CAN HETEROGENEOUS EXPECTATIONS NEW KEYNESIAN MODELS MATCH THE DISPERSION OF SURVEY FORECASTS?

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Abstract. This paper estimates a Heterogeneous Expectations New Keynesian model to assess its ability to capture the dispersion of expectations observed in surveys. We use realized macroeconomic data and survey data on expectations in the estimation, exploiting both first moments (mean forecasts) and second moments (the cross-sectional forecast dispersion) as observables.

The results reveal reasonable correlations between the model-implied and observed dispersion series. However, the model significantly overestimates the magnitude and volatility of disagreement compared with their levels in survey forecasts.

Keywords: Heterogeneous Expectations in New Keynesian Model, Bounded Rationality, Disagreement in Survey Data, Cross-Sectional Forecast Dispersion, SPF.
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1. Introduction

Traditional New Keynesian models typically rely on two restrictive assumptions about expectations: first, that agents form rational expectations, and second, that expectations are homogeneous across all agents, precluding any role for disagreement.

An extensive body of research, however, shows that these restrictions are often at odds with the data. Several studies document systematic biases in the formation of observed survey expectations that are inconsistent with the rational expectations hypothesis (e.g., Lovell (1986), for an older survey, or Coibion and Gorodnichenko (2015), for more recent results). Moreover, a growing literature highlights the importance of accounting for the heterogeneity in agents' forecasts.[1]

To address these limitations, Branch and McGough (2009) develop the Heterogeneous Expectations New Keynesian (HENK) model. The model extends the New Keynesian framework to incorporate agents who form expectations heterogeneously: a proportion forms expectations rationally, while the rest adopt boundedly-rational expectations, which can be adaptive, naïve, or extrapolative, depending on parameter values.

The HENK model fits macroeconomic data better than the alternative under homogeneous expectations (e.g., Ilabaca and Milani (2021), Elias (2022)), it has stronger internal propagation properties (Branch and McGough (2011)), and it carries implications for the conduct of monetary policy (Gasteiger (2014, 2021), Di Bartolomeo et al. (2016), Beqiraj et al. (2019), Özden (2025)).

This paper estimates a HENK model using U.S. real-time macroeconomic data and survey expectations to empirically study whether this framework can match the level of forecast dispersion observed in survey data. This is the paper's main contribution to the literature, since estimations of HENK models do not include expectational data, or focus only on mean survey forecasts.[2]

The empirical results show the importance of accounting for deviations from rational expectations: almost half of the agents form boundedly-rational expectations about output and two thirds form non-rational expectations about inflation. In both cases, forecasts are characterized by adaptive behavior.

Turning to the main question of the paper, we find that the HENK model can go some extent toward matching the dynamics of dispersion: the correlations between model-implied and survey-based series are in the 0.3-0.4 range. But the model implies a forecast dispersion that is exceedingly large and far too volatile compared to the data. Therefore, our findings highlight some

[1]See for instance, Mankiw et al. (2004), Carroll (2003) and Branch (2004, 2007) who analyze the role of heterogeneous expectations and disagreement. The heterogeneity in expectations has also been documented on data from laboratory experiments, as in Hommes (2011).

[2]For general reviews on the use of survey data, see Pesaran and Weale (2006), Clements et al. (2023), and Milani (2023).

potential limitations of HENK models in capturing the heterogeneity of expectations, which should be addressed in future research.

2. Model

We use a New Keynesian model with heterogeneous expectations (e.g., Branch and McGough (2009) and Gasteiger (2021)) to describe the aggregate dynamics of the economy. The log-linearized equations are given by:

$$y_t = \tilde{E}_t y_{t+1} - \sigma^{-1}(i_t - \tilde{E}_t \pi_{t+1}) + g_t \tag{1}$$

$$\pi_t = \beta \tilde{E}_t \pi_{t+1} + \kappa y_t + u_t \tag{2}$$

$$i_t = \rho_i i_{t-1} + (1-\rho_i)(\psi_\pi \pi_t + \psi_y y_t) + \varepsilon_t \tag{3}$$

$$g_t = \rho_g g_{t-1} + \varepsilon_t^g \tag{4}$$

$$u_t = \rho_u u_{t-1} + \varepsilon_t^u. \tag{5}$$

Equation (1) represents the Euler equation, which expresses the output gap, y_t, as a function of its one-period-ahead expectation, the real interest rate, and a demand shock, g_t; the parameters σ and β denote the inverse of the intertemporal elasticity of substitution and the discount factor. Equation (2) describes the new Keynesian Phillips Curve: current inflation, π_t, is affected by expected inflation, the output gap, and the cost-push shock, u_t. The composite coefficient κ negatively depends on the degree of Calvo price stickiness ξ_p as $\kappa \equiv \frac{(1-\xi_p)(1-\xi_p\beta)}{\xi_p}\frac{(\omega+\sigma)}{(1+\omega\epsilon)}$.[3] The disturbances g_t and u_t follow AR(1) processes. Finally, monetary policy is characterized by the Taylor rule in Equation (3), where i_t denotes the short-term nominal interest rate, ρ_i, ψ_π, and ψ_y are monetary reaction coefficients, and ε_t is an *i.i.d.* monetary shock.

