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FORECASTING U.S. HOUSING STARTS UNDER ASYMMETRIC LOSS

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Zusammenfassung/ Abstract

Survey data of forecasts of the housing market may provide a particularly rich data environment for researchers and policymakers to study developments in housing markets. Based on the approach advanced by Elliott et al. (Rev. Ec. Studies. 72, 1197-1125, 2005), we studied the properties of a large set of survey data of housing starts in the United States. We document the heterogeneity of forecasts, analyze the shape of forecasters' loss function, study the rationality of forecasts, and the temporal variation in forecasts.

JEL-Klassifikation / JEL-Classification: D84

Schlagworte / Keywords: Housing starts; Loss function; Rationality of forecasts

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1 Introduction

The recent economic and financial crisis has witnessed that developments in the housing market may have the potential to accelerate macroeconomic fluctuations. Developments in the housing market also may be interlinked to changes in the pricing of risk and concerns about market illiquidity (Fender and Scheicher 2009, Sarmiento 2009). A key question for policymakers and investors thus is whether it is possible to forecast developments in housing markets. Survey data of forecasts of the housing market may provide a particularly rich data environment to study this question. Before policymakers and investors should use survey data of forecasts of the housing market to address important policy questions or to solve difficult asset-allocation problems, however, it is necessary to deepen our knowledge of the key properties of such survey data. In this paper, we study the properties of a large set of survey data comprising more than 4,000 forecasts of housing starts in the United States, where the sample period runs from 1989 to 2010 and thus covers more than twenty years of data. The properties of the survey data we focus at the question whether forecasts of housing starts are unbiased and rational.

In earlier literature, it has been common practice among researchers to study the unbiasedness and rationality of forecasts by assuming that forecasters have a symmetric (quadratic) loss function (Ito 1990). Recent literature (Elliott et al. 2005) has questioned this assumption as evidence is mounting

that forecasters often form their forecasts under an asymmetric loss function. Under an asymmetric loss function, the loss forecasters incur when they underestimate housing starts is not identical to the loss they incur when they overestimate housing starts by the same amount. If one maintains the assumption of a symmetric loss function when forecasters, in fact, have an asymmetric loss function, one is likely to conclude erroneously that forecasts show systematic biases and deviations from rationality. In order to account for the insights of the recent literature on forecasting under an asymmetric loss function, we applied the approach advanced by Elliott et al. (2005) to study the properties of forecasts of housing starts. Their approach is easy to implement, it informs about the type of a potential asymmetry in forecasters' loss function, and it allows the rationality of forecasts under an asymmetric loss function to be tested.

While much significant empirical research on asymmetric loss functions has been done in earlier literature (Batchelor and Peel 1999, Elliott et al. 2008, to name just a few), the insights of this research have not been applied, to the best of our knowledge, to the study of forecasts of housing starts.¹ Our research thus closes a significant gap in earlier literature. The main results of our research can be summarized as follows. We find a substantial degree of heterogeneity across forecasters with respect to the shape of their loss

¹See Cain and Janssen (1995) for an early study of predicting real estate prices under asymmetric loss. See Skitmore et al. (2007) for an analysis of asymmetric loss functions for construction-price forecasting.

function. While some forecasters seem to forecast under a symmetric loss function, the symmetry assumption cannot be retained for other forecasters. As a general tendency, it seems that, when we use the full sample of data, overpredictions of housing starts cause a higher loss than underpredictions. We observe this general tendency for short-term forecasts with a forecasting horizon of up to six months, and for long-term forecasts with a forecasting horizon of up to one year. Allowing for an asymmetric loss function often allows the hypothesis of rationality of forecasts of housing starts not to be rejected, especially for short-term forecasts. We also show that our results hold for alternative asymmetric loss function (so called lin-lin and quad-quad functions). Finally, we show that when we pool our survey data across forecasters, the asymmetry parameter shows, at the aggregate level, a tendency to increase during our sample period. This increase may reflect that forecasters did not want to miss the upswing of housing starts in the first half of the sample period, and that they became increasingly skeptical about the sustainability of the upswing in the second half of the sample period.

We organize the remainder of our analysis as follows. In Section 2, we briefly sketch the approach developed by Elliott et al. (2005). In Section 3, we summarize our empirical analysis. In Section 4, we offer some concluding remarks.

2 Theoretical Background

The approach developed by Elliott et al. (2005) rests on the assumption that the loss function, \mathcal{L} , of forecasters can be described in terms of the following general functional form:

$$\mathcal{L} = [\alpha + (1 - 2\alpha)I(s_{t+1} - f_{t+1} < 0)]|s_{t+1} - f_{t+1}|^p, \quad (1)$$

where s_{t+1} (f_{t+1}) reflects the (period- t forecast of) housing starts in period $t + 1$ and I reflects an indicator function. For $p = 1$, Equation (1) refers to a linear-linear (lin-lin) loss function and for $p = 2$ to a quadratic-quadratic (quad-quad) loss function. The parameter $\alpha \in (0, 1)$ governs the degree of asymmetry of the loss function. The general functional form given in Equation (1) implies that, in the case of $\alpha = 0.5$, the loss function is symmetric. The standard symmetric quadratic loss function obtains for $\alpha = 0.5$ and $p = 2$. In this case, the loss forecasters incur increases in the squared forecast error. For $\alpha = 0.5$ and $p = 1$, the loss increases in the absolute forecast error.

