Would Some Model Please Give Me Some Hints?— An Empirical Investigation on Monetary Policy and Asset Return Dynamics

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Why Should we care about forecasting?

Reason #1: Expectation from the society

Economists mostly failed to predict the worst economic crisis since the 1930s. Now they can't agree how to solve it. People are starting to wonder: What good are economists anyway? A commenter on a housing blog wrote recently that economists did a worse job of forecasting the housing market than either his father, who has no formal education, or his mother, who got up to second grade. "If you are an economist and did not see this coming, you should seriously reconsider the value of your education and maybe do something with a tangible value to society, like picking vegetables,"

Why Should we care about forecasting?
Reason #2: sign for structural change?

Sanders (2008, JHE, p.261): " ... However, in the 2005–2008Q2 period, we found that the relationship had fundamentally changed and that house price changes and seriously delinquent subprime mortgage rates were strongly related.... The sudden paradigm shift in 2005 and 2006 demonstrates that markets can change dramatically and **the most sophisticated models can be taken by surprise**."

More Introduction...

- By OFHEO (S&P Case-Shiller) national house price index, the US average house price has grown consecutively around 1.6% (2.1%) for the period $1995Q4 - 2005Q4$, reaching a total of 89% (135%) in net gains.

- Such fluctuations in asset prices and returns $\implies$ (1) Large effects on consumption (Case, Quigley and Shiller, 2005, Campbell and Cocco, 2007, among others); (2) Continuous $\downarrow$ in house prices $\implies$ collateral quality and value $\downarrow \implies$ credit crunch, and subsequent $\uparrow$ in bankruptcy and foreclosures (Japan experience).

- Important for researchers and policymakers to predict asset prices (Mishkin, 2001, 2007, and others).

From Chen and Leung, *JREFE*, 2008
Collateral + spillover => non-linearity
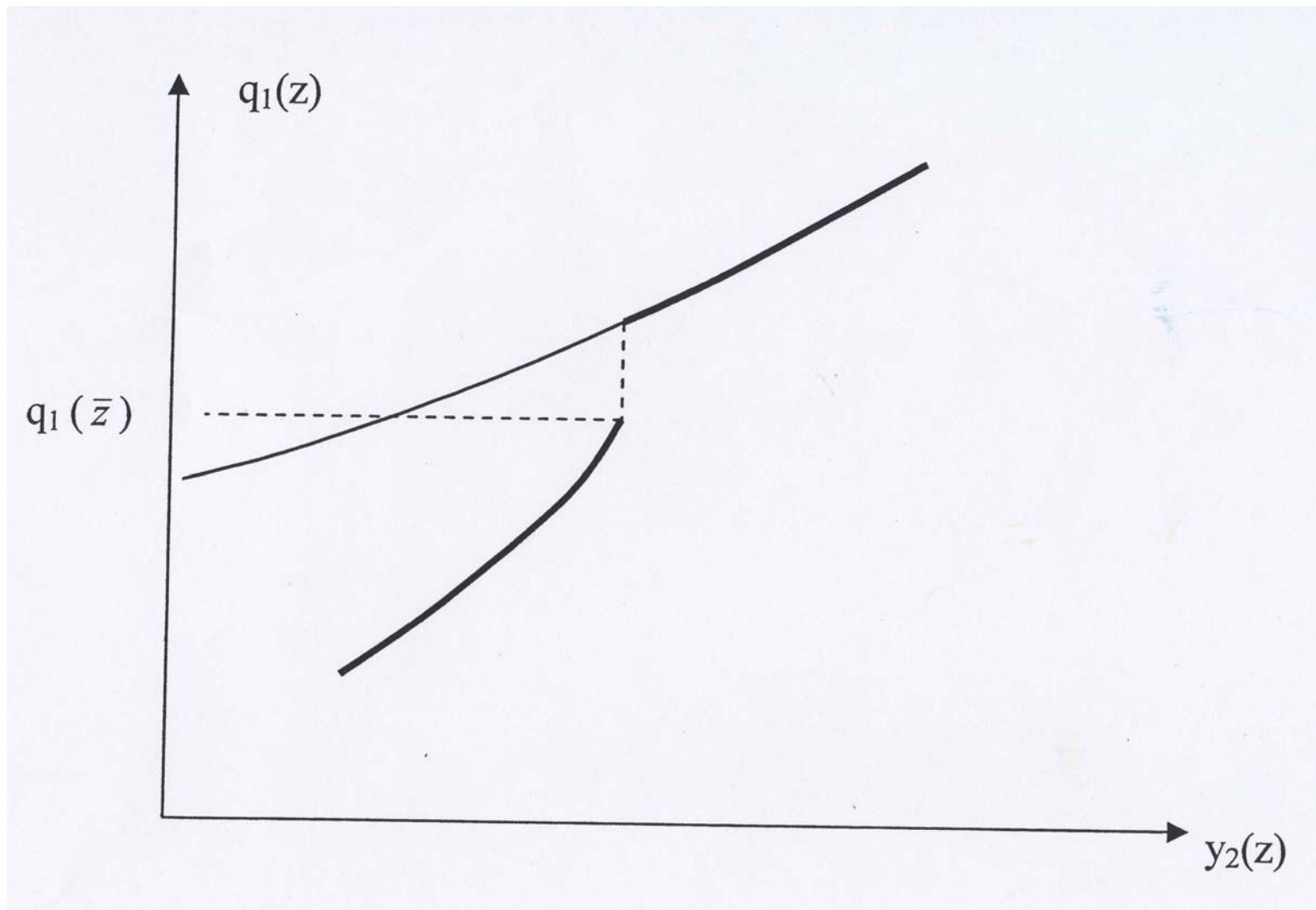
- This paper: MULTI-variate regime-switching SVAR models, NOT UNI-variate; will compare with linear VAR; include BOTH stock and housing return; US data, $1975Q2 - 2008Q3$