The main deviation from a baseline NK model is that the economy has two types of agents who differ in how they form expectations. A proportion n_j of agents forms conventional rational expectations, E_t, and the rest, $(1-n_j)$, form subjective expectations, $\hat{E}_t$.[4] Aggregate expectations are, therefore, given by:

$$\tilde{E}_t y_{t+1} = n_y E_t y_{t+1} + (1-n_y)\hat{E}_t y_{t+1} \tag{6}$$

$$\tilde{E}_t \pi_{t+1} = n_\pi E_t \pi_{t+1} + (1-n_\pi)\hat{E}_t \pi_{t+1}. \tag{7}$$

[3]The remaining parameters ω and ϵ denote the sensitivity of output to real marginal costs and the steady-state elasticity of substitution across differentiated goods, respectively.

[4]We allow the proportions of rational/non-rational agents to differ in the formation of inflation or output expectations; therefore, we have $j = \pi, y$. In the robustness section, we check the results when imposing equal shares.

Boundedly-rational expectations $\hat{E}_t$ are formed as:

$$\hat{E}_t y_{t+1} = \theta_y^2 y_{t-1} \tag{8}$$

$$\hat{E}_t \pi_{t+1} = \theta_\pi^2 \pi_{t-1}. \tag{9}$$

These expectations are backward-looking (adaptive) if $0 \leq \theta_j < 1$, naïve if $\theta_j = 1$, or extrapolative when $\theta_j > 1$. Hence, aggregate expectations, $\tilde{E}_t$, are a weighted average of all forecasts constructed by agents under rational and bounded-rational mechanisms, introducing, in this way, both backward and forward-looking elements into the economy.

Lastly, dispersion, or disagreement, is defined as the difference between agents' forecasts:

$$\tilde{E}_t y_{t+1}^{disp} = \left| E_t y_{t+1} - \hat{E}_t y_{t+1} \right| \tag{10}$$

$$\tilde{E}_t \pi_{t+1}^{disp} = \left| E_t \pi_{t+1} - \hat{E}_t \pi_{t+1} \right|. \tag{11}$$

3. Empirical strategy

Data. We use quarterly data from 1968:IV to 2020:I obtained from the Survey of Professional Forecasters.[5] Real-time (first-vintage) data on real output growth, inflation, and interest rates are used as observables. Output growth and inflation are constructed as the log-difference of Real GDP and the GDP Implicit Price Deflator, respectively; the interest rate is given by the Federal Funds rate, re-expressed as quarterly rate.[6] Additionally, we exploit survey data in the estimation. For expectations about inflation and the growth rate of real GDP, we use the mean of one-quarter-ahead forecasts across all respondents. As an observable for their cross-sectional dispersion, we use the interquartile range of forecasts for output growth and inflation.[7]

State-space form. The state-space form for the model can be expressed as:

$$S_t = F S_{t-1} + G \epsilon_t \tag{12}$$

$$Y_t = H_0 + H_1 S_t \tag{13}$$

where S_t is a state vector that includes endogenous variables, expectations, and structural shocks, ϵ_t is a vector containing the *i.i.d.* innovations, and Y_t is the vector of observable variables; F, G, H_0, and H_1 are parameter matrices and vectors. The details of the measurement equation (13) are

[5]We stop before COVID to avoid the undue influence of outlier observations in subsequent quarters.

[6]For the ZLB period between 2009:I to 2015:III, we used the Wu-Xia shadow rate.