Elliott et al. (2005) show that, given the general functional form of the loss function (as defined in terms of the parameter p), the asymmetry parameter, α , can be consistently estimated as

$$\hat{\alpha} = \frac{\gamma'_1 \hat{S}^{-1} \gamma_2}{\gamma'_1 \hat{S}^{-1} \gamma_1}, \quad (2)$$

where $\hat{\alpha}$ denotes the estimate, and where we define

$$\gamma_1 = \frac{1}{T} \sum_{t=\tau}^{T+\tau-1} v_t |s_{t+h} - f_{t+h}|^{p-1} \quad (3)$$

and

$$\gamma_2 = \frac{1}{T} \sum_{t=\tau}^{T+\tau-1} v_t I(s_{t+h} - f_{t+h} < 0) |s_{t+h} - f_{t+h}|^{p-1}, \quad (4)$$

and the vector of instruments, v_t , is used to estimate a weighting matrix given by $\hat{S} = \frac{1}{T} \sum_{t=\tau}^{T+\tau-1} v_t v_t' (I(s_{t+1} - f_{t+1} < 0) - \hat{\alpha})^2 |s_{t+1} - f_{t+1}|^{2p-2}$, and $I(\cdot)$ denotes the indicator function, and T denotes the number of forecasts available, starting in period $\tau + 1$. When the weighting matrix depends on $\hat{\alpha}$, estimation is done iteratively. We consider a constant (Model 1), and a constant and the lagged housing starts (Model 2) as instruments.²

Testing whether $\hat{\alpha}$ differs from α_0 is done by using the following z-test $\sqrt{T}(\hat{\alpha} - \alpha_0) \rightarrow \mathcal{N}(0, (\hat{h}' \hat{S}^{-1} \hat{h})^{-1})$, where $\hat{h} = \frac{1}{T} \sum_{t=\tau}^{T+\tau-1} v_t |s_{t+1} - f_{t+1}|^{p-1}$. Elliott et al. (2005) further prove that a test for rationality of forecasts, given a loss function of the lin-lin or a quad-quad type ($p = 1, 2$), can be performed by computing

$$J(\hat{\alpha}) = \frac{1}{T} \left(x_t' \hat{S}^{-1} x_t \right) \sim \chi_{d-1}^2, \quad (5)$$

²Elliott et al. (2005) suggest to use the lagged forecast error as an additional instrument. We do not use the lagged forecast error as an instrument because our survey data consists of an unbalanced panel of forecasts of housing starts.

where $x_t = \sum_{t=\tau}^{T+\tau-1} v_t [I(s_{t+1} - f_{t+1} < 0) - \hat{\alpha}] |s_{t+1} - f_{t+1}|^{p-1}$ and d denotes the number of instruments. In the case of a symmetric loss function, the rationality test is given by $J(0.5) \sim \chi_d^2$. The statistic $J(0.5)$ answers the question of whether forecasters under the maintained assumption of a symmetric loss function form rational forecasts of housing starts. The statistic $J(\hat{\alpha})$, answers the question of whether forecasters form rational forecasts of housing starts, given an estimated asymmetric loss function of the lin-lin or quad-quad functional form. A comparison of $J(\hat{\alpha})$ with $J(0.5)$ shows whether an asymmetric loss function helps to remedy a potential failure of rationality of forecasts of housing starts observed under a symmetric loss function.

3 Empirical Analysis

We start with a description of our data (Subsection 3.1). We then present estimates of the asymmetry parameter, $\hat{\alpha}$, for short-term forecasts (Subsection 3.2) and document the results of tests for forecast rationality (Subsection 3.3). Finally, we summarize the results we obtained for longer-term forecasts (Subsection 3.4) and present rolling-window estimates (Subsection 3.5).