- Changes of monetary policy as stochastic (Sims and Zha, 2006, AER)

- Stock market: characterized by a Regime-Switching model (Maheu and McCurdy, 2000).

- Out-of-Sample forecasting using 2 different approaches: conditional expectations and simulation-based methods (obtain confidence intervals; following Sargent, Williams and Zha, 2006, AER)

- Bayesian Literature is controverisal (Sims and Zha: YES; Sargent, WIlliams and Zha: NO)

Figure 1a Federal Funds Rate (FFR), Term Spread (SPR), Percentage Changes in Gross Domestic Production (GDP), External Finance Premium (EFP)
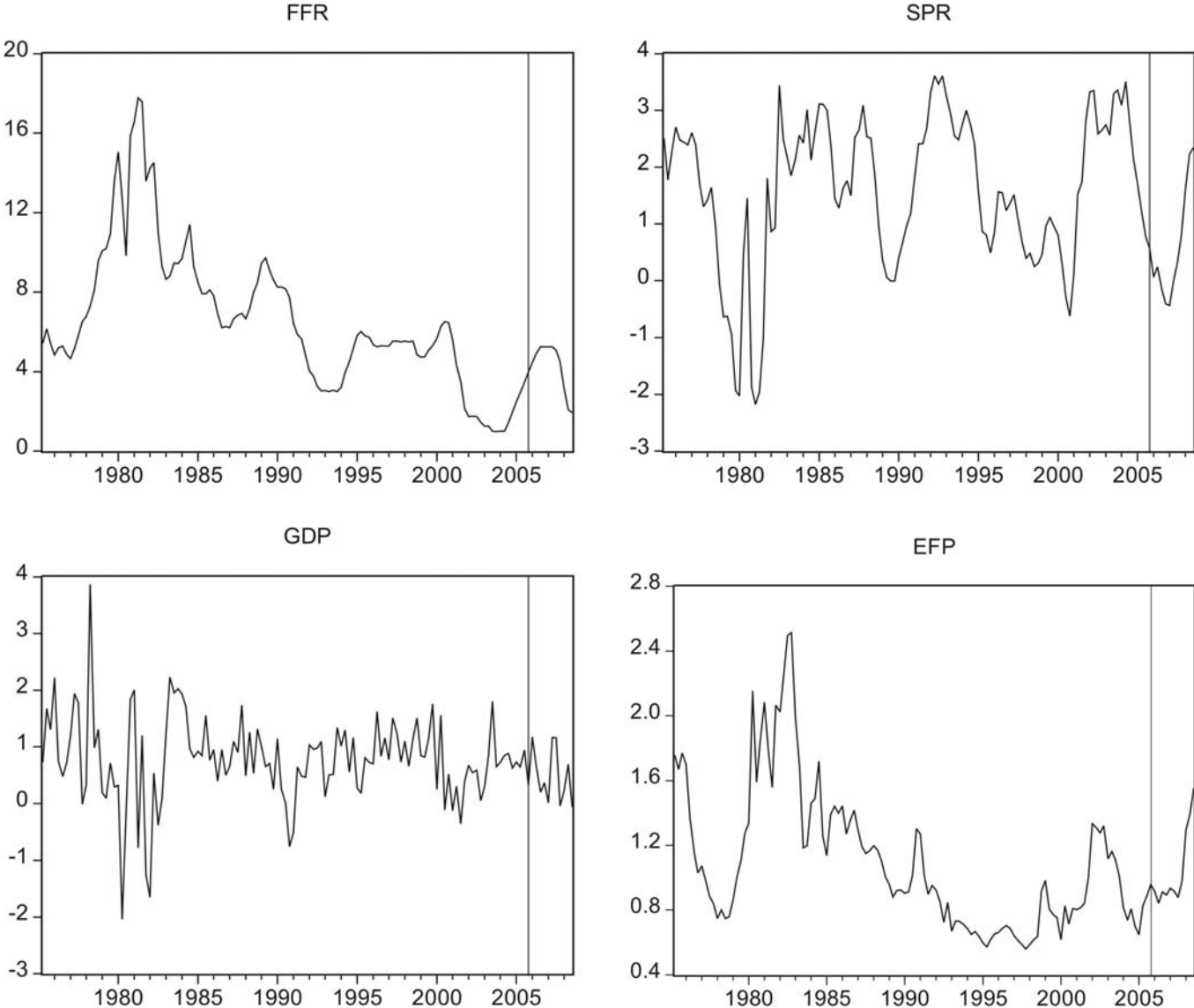
Figure 1b   Market Liquidity (TED), Stock Index Return (SRET), Housing Market Return (HRET)
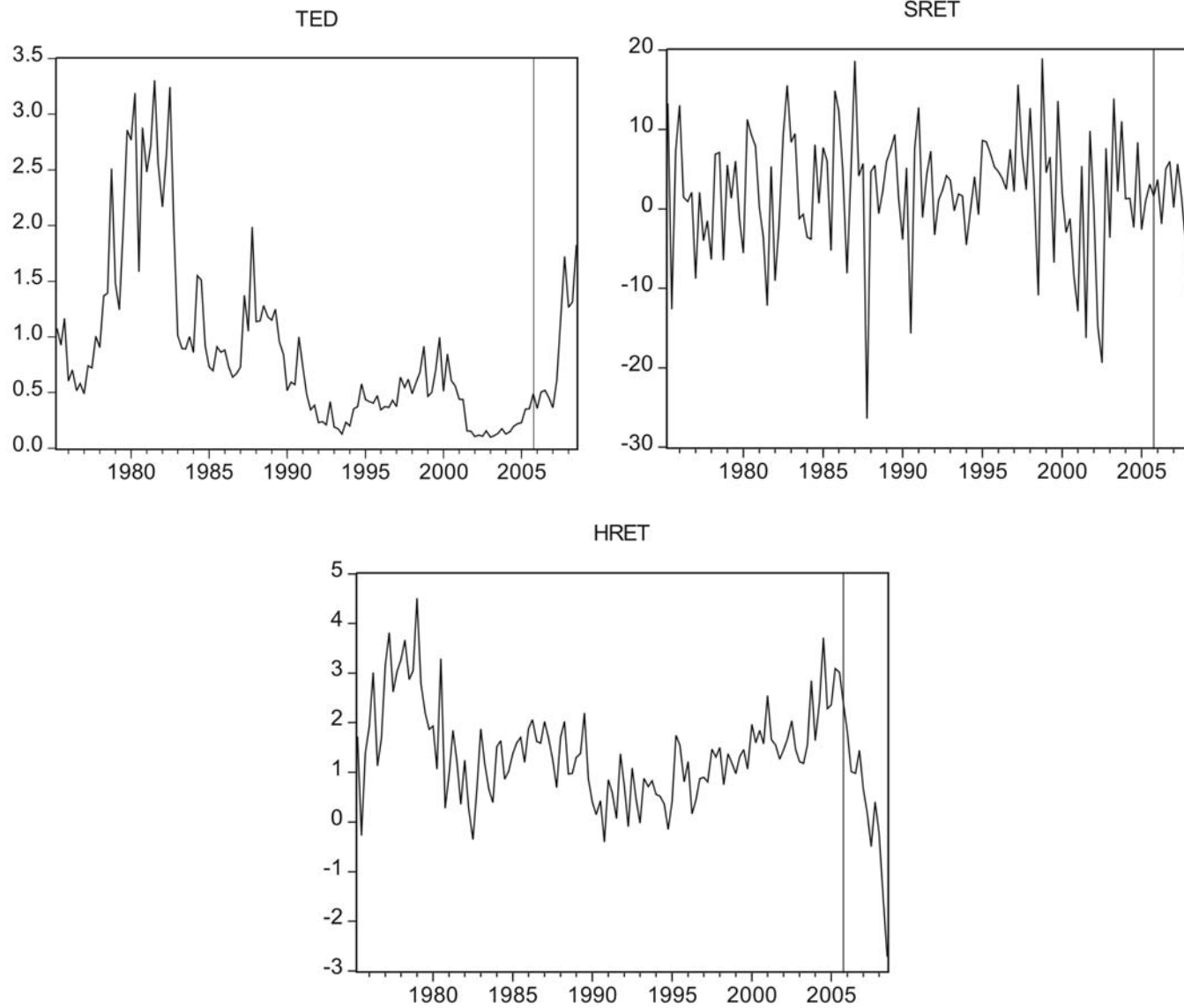
Table 5 Statistical Summary of Federal Funds Rate, Term Spread, Gross Domestic Production Growth Rate, External Finance Premium, Market Liquidity, Stock Index Return and Housing Market Return (1975Q2-2008Q3)