[7]The same measure has been used to characterize forecast dispersion in Abel et al. (2016), Glas and Hartmann (2016), and Lahiri and Sheng (2010).

as follows:

$$\begin{bmatrix} \Delta GDP_t \\ \Delta GDP\ Deflator_t \\ FFR_t \\ E_t(\Delta GDP_{t+1}) \\ E_t(\Delta GDP\ Deflator_{t+1}) \\ Dispersion\ of\ E_t(\Delta GDP_{t+1}) \\ Dispersion\ of\ E_t(\Delta GDP\ Deflator_{t+1}) \end{bmatrix} = \begin{bmatrix} \gamma \\ \bar{\pi} \\ \bar{\pi}+\bar{r} \\ \gamma \\ \bar{\pi} \\ \delta_0^y \\ \delta_0^\pi \end{bmatrix} + \begin{bmatrix} y_t - y_{t-1} \\ \pi_t \\ i_t \\ \tilde{E}_t y_{t+1} - y_t \\ \tilde{E}_t \pi_{t+1} \\ \delta_1^y \tilde{E}_t y_{t+1}^{disp} \\ \delta_1^\pi \tilde{E}_t \pi_{t+1}^{disp} \end{bmatrix} + \nu_t, \tag{14}$$

where γ, $\bar{\pi}$, and $\bar{r}$ are steady-state values for the growth rate, inflation, and real interest rate, and where $\nu_t = [0, 0, 0, me_t^{Ey}, me_t^{E\pi}, me_t^{disp_y}, me_t^{disp_\pi}]' \sim \mathcal{N}(0, \Sigma^{me})$ contains *i.i.d.* measurement errors for expectations and for the dispersion related to output and inflation.[8]

The last two rows of the observation equation assess the ability of the HENK model to capture the dispersion in survey forecasts. If the dispersion implied by the model aligns perfectly with that of the data, the parameters δ_0^y and δ_0^π will be zero and δ_1^y and δ_1^π will equal one (with $\sigma_{disp_y}^{me} = \sigma_{disp_\pi}^{me} = 0$). Here, however, we allow for a more flexible, linear, relationship between model-implied and actual dispersion, by estimating the δ parameters.

Bayesian estimation. The HENK model is estimated via Bayesian techniques. Prior distributions follow the previous literature and are shown in Table 1. We assume rather diffuse Beta priors centered at 0.5 for the RE shares n_y and n_π and Normal priors centered at 1 for the expectation parameters θ_y and θ_π. Sample means for inflation and interest rates are instead used to calibrate $\bar{\pi}$ and $\bar{i}$. We run a random-walk Metropolis-Hastings algorithm to generate 1,000,000 draws and discard 25% of them as burn-in. We summarize the posterior distributions of the parameters by showing posterior means and 95% credible intervals.

4. Results

The posterior estimates are shown in the *Baseline* column of Table 2. We find that a sizable proportion of agents form expectations that deviate from the rational expectations hypothesis: the estimated RE share equals 57.5% for the output gap and 36.9% for inflation. Moreover, boundedly-rational expectations are formed adaptively for both variables, with posterior means for autoregressive coefficients equal to 0.981 for θ_y and to 0.92 for θ_π, indicating that agents adjust their beliefs by anchoring them to recent experiences.[9] The remaining estimates mirror those in the literature: the policy coefficients are consistent with a stabilizing response to inflation and interest-rate inertia.

[8]The standard deviations for these errors are denoted σ_k^{me} for $k = \{E_y, disp_y, E_\pi, disp_\pi\}$.

[9]Similarly to the previous findings, for instance, in Milani (2007), Ilabaca and Milani (2021), and Acuña Armenta (2022).

The Calvo parameter indicates prices that are reoptimized on average once a year; the sensitivity of output to real interest rates, expressed by $1/\sigma$, is modest.

Regarding the dispersion of expectations, we find that the posterior means for δ_0^y and δ_0^π are 0.32 and 0.22, indicating a higher average disagreement about future output growth than inflation. Additionally, the results suggest an imperfect match between the dispersion of expectations predicted by the HENK model and that in the data. The credible intervals for δ_1^y and δ_1^π lie closer to zero than one, with mean estimates equal to 0.06 and 0.03.[10]

Figure 1 shows the scatter plot relating the values of the model-implied and observed dispersion series. The correlation between the two series is equal to 0.41 for output and 0.31 for inflation. Therefore, the model does a reasonable job in approximating the period-by-period fluctuations of dispersion.

As apparent in Figure 2, however, the HENK model produces disagreement for output growth expectations that is excessive and too volatile, compared with what is observed in the data; there are, in particular, spikes in correspondence of recessions, which remain much milder in survey forecasts. The model does a better job in approximating the magnitude of dispersion for inflation forecasts. But, again, the model-implied series substantially overestimates the volatility in the data.[11]

4.1. **Robustness Analysis.** We re-estimate the model under different assumptions and for various sub-samples. These results are presented in Tables 2 and 3. Most estimates remain consistent across all robustness checks, with the exception, in some cases, of the parameters related to expectations. Moreover, our baseline specification outperforms all other estimations performed using the same sample.[12]

Unique n and θ. In this specification, we constrain the RE shares and expectation parameters to be identical for output growth and inflation forecasts. The estimation suggests that 54.8% of agents form rational expectations. The remaining share forms expectations that are closely linked to lagged values, with a coefficient close to 1 ($\theta = 0.981$). The parameters related to empirical dispersion remain similar.