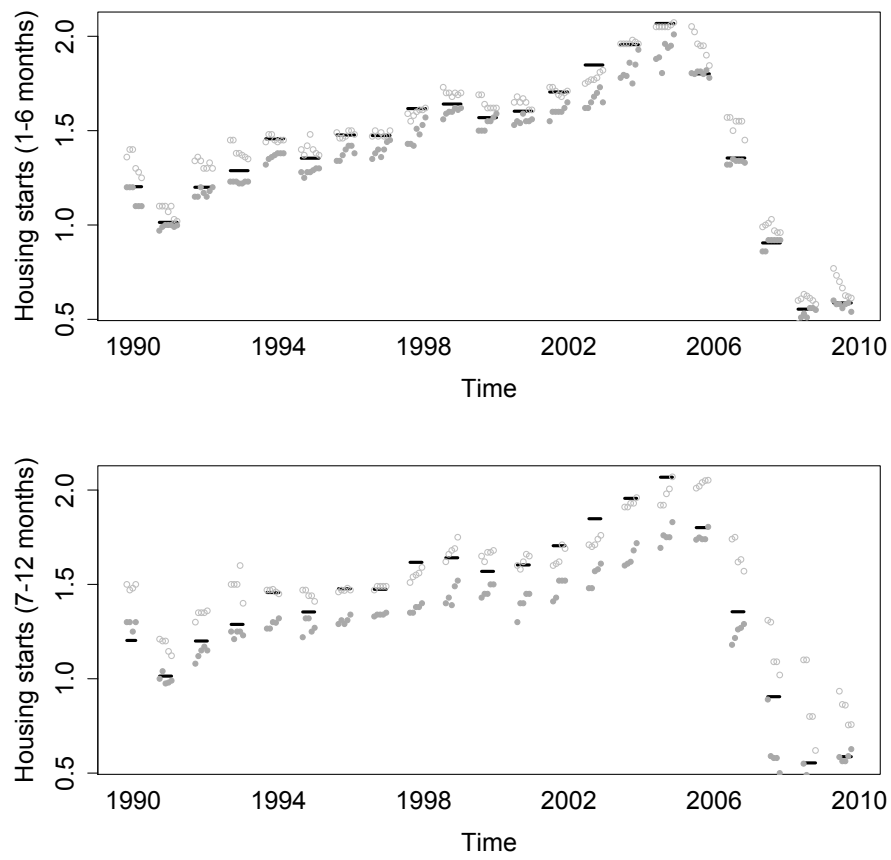
3.1 The Data

Monthly survey data of forecasts of housing starts are available from Consensus Economics. The sample period ranges from January 1989 to December 2010. We analyze survey data comprising short-term forecasts with a forecast horizon of 1 to 6 months, and longer-term forecasts with a forecast horizon of 7 to 12 months. The survey data are unbalanced because not all forecasters participated in all surveys. In our empirical analysis we considered only those forecasters who made at both forecasting horizons at least 50 forecasts which applies to 32 forecasters providing more than 4,000 forecasts of housing starts in the United States.

Figure 1 plots the actual housing starts and the cross-sectional range of forecasts for the two different forecasting horizons.³ The solid horizontal lines represent actual housing starts, the light circles represent the maximum of the cross-section of forecasts, and the solid circles denote the minimum of the cross-section of forecasts. The cross-sectional range of forecasts is defined as the maximum forecast of housing starts in a given forecasting cycle minus the minimum forecast of housing starts in the same forecasting cycle. Housing starts witnessed a substantial boom-bust cycle during our sample period, where the peak of about 2 million housing starts was reached just before the recent economic and financial crisis in 2005. The cross-sectional

³All figures and all computations were implemented using the software R (R Development Core Team 2012).

Figure 1: Actual and Expected Housing Starts (in mn units)



Note: The solid horizontal lines represent actual housing starts (in mn. units), the light circles represent the maximum of the cross-section of forecasts, and the solid circles denote the minimum of the cross-section of forecasts.

range of forecasts shows that forecasts scattered around actual housing starts, where the range of forecasts tended to increase in the forecasting horizon. The apparent cross-sectional range of forecasts implies that differences in the shape of forecasters loss function may be one source of cross-sectional heterogeneity.⁴

3.2 Estimates of the Asymmetry Parameter

Table 1 summarizes, for every forecaster, the estimates of the asymmetry parameter, $\hat{\alpha}$, the corresponding standard error, and the z-test of the null hypothesis $\hat{\alpha} = \alpha_0 = 0.5$. The loss function is of the lin-lin form, and the forecasts belong to the category of short-term forecasts. Table 2 summarizes the results for the quad-quad loss function. We present results for short-term forecasts with a forecasting horizon of 1 to 6 months. The results for longer-term forecasts with a forecasting horizon of 7 to 12 months are similar (not reported, but available upon request; see also Figure 2).

Our estimates reveal a substantial degree of heterogeneity across forecasters with respect to the shape of their loss function. While eleven forecasters

⁴The kind of cross-sectional scattering of forecasts as illustrated in Figure 1 has been analyzed also in earlier empirical studies of, for example, exchange-rate forecasts (e.g., Benassy-Quere et al. 2003) and forecasts of inflation rates (e.g., Capistrán and Ramos-Francia 2010). Capistrán and Timmermann (2009) study the link between the cross-sectional range of forecasts and the asymmetry of forecasters' loss functions in their study of inflation forecasts.

