.20	0.33	0.09	0.15	0.12	0.13	0.33	0.33	0.59	0.95	0.28	0.84	0.69	0.49	0.20	0.30
	3	0.35	0.26	0.74	0.69	0.38	0.53	0.43	0.39	0.42	0.50	0.68	0.95	0.24	0.79	0.83	0.46	0.19	0.56
Fresh vegetables	1	—	0.35	0.35	0.35	0.18	0.70	0.55	0.65	0.53	0.33	0.34	0.61	—	0.35	0.35	0.28	0.73	0.50
	2	—	—	—	0.33	0.34	0.56	0.33	0.39	0.34	0.38	0.28	0.33	—	—	—	0.19	**0.05**	0.72
	3	—	—	—	0.33	0.34	0.77	0.36	0.39	0.33	0.34	0.28	0.33	—	—	—	0.29	0.35	0.66
Processed fruits and vegetables	1	0.54	0.59	0.69	0.80	0.80	0.87	0.96	0.75	0.99	0.68	0.57	0.91	0.47	0.54	0.54	0.19	0.13	**0.04**
	2	0.09	0.10	0.26	0.11	0.52	0.69	0.78	0.09	0.09	**0.05**	0.13	0.63	0.15	0.45	0.45	0.21	**0.04**	0.07
	3	0.23	**0.02**	**0.01**	**0.04**	**0.03**	0.09	0.09	**0.01**	**0.01**	**0.02**	**0.04**	**0.05**	0.27	0.33	0.33	0.21	0.26	0.09
Sugar and sweets	1	0.37	0.78	0.49	0.36	0.35	0.38	0.59	0.31	0.94	0.19	0.13	0.91	0.91	0.90	0.49	0.46	0.25	0.04
	2	0.18	0.34	0.35	—	0.38	0.32	0.42	0.07	0.97	0.61	0.32	0.44	0.40	0.37	0.36	0.37	0.32	0.09
	3	—	0.34	0.36	—	0.47	0.41	0.57	0.07	0.81	0.65	0.26	0.23	0.27	0.14	0.22	0.25	0.30	0.09
Cereals and bakery products	1	0.11	0.30	0.36	**0.04**	0.25	0.16	0.35	0.51	0.99	0.85	0.59	0.40	0.34	0.38	0.37	0.35	0.33	0.26
	2	**0.01**	0.37	0.43	0.08	0.50	0.30	0.41	0.43	0.53	0.48	0.44	0.42	0.42	0.58	0.55	0.51	0.34	0.46
	3	**0.05**	0.38	0.45	0.09	0.51	0.40	0.41	0.48	0.89	0.75	0.62	0.40	0.28	0.56	0.51	0.49	0.51	0.37
Nonalcoholic beverages	1	0.07	**0.00**	0.39	0.92	0.96	0.94	0.84	0.82	0.67	0.72	0.78	0.89	0.09	**0.05**	0.50	0.16	0.06	0.12
	2	**0.02**	**0.01**	0.61	0.98	0.99	0.99	0.92	0.97	0.77	0.79	0.75	0.47	0.06	**0.03**	0.73	0.32	0.14	**0.04**
	3	0.10	**0.01**	0.54	0.88	0.85	0.87	0.85	0.62	0.84	0.59	0.93	0.98	0.20	0.12	0.48	0.12	0.08	0.06
Other foods	1	**0.03**	0.20	0.12	0.08	**0.01**	0.09	0.35	0.33	0.18	0.20	0.49	0.07	0.09	**0.03**	0.17	0.19	0.27	0.34
	2	**0.01**	**0.02**	**0.01**	**0.00**	**0.00**	**0.04**	0.07	0.12	0.08	0.32	**0.04**	**0.02**	**0.03**	0.11	0.31	0.33	0.33	0.31
	3	**0.02**	**0.03**	**0.01**	**0.01**	**0.02**	0.10	0.32	0.15	0.22	0.16	0.22	**0.03**	0.07	0.22	0.33	0.33	0.33	0.20

Figure 3: Rationality Test p-values, 2004 – 2022



5 Conclusions

ERS's food price inflation forecasts are important source of information on U.S. retail food price changes and used by researchers, policymakers, food industry professionals, and the media (Kuhns et al., 2015). Despite their widespread use, the forecasts have not been rigorously evaluated. We apply Dimitriadis et al. (2019) joint test forecast rationality (bias and efficiency) to ERS's 22 price series across 18 horizons from 2004 through 2022.

We find that rationality cannot be rejected for a large number of series across all or most horizons. Thus, the forecast generally provides good predictions of observed retail food price changes. It should be noted that, despite this performance, the forecast approach for the series examined has been retired by USDA's Economic Reseach Service (MacLachlan et al., 2022).

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