Fixed $\delta_0 = 0$ and $\delta_1 = 1$. In this case, we fix the parameters in the dispersion observation equations to force the model-implied dispersion to match as closely as possible the empirical dispersion of expectations (without allowing for a non-zero intercept or under/overreaction). As a consequence, the fit deteriorates. The estimates adjust to increase the proportion of agents forming

[10] As discussed, were these parameters equal to one, the model would perfectly match the empirical dispersion of expectations. This restriction is explored in the robustness section.

[11] The large differences in volatility also explain our low estimated values for δ_1^y and δ_1^π.

[12] Recall that by construction, the log marginal likelihood grows roughly linearly in sample size. Thus, estimations using sub-samples, such as in 3, would consequently have a lower magnitude in this Bayesian model fit measure.

rational expectations for output and imply substantially larger measurement errors for the dispersion variables compared to the benchmark estimation. Overall, this estimation confirms that model-implied and observed dispersion have magnitudes that are hard to reconcile.

No dispersion data. Now, we require the model to match only the first moments of expectations, but not the second moments, excluding dispersion data from the list of observables. The results are similar to those in our baseline estimation.

No survey expectations and dispersion data. We repeat the estimation using only realized macroeconomic data, omitting both expectations and dispersion data. The exclusion of mean survey expectations has a larger impact on the estimates. The fraction of agents that form rational expectations for output and the autoregressive parameter related to inflation expectations both significantly decrease. In the absence of expectations data, the exogenous disturbances are modified: the supply shock is much more persistent, and the demand shock more volatile, than in the baseline estimation. These findings clarify the importance of expectation data for the correct identification of parameters related to heterogeneous expectations: in the absence of these observables, the estimates can be quite different.

Different sub-samples. Lastly, we run the estimation under multiple sub-samples (1982:I-2007:IV, 2008:I-2020:I, 1968:IV-1979:II, and 1979:III-2020:I). As in previous literature, we find an inflation reaction coefficient in the Taylor rule that is substantially weaker in the pre-Volcker era and stronger in the post-Volcker period, capturing central banks' evolving aggressiveness toward inflation. Turning to expectations, shares of rational expectation agents are higher in the post-2008 and pre-Volcker sample. Output growth expectations are characterized by extrapolative behavior before 1979.[13] For inflation expectations, adaptive behavior in the formation of expectations dominates in all samples, with a reduced autoregressive coefficient in the 2008-2020 period.

5. Conclusions

In this paper, we estimated a Heterogeneous Expectations New Keynesian model to assess its ability to explain the cross-sectional dispersion of expectations that exists in survey data.

The estimates confirm the existence of large shares of agents that form non-rational expectations and display adaptive behavior. The estimated HENK model, however, yields a measure of dispersion across expectations that is too large and volatile compared to the corresponding measure in the data.

The results highlight the need for further research. Observations about higher moments in survey forecasts should be used more frequently to test heterogeneous expectations models. Here, we found that the discrepancy between rational expectations and expectations formed from backward-looking

[13]Ilabaca and Milani (2021) also find extrapolative behavior for an estimation that includes the pre-1980 period.

models with constant parameters is too large compared to the dispersion of survey forecasts. Future research can test if allowing for learning in boundedly-rational expectations, endogenous shifts in model shares, or an expanded set of non-rational forecasting models, could help HENK models more closely replicate the observed dispersion.