Table 1: Asymmetry parameter, lin-lin loss function, forecasting horizon 1–6 months

No.	Obs.	Model 1			Model 2		
		$\hat{\alpha}$	se	z-test	$\hat{\alpha}$	se	z-test
1	54	0.3889	0.0663	-1.6749	0.3037	0.0626	-3.1360
2	75	0.4667	0.0576	-0.5786	0.4660	0.0576	-0.5897
3	66	0.3182	0.0573	-3.1713	0.3098	0.0569	-3.3410
4	92	0.3152	0.0484	-3.8148	0.2922	0.0474	-4.3830
5	53	0.4151	0.0677	-1.2545	0.3865	0.0669	-1.6971
6	62	0.2581	0.0556	-4.3536	0.2467	0.0547	-4.6263
7	129	0.3721	0.0426	-3.0055	0.3629	0.0423	-3.2384
8	122	0.4180	0.0447	-1.8355	0.4121	0.0446	-1.9734
9	101	0.3663	0.0479	-2.7881	0.3626	0.0478	-2.8732
10	140	0.3857	0.0411	-2.7780	0.3758	0.0409	-3.0333
11	122	0.3443	0.0430	-3.6205	0.3337	0.0427	-3.8961
12	81	0.4198	0.0548	-1.4634	0.4080	0.0546	-1.6847
13	52	0.5577	0.0689	0.8376	0.6216	0.0673	1.8083
14	75	0.4933	0.0577	-0.1155	0.4918	0.0577	-0.1423
15	68	0.3382	0.0574	-2.8195	0.3292	0.0570	-2.9965
16	87	0.5057	0.0536	0.1072	0.5061	0.0536	0.1140
17	117	0.3504	0.0441	-3.3910	0.3430	0.0439	-3.5776
18	64	0.4375	0.0620	-1.0079	0.4273	0.0618	-1.1762
18	72	0.5139	0.0589	0.2358	0.5155	0.0589	0.2625
20	116	0.3879	0.0452	-2.4771	0.3768	0.0450	-2.7388
21	124	0.3548	0.0430	-3.3784	0.3445	0.0427	-3.6428
22	52	0.1538	0.0500	-6.9184	0.0060	0.0107	-45.9751
23	108	0.3704	0.0465	-2.7897	0.3672	0.0464	-2.8639
24	108	0.4259	0.0476	-1.5568	0.4259	0.0476	-1.5568
25	86	0.3721	0.0521	-2.4540	0.3623	0.0518	-2.6572
26	76	0.2632	0.0505	-4.6889	0.2616	0.0504	-4.7290
27	95	0.3158	0.0477	-3.8626	0.2959	0.0468	-4.3593
28	111	0.4955	0.0475	-0.0949	0.4952	0.0475	-0.1007
29	78	0.3846	0.0551	-2.0946	0.3401	0.0536	-2.9806
30	108	0.4074	0.0473	-1.9584	0.4048	0.0472	-2.0150
31	123	0.4715	0.0450	-0.6322	0.4681	0.0450	-0.7100
32	121	0.3967	0.0445	-2.3228	0.3949	0.0444	-2.3648

Note: se = standard error, z-test = test of the null hypothesis that $\hat{\alpha} = 0.5$. The instruments used are the following: a constant (Model 1), a constant and lagged housing starts (Model 2).

Table 2: Asymmetry parameter, quad-quad loss function, forecasting horizon 1–6 months

No.	Obs.	Model 1			Model 2		
		$\hat{\alpha}$	se	z-test	$\hat{\alpha}$	se	z-test
1	54	0.4424	0.0816	-0.7049	0.4808	0.0797	-0.2413
2	75	0.5536	0.0729	0.7362	0.5579	0.0704	0.8225
3	66	0.4462	0.0802	-0.6712	0.4433	0.0797	-0.7119
4	92	0.2789	0.0560	-3.9453	0.2532	0.0530	-4.6531
5	53	0.3918	0.0887	-1.2189	0.4171	0.0851	-0.9739
6	62	0.3161	0.0854	-2.1542	0.3044	0.0846	-2.3132
7	129	0.3285	0.0503	-3.4093	0.3317	0.0503	-3.3489
8	122	0.4448	0.0587	-0.9405	0.4529	0.0587	-0.8027
9	101	0.3655	0.0567	-2.3709	0.3657	0.0558	-2.4083
10	140	0.3426	0.0511	-3.0776	0.3101	0.0495	-3.8403
11	122	0.3350	0.0526	-3.1391	0.3188	0.0517	-3.5018
12	81	0.2648	0.0581	-4.0469	0.2207	0.0536	-5.2105
13	52	0.5095	0.0989	0.0964	0.5281	0.0987	0.2849
14	75	0.4390	0.0792	-0.7707	0.4598	0.0728	-0.5523
15	68	0.4345	0.0727	-0.9011	0.3858	0.0702	-1.6261
16	87	0.5488	0.0711	0.6861	0.5519	0.0691	0.7516
17	117	0.2705	0.0484	-4.7407	0.2789	0.0458	-4.8261
18	64	0.3981	0.0804	-1.2669	0.4162	0.0789	-1.0618
19	72	0.5379	0.0749	0.5062	0.5265	0.0747	0.3541
20	116	0.3655	0.0602	-2.2357	0.3692	0.0601	-2.1759
21	124	0.3114	0.0556	-3.3930	0.2812	0.0538	-4.0630
22	52	0.0971	0.0399	-10.1059	0.0077	0.0097	-50.7220
23	108	0.3127	0.0527	-3.5550	0.3120	0.0519	-3.6241
24	108	0.4471	0.0698	-0.7581	0.4577	0.0649	-0.6517
25	86	0.3447	0.0671	-2.3136	0.3538	0.0664	-2.2037
26	76	0.3275	0.0762	-2.2639	0.2528	0.0703	-3.5184
27	95	0.4250	0.0698	-1.0747	0.3767	0.0676	-1.8256
28	111	0.4828	0.0649	-0.2645	0.4902	0.0623	-0.1570
29	78	0.3486	0.0655	-2.3130	0.2735	0.0587	-3.8597
30	108	0.4048	0.0640	-1.4871	0.3965	0.0617	-1.6768
31	123	0.4596	0.0617	-0.6558	0.4678	0.0611	-0.5274
32	121	0.4234	0.0577	-1.3270	0.4221	0.0563	-1.3846

Note: se = standard error, z-test = test of the null hypothesis that $\hat{\alpha} = 0.5$. The instruments used are the following: a constant (Model 1), a constant and lagged housing starts (Model 2).

seem to form forecasts under a symmetric loss function, the shape of the loss function of 21 forecasters appears to be asymmetric, where the estimated asymmetry parameter, $\hat{\alpha}$, tends to be smaller than 0.5. It follows that, for those forecasters who seem to have an asymmetric loss function, the loss in case of a negative forecast error (actual housing starts fall short of the forecast) tends to be larger than the loss in case of a positive forecast error (actual housing starts exceed the forecast) of the same magnitude. We observe this tendency towards a higher loss of overpredictions relative to underpredictions for both the lin-lin loss function and the quad-quad loss function.

3.3 Results of Rationality Tests

Table 3 (for a lin-lin loss function) and Table 4 (for a quad-quad loss function) summarize the results of the $J(0.5)$ and $J(\hat{\alpha})$ tests of forecast rationality, given a loss function. We present results for short-term forecasts with a forecasting horizon of 1 to 6 months. The results for longer-term forecasts with a forecasting horizon of 7 to 12 months are not reported, but are available upon request (see also Figure 3).

Rationality of forecasters cannot be rejected under a symmetric loss function of the quadratic (linear) type in case of 11 (8) forecasters (5 % level of significance). For those forecasters whose forecasts appear to violate the

Table 3: J-test, lin-lin loss function, forecast horizon 1–6 months

No.	Obs.	$J_2(0.5)$	p-value	$J_2(\hat{\alpha})$	p-value
1	54	17.3721	0.0002	13.5650	0.0002
2	75	1.0583	0.5891	0.6989	0.4031
3	66	10.2152	0.0061	1.4712	0.2252
4	92	17.4596	0.0002	5.3333	0.0209
5	53	9.4252	0.0090	6.8620	0.0088
6	62	16.5424	0.0003	1.4323	0.2314
7	129	14.1434	0.0008	4.3711	0.0366
8	122	8.1731	0.0168	4.1612	0.0414
9	101	8.9532	0.0114	1.3940	0.2377
10	140	14.3630	0.0008	5.6289	0.0177
11	122	16.8402	0.0002	3.9437	0.0470
12	81	8.4942	0.0143	5.2198	0.0223
13	52	11.2471	0.0036	14.5694	0.0001
14	75	7.2194	0.0271	7.0715	0.0078
15	68	9.6436	0.0081	1.8164	0.1777
16	87	2.5515	0.2792	2.5726	0.1087
17	117	14.1964	0.0008	2.7997	0.0943
18	64	5.9999	0.0498	4.5296	0.0333
19	72	3.6475	0.1614	3.6565	0.0559
20	116	11.6759	0.0029	5.3123	0.0212
21	124	15.1717	0.0005	4.1661	0.0412
22	52	27.7382	0.0000	197.0359	0.0000
23	108	8.9912	0.0112	1.3092	0.2525
24	108	2.3726	0.3053	0.0023	0.9621
25	86	9.8593	0.0072	3.1014	0.0782
26	76	17.3091	0.0002	0.2507	0.6166
27	95	17.4616	0.0002	4.8181	0.0282
28	111	3.2377	0.1981	3.2039	0.0735
29	78	20.1821	0.0000	11.5429	0.0007
30	108	5.5329	0.0629	1.4680	0.2257
32	123	7.5314	0.0232	6.7243	0.0095
32	121	6.4004	0.0408	1.0278	0.3107

Note: J_2 , denotes the J -test for Model 2. $J(0.5)$ denotes the J -test under the assumption of a symmetric loss function.