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6. Tables and Figures

Description	Param.	Distr.	Mean	95% Prior Interval
IES	σ	Γ	2	[0.811, 3.716]
Calvo price stickiness	ξ_p	$\mathcal{B}$	0.66	[0.45, 0.85]
Int. Rate Smooth.	ρ_i	$\mathcal{B}$	0.7	[0.35, 0.93]
Feedback Inflation	ψ_π	$\mathcal{N}$	1.5	[1.01, 1.99]
Feedback Output gap	ψ_y	$\mathcal{N}$	0.125	[0.027, 0.223]
Share RE in Output	n_y	$\mathcal{B}$	0.5	[0.13, 0.87]
Param. Output Exp.	θ_y	$\mathcal{N}$	1	[0.51, 1.49]
Share RE in Inflation	n_π	$\mathcal{B}$	0.5	[0.13, 0.87]
Param. Infl. Exp.	θ_π	$\mathcal{N}$	1	[0.51, 1.49]
Autoregr. Demand shock	ρ_g	$\mathcal{B}$	0.5	[0.13, 0.87]
Autoregr. Cost-push shock	ρ_u	$\mathcal{B}$	0.5	[0.13, 0.87]
Std. Demand shock	σ_g	Γ^{-1}	0.3	[0.057, 1.208]
Std. Cost-push shock	σ_u	Γ^{-1}	0.3	[0.057, 1.208]
Std. MP shock	σ_ϵ	Γ^{-1}	0.3	[0.057, 1.208]
Std. M.E. Output Exp.	σ^{me}_{Ey}	Γ	0.5	[0.013, 1.844]
Std. M.E. Infl. Exp.	$\sigma^{me}_{E\pi}$	Γ	0.5	[0.013, 1.844]
Std. M.E. Output Disp.	$\sigma^{me}_{disp_y}$	Γ	0.5	[0.013, 1.844]
Std. M.E. Infl. Disp.	$\sigma^{me}_{disp_\pi}$	Γ	0.5	[0.013, 1.844]
Output growth	γ	$\mathcal{N}$	0.5	[0.451, 0.549]
Output Dispersion Constant	δ^y_0	Γ	0.5	[0.013, 1.844]
Output Dispersion Slope	δ^y_1	Γ	1	[0.273, 2.192]
Inflation Dispersion Constant	δ^π_0	Γ	0.5	[0.013, 1.844]
Inflation Dispersion Slope	δ^π_1	Γ	1	[0.273, 2.192]

Table 1. Prior distributions.

Notes:
The same prior distributions are used for all the estimations presented in this paper.

	Baseline		Unique n and θ		Fixed δ_0 and δ_1		No dispersion data		No survey expectations + No dispersion data	
Parameters	Mean	95% Credible Int.	Mean	95% Credible Int.	Mean	95% Credible Int.	Mean	95% Credible Int.	Mean	95% Credible Int.
σ	8.856	[6.726, 11.542]	8.043	[6.262, 10.112]	9.399	[7.350, 12.653]	8.876	[6.760, 11.646]	4.162	[2.744, 6.064]
ξ_p	0.745	[0.549, 0.881]	0.837	[0.726, 0.926]	0.760	[0.611, 0.884]	0.734	[0.556, 0.881]	0.665	[0.462, 0.844]
ρ_i	0.901	[0.867, 0.933]	0.901	[0.867, 0.935]	0.888	[0.858, 0.915]	0.898	[0.863, 0.930]	0.933	[0.899, 0.964]