Table 4: J-test, quad-quad loss function

No.	Obs.	$J_2(0.5)$	p-value	$J_2(\hat{\alpha})$	p-value
1	54	12.7760	0.0017	12.7324	0.0004
2	75	0.6966	0.7059	0.0588	0.8084
3	66	0.6172	0.7345	0.0980	0.7543
4	92	16.5128	0.0003	2.3608	0.1244
5	53	2.3407	0.3103	1.3309	0.2486
6	62	5.4435	0.0658	0.6237	0.4297
7	129	10.2392	0.0060	1.3501	0.2453
8	122	7.0556	0.0294	6.2583	0.0124
9	101	5.2837	0.0712	0.0004	0.9833
10	140	15.2409	0.0005	7.5208	0.0061
11	122	12.8974	0.0016	3.6134	0.0573
12	81	15.6134	0.0004	5.7847	0.0162
13	52	1.8666	0.3933	2.0422	0.1530
14	75	0.8162	0.6649	0.5367	0.4638
15	68	8.1283	0.0172	5.4343	0.0197
16	87	0.5835	0.7469	0.0387	0.8441
17	117	15.4469	0.0004	0.3028	0.5821
18	64	2.2264	0.3285	1.2077	0.2718
19	72	4.5671	0.1019	4.9484	0.0261
20	116	5.4403	0.0659	1.3566	0.2441
21	124	14.6386	0.0007	5.5045	0.0190
22	52	25.4457	0.0000	90.0571	0.0000
23	108	10.3360	0.0057	0.0061	0.9376
24	108	0.5947	0.7428	0.1982	0.6561
25	86	5.0922	0.0784	0.7605	0.3832
26	76	11.0525	0.0040	5.1925	0.0227
27	95	8.5024	0.0142	5.1577	0.0231
28	111	0.1880	0.9103	0.1737	0.6768
29	78	16.0187	0.0003	8.4286	0.0037
30	108	2.9922	0.2240	0.2498	0.6172
31	123	1.7878	0.4091	1.3973	0.2372
32	121	1.9112	0.3846	0.0111	0.9160

Note: J_2 , denotes the J -test for Model 2. $J(0.5)$ denotes the J -test under the assumption of a symmetric loss function.

rationality property under a symmetric loss function, switching to an asymmetric loss function often implies that the hypothesis of forecast rationality can no longer be rejected. We also note that, for some forecasters, the hypothesis of forecast rationality cannot be maintained irrespective of whether we assume a symmetric or an asymmetric loss function.

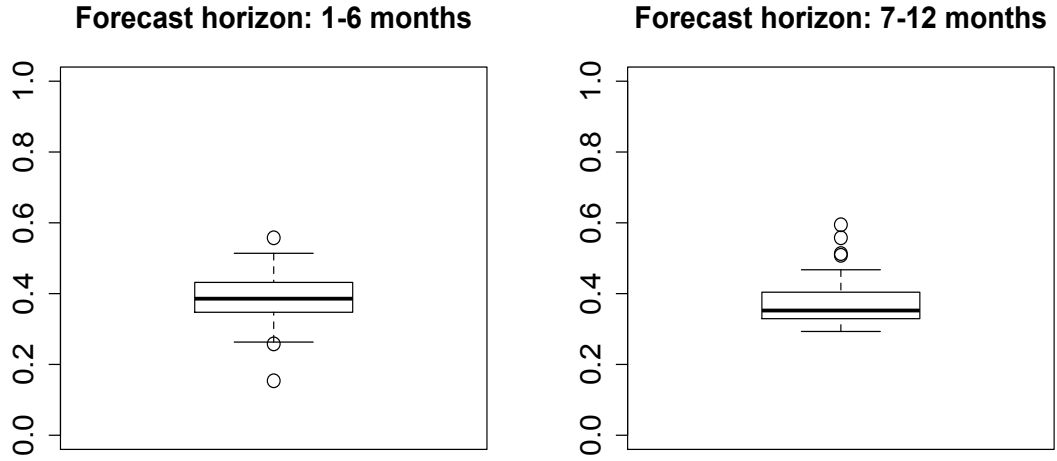
3.4 Longer-Term Forecasts

We now compare the results for short-term forecasts with the results for longer-term forecasts. We first focus on the estimated asymmetry parameter, $\hat{\alpha}$. In the boxplots shown in Figure 2, the boxes contain 50% of the estimates, the solid horizontal lines represent the median over all estimates, and the whiskers show the interquartile range of the estimates. The boxplots illustrate that the results we have derived for short-term forecasts extend to longer-term forecasts. We observe for longer-term forecasts a substantial heterogeneity of the estimated asymmetry parameter, $\hat{\alpha}$. Moreover, we observe a tendency of the estimated asymmetry parameter, $\hat{\alpha}$, to be smaller than 0.5, where this tendency is stronger under a lin-lin loss function than under a quad-quad loss function.