ψ_π	1.591	[1.222, 1.988]	1.581	[1.220, 1.929]	1.465	[1.076, 1.819]	1.581	[1.236, 1.933]	1.570	[1.166, 1.990]
ψ_y	0.141	[0.070, 0.218]	0.142	[0.070, 0.222]	0.147	[0.073, 0.217]	0.139	[0.065, 0.217]	0.128	[0.043, 0.216]
n_y	0.575	[0.528, 0.630]	-	-	0.972	[0.930, 0.995]	0.576	[0.528, 0.631]	0.128	[0.028, 0.272]
θ_y	0.981	[0.962, 0.998]	-	-	0.959	[0.944, 0.968]	0.983	[0.963, 1.001]	0.947	[0.869, 0.984]
n_π	0.369	[0.274, 0.479]	-	-	0.442	[0.397, 0.500]	0.365	[0.277, 0.451]	0.428	[0.116, 0.775]
θ_π	0.920	[0.888, 0.955]	-	-	0.913	[0.885, 0.941]	0.920	[0.888, 0.949]	0.205	[-0.008, 0.450]
n	-	-	0.548	[0.513, 0.578]	-	-	-	-	-	-
θ	-	-	0.981	[0.966, 0.994]	-	-	-	-	-	-
ρ_g	0.923	[0.857, 0.972]	0.923	[0.861, 0.973]	0.950	[0.935, 0.964]	0.919	[0.858, 0.972]	0.583	[0.428, 0.795]
ρ_u	0.082	[0.015, 0.194]	0.040	[0.007, 0.103]	0.017	[0.003, 0.045]	0.084	[0.019, 0.196]	0.806	[0.725, 0.881]
σ_g	0.083	[0.061, 0.111]	0.092	[0.068, 0.122]	0.057	[0.046, 0.071]	0.081	[0.060, 0.108]	0.534	[0.392, 0.651]
σ_u	0.252	[0.219, 0.288]	0.218	[0.195, 0.242]	0.259	[0.230, 0.291]	0.252	[0.220, 0.286]	0.225	[0.128, 0.317]
σ_ϵ	0.240	[0.217, 0.265]	0.240	[0.218, 0.265]	0.241	[0.219, 0.268]	0.241	[0.218, 0.266]	0.239	[0.217, 0.264]
σ_{Ey}^{me}	0.451	[0.407, 0.502]	0.456	[0.411, 0.507]	0.453	[0.410, 0.502]	0.448	[0.404, 0.499]	-	-
$\sigma_{E\pi}^{me}$	0.179	[0.162, 0.197]	0.182	[0.165, 0.200]	0.180	[0.163, 0.199]	0.179	[0.162, 0.197]	-	-
$\sigma_{disp_y}^{me}$	0.201	[0.182, 0.222]	0.201	[0.182, 0.221]	0.644	[0.581, 0.716]	-	-	-	-
$\sigma_{disp_\pi}^{me}$	0.124	[0.112, 0.137]	0.123	[0.111, 0.136]	0.408	[0.367, 0.453]	-	-	-	-
γ	0.592	[0.579, 0.605]	0.594	[0.582, 0.608]	0.596	[0.585, 0.606]	0.591	[0.578, 0.604]	0.576	[0.552, 0.594]
δ_0^y	0.317	[0.287, 0.347]	0.316	[0.287, 0.346]	0	-	-	-	-	-
δ_1^y	0.061	[0.037, 0.086]	0.059	[0.037, 0.083]	1	-	-	-	-	-
δ_0^π	0.217	[0.200, 0.234]	0.215	[0.198, 0.232]	0	-	-	-	-	-
δ_1^π	0.031	[0.009, 0.066]	0.045	[0.015, 0.084]	1	-	-	-	-	-
Log Marginal Likelihood	**-276.617**		-279.260		-789.612		-423.587		-308.804	

TABLE 2. Posterior estimates, under different specifications.

Notes:
The table shows posterior means, along with 2.5% and 97.5% percentiles, computed over 1,000,000 Metropolis-Hastings draws with a burn-in of 25% of the initial draws for different scenarios. All estimations use U.S. real-time macroeconomic series, prior distributions as in Table 1, and a sample for 1968:IV-2020:I. Prior distributions for parameters n and θ are the same as those for (n_π, n_y) and (θ_π. θ_y), respectively.

	Baseline		1982:I–2007:IV		2008:I–2020:I		Pre-Volcker		Post-Volcker	
Parameters	Mean	95% CI	Mean	95% CI	Mean	95% CI	Mean	95% CI	Mean	95% CI
σ	8.856	[6.726, 11.542]	6.062	[4.394, 7.855]	3.985	[2.559, 5.706]	3.647	[2.282, 5.567]	7.488	[5.710, 9.822]
ξ_p	0.745	[0.549, 0.881]	0.686	[0.514, 0.853]	0.672	[0.472, 0.844]	0.652	[0.437, 0.837]	0.775	[0.610, 0.903]
ρ_i	0.901	[0.867, 0.933]	0.834	[0.764, 0.904]	0.879	[0.800, 0.950]	0.737	[0.615, 0.844]	0.870	[0.830, 0.909]
ψ_π	1.591	[1.222, 1.988]	1.564	[1.089, 2.027]	1.474	[1.021, 1.942]	0.907	[0.537, 1.347]	1.906	[1.535, 2.281]
ψ_y	0.141	[0.070, 0.218]	0.072	[0.004, 0.164]	0.132	[0.039, 0.225]	0.192	[0.118, 0.267]	0.073	[0.000, 0.152]
n_y	0.575	[0.528, 0.630]	0.492	[0.422, 0.599]	0.577	[0.451, 0.789]	0.634	[0.519, 0.781]	0.521	[0.480, 0.568]
θ_y	0.981	[0.962, 0.998]	0.995	[0.970, 1.010]	0.947	[0.858, 0.997]	1.037	[0.946, 1.093]	0.988	[0.976, 0.999]
n_π	0.369	[0.274, 0.479]	0.406	[0.216, 0.657]	0.493	[0.144, 0.844]	0.492	[0.200, 0.804]	0.401	[0.310, 0.489]
θ_π	0.920	[0.888, 0.955]	0.849	[0.742, 0.978]	0.402	[0.126, 0.665]	0.700	[0.326, 0.968]	0.950	[0.920, 0.979]
ρ_g	0.923	[0.857, 0.972]	0.897	[0.800, 0.972]	0.875	[0.780, 0.956]	0.783	[0.543, 0.933]	0.893	[0.829, 0.950]
ρ_u	0.082	[0.015, 0.194]	0.148	[0.034, 0.351]	0.079	[0.015, 0.188]	0.405	[0.079, 0.780]	0.056	[0.011, 0.126]
σ_g	0.083	[0.061, 0.111]	0.083	[0.056, 0.119]	0.112	[0.077, 0.164]	0.187	[0.104, 0.315]	0.088	[0.064, 0.115]
σ_u	0.252	[0.219, 0.288]	0.189	[0.150, 0.232]	0.211	[0.172, 0.262]	0.298	[0.198, 0.417]	0.215	[0.185, 0.250]
σ_ϵ	0.240	[0.217, 0.265]	0.218	[0.189, 0.250]	0.163	[0.134, 0.201]	0.246	[0.196, 0.313]	0.248	[0.222, 0.278]
σ^{me}_{Ey}	0.451	[0.407, 0.502]	0.282	[0.241, 0.332]	0.304	[0.241, 0.389]	0.746	[0.593, 0.951]	0.354	[0.314, 0.401]
$\sigma^{me}_{E\pi}$	0.179	[0.162, 0.197]	0.174	[0.151, 0.201]	0.110	[0.090, 0.137]	0.306	[0.241, 0.389]	0.165	[0.147, 0.184]
$\sigma^{me}_{disp_y}$	0.201	[0.182, 0.222]	0.108	[0.094, 0.125]	0.082	[0.066, 0.102]	0.220	[0.175, 0.278]	0.159	[0.142, 0.178]
$\sigma^{me}_{disp_\pi}$	0.124	[0.112, 0.137]	0.077	[0.067, 0.089]	0.071	[0.057, 0.088]	0.190	[0.150, 0.241]	0.093	[0.084, 0.104]
γ	0.592	[0.579, 0.605]	0.651	[0.577, 0.697]	0.482	[0.452, 0.510]	0.551	[0.509, 0.592]	0.586	[0.568, 0.603]
δ^y_0	0.317	[0.287, 0.347]	0.272	[0.251, 0.293]	0.189	[0.163, 0.214]	0.516	[0.435, 0.591]	0.264	[0.238, 0.291]
δ^y_1	0.061	[0.037, 0.086]	0.032	[0.013, 0.056]	0.068	[0.037, 0.110]	0.046	[0.016, 0.086]	0.056	[0.033, 0.080]
δ^π_0	0.217	[0.200, 0.234]	0.193	[0.178, 0.208]	0.165	[0.145, 0.187]	0.285	[0.221, 0.349]	0.197	[0.182, 0.211]
δ^π_1	0.031	[0.009, 0.066]	0.052	[0.016, 0.105]	0.250	[0.059, 0.672]	0.154	[0.049, 0.317]	0.036	[0.011, 0.069]
Log Marginal Likelihood	-276.617		56.924		76.278		-175.966		-64.314	