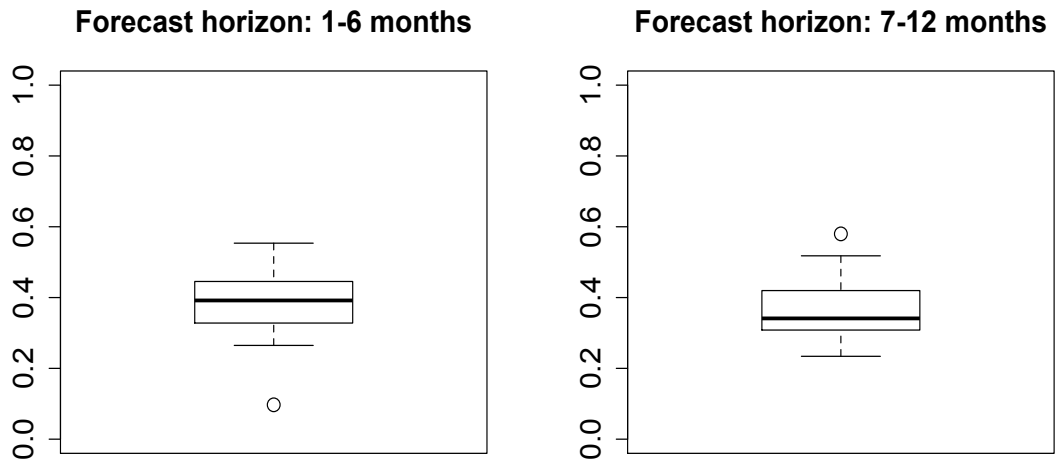
With regard to the $J(\hat{\alpha})$ tests, the boxplots in Figure 3 illustrate that for some forecasters forecasts look rational under an asymmetric loss function. The tendency not to reject rationality of forecasts under an asymmetric loss

Figure 2: Boxplots of the estimated asymmetry parameter

Panel A: Estimates, $\hat{\alpha}$, for a lin-lin loss function



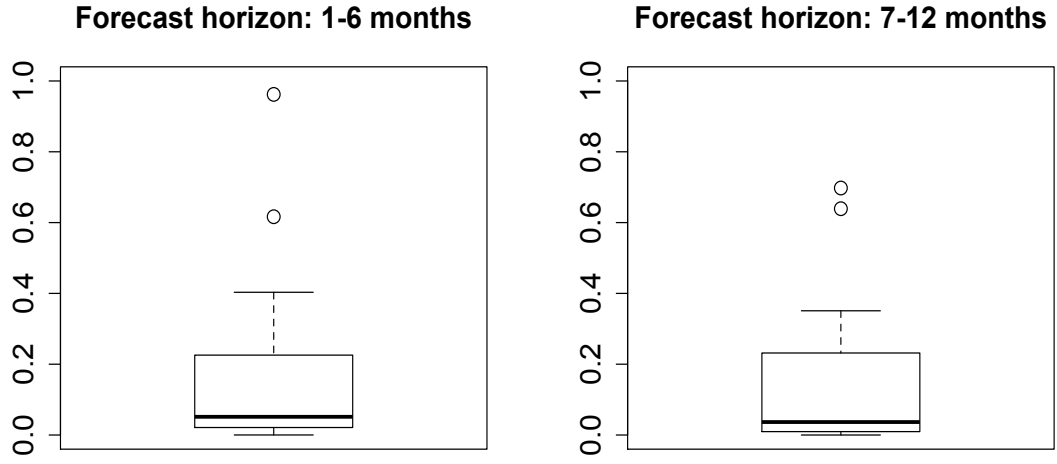
Panel B: Estimates, $\hat{\alpha}$, for a quad-quad loss function



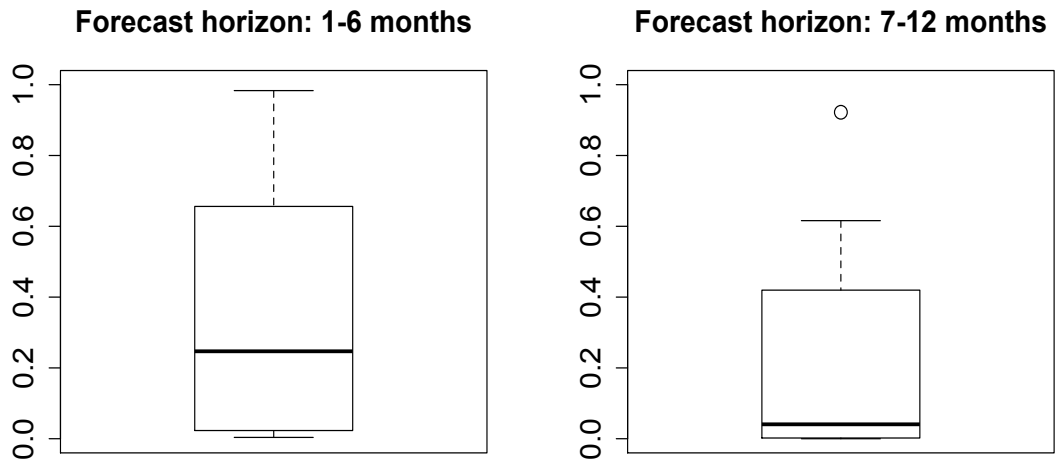
Note: The boxes contain 50% of the estimates, the solid horizontal lines represent the median over all estimates, and the whiskers show the interquartile range of the estimates.

Figure 3: Boxplots of the J -tests of forecast rationality

Panel A: $J(\hat{\alpha})$ tests (p-values) for a lin-lin loss function



Panel B: $J(\hat{\alpha})$ tests p-values for a quad-quad loss function



Note: The boxes contain 50% of the estimates, the solid horizontal lines represent the median over all estimates, and the whiskers show the interquartile range of the estimates.

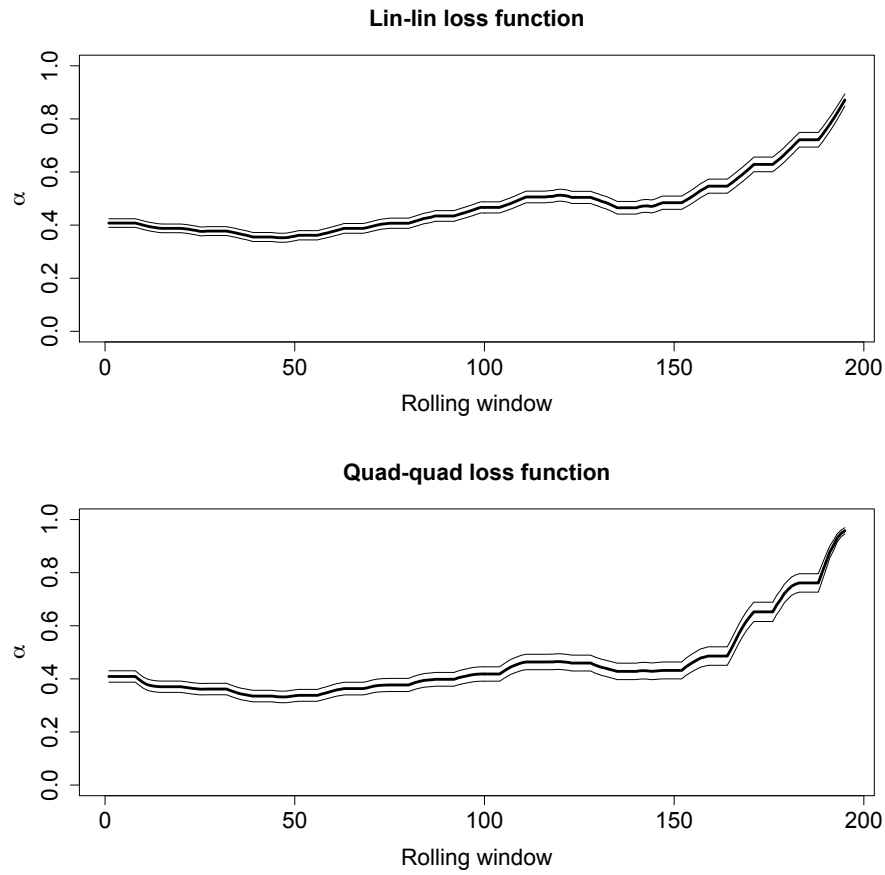
function gets less strong for longer-term forecasts, where a quad-quad loss function seems to provide a stronger case of forecast rationality than a lin-lin loss function.

3.5 Rolling-Window Estimates

The tendency for overpredictions of housing starts to lead to higher costs than underpredictions may reflect that forecasters feared a collapse of housing starts while actual housing starts climbed up until they peaked in 2005. In order to examine this possibility in more detail, we estimated the asymmetry parameter, $\hat{\alpha}$, for five-year rolling-estimation windows of the pooled data. We, thus, started this estimation by pooling the forecasts of all forecasters observed during the first five years of our sample period. We then dropped data for the first month in our sample, and added data for another month at the end of the five year rolling-estimation window. Finally, we moved the rolling-estimation window across our sample period and, thereby, computed a time-series of the asymmetry parameter, $\hat{\alpha}$. We did this for all four categories of forecasts.

Figure 4 summarizes the results. The figure shows the estimated asymmetry parameter, $\hat{\alpha}$, along with the corresponding confidence bands ($\pm 2 \times$ standard errors, thin lines). The figure plots the results for 1–6 months forecasts. The results imply that the estimated asymmetry parameter, $\hat{\alpha}$, was relatively

Figure 4: Rolling-window estimates



Note: The rolling-window estimates are based on forecasts for 1–6 months. The solid line shows the aggregate asymmetry parameter, $\hat{\alpha}$, estimated on five year rolling-estimation windows. The thin demarcation lines represent the boundaries of the confidence interval.

stable, at the aggregate level at the beginning of the sample period. Then, however, the estimated asymmetry parameter, $\hat{\alpha}$, started to increase as we moved the rolling-estimation window across our sample period. Underestimations of housing starts, thus, were more costly at the macro level than overpredictions at the beginning of the sample period, while overestimations become more and more costly in the second half of the sample period. It, thus, seems that forecasters did not want to miss the upswing in housing starts in the first half of the sample period, and that they became increasingly skeptical regarding the sustainability of the upswing in the second half of the sample period.

4 Concluding Remarks

Based on a large set of survey data of housing starts in the United States, we have analyzed the heterogeneity of forecasts, the shape of forecasters' loss function, the rationality of forecasts, and the temporal variation in forecasts at the aggregate level. The heterogeneity of forecasts of housing starts is substantial, and differences in the shape of forecasters loss functions may account at least in part for this heterogeneity. Accounting for an asymmetric loss function has the potential to make forecasts look rational in some, but not in all cases. Finally, shifts in the asymmetry parameter observed at the aggregate level seem to reflect changes in overall market conditions.

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