TABLE 3. Posterior estimates, across different sub-samples.

Notes:
The table shows posterior means, along with 2.5% and 97.5% percentiles, computed over 1,000,000 Metropolis-Hastings draws with a burn-in of 25% of the initial draws for different sub-samples. All estimations use U.S. real-time macroeconomic series, survey data on expectations and dispersion, and prior distributions as in Table 1.

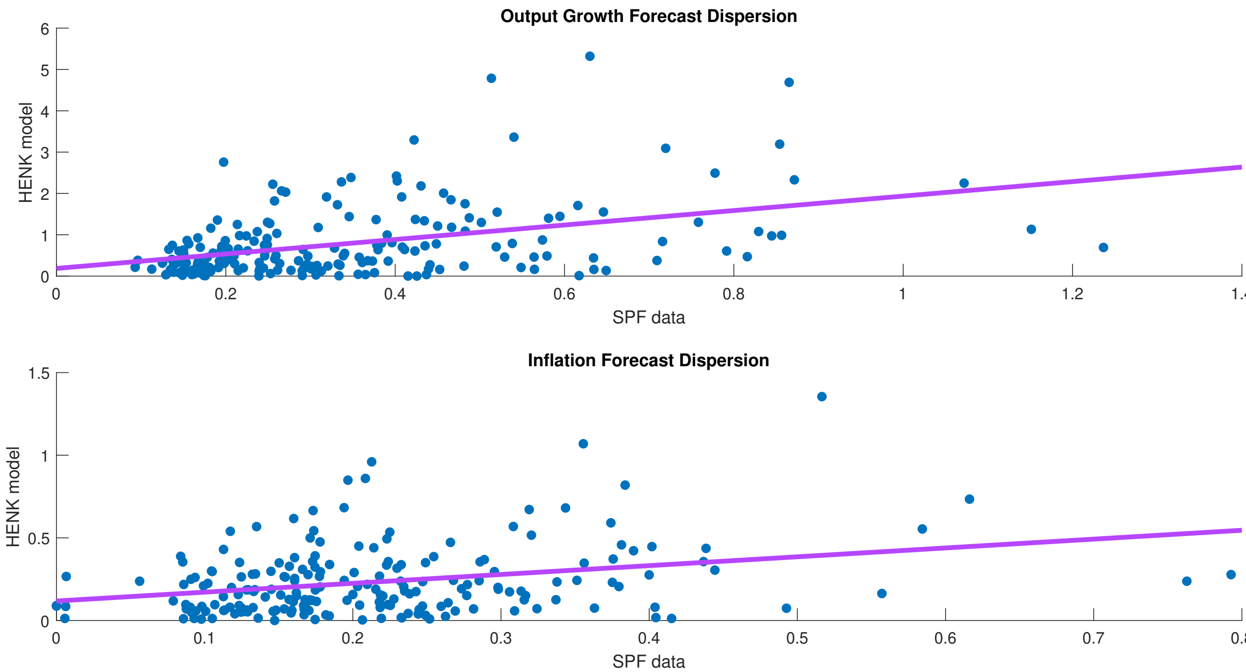

Figure 1. Scatter plot between model-implied and observed forecast dispersion (Baseline model).

Notes:
The figure shows the scatter plot for dispersion values implied by the HENK model and the cross-sectional forecast dispersion observed from the SPF. The top panel refers to data for output growth expectations; the bottom panel for inflation expectations. Both panels include a regression line.

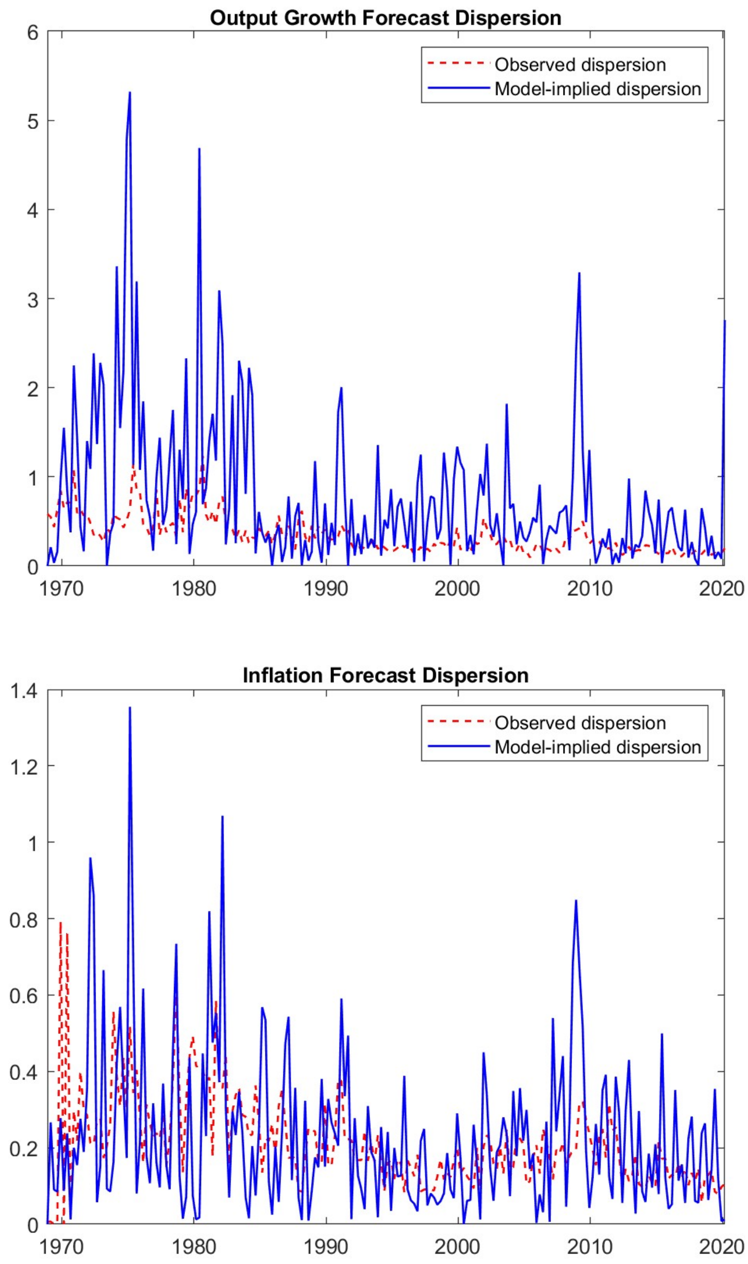

Figure 2. Dispersion, model implied vs observed (Baseline model).

Notes:
The figure displays dispersion data for output growth (top panel) and inflation expectations (bottom panel). Empirical dispersion is shown in red (dashed), while the model's estimated dispersion is presented in blue (solid line).