	FFR	SPR	GDP	EFP	TED	SRET	HRET
Mean	6.397	1.502	0.759	1.087	0.883	1.968	1.344
Median	5.563	1.604	0.731	0.957	0.637	2.263	1.313
Maximum	17.780	3.611	3.865	2.513	3.307	18.952	4.511
Minimum	0.997	-2.182	-2.038	0.560	0.097	-26.431	-2.713
Std. Dev.	3.508	1.335	0.750	0.422	0.742	7.659	1.040
Skewness	1.037	-0.627	-0.127	1.220	1.552	-0.664	-0.040
Kurtosis	4.283	2.941	6.150	4.229	4.917	4.070	4.691
Obervations	134.000	134.000	134.000	134.000	134.000	134.000	134.000

Note: FFR denotes the federal funds rate, SPR denotes interest rate spread, GDP means the gross domestic production growth rate, EFP means the external finance premium, TED means the market liquidity, SRET means stock index return, and HRET means housing market return.

Table 6 Correlation Coefficients (1975Q2-2008Q3)

	FFR	SPR	GDP	EFP	TED	SRET	HRET
FFR	1.000	**-0.557**	-0.104	**0.544**	**0.833**	0.009	0.015
SPR		1.000	0.145	0.037	**-0.437**	0.021	-0.115
GDP			1.000	-0.179	-0.165	0.030	0.111
EFP				1.000	**0.650**	0.057	-0.151
TED					1.000	-0.049	-0.076
SRET						1.000	0.055
HRET							1.000

The Econometric Analysis

- A regime-switching SVAR model with lag length p for y_t:

$$A_0 y_t = \gamma(s_t) + A_1(s_t) y_{t-1} + A_2(s_t) y_{t-2} + \ldots + A_p(s_t) y_{t-p} + u_t(s_t),$$

or,

$$y_t = \delta(s_t) + \Phi_1(s_t) y_{t-1} + \Phi_2(s_t) y_{t-2} + \ldots + \Phi_p(s_t) y_{t-p} + \epsilon_t(s_t),$$

where all parameters are regime-dependent, $s_t \in S = \{1, 2\}$.

- The transition probability matrix:

$$P = \begin{pmatrix} p_{11} & 1 - p_{11} \\ 1 - p_{22} & p_{22} \end{pmatrix},$$

where $p_{ij} \equiv Pr(s_t = j \mid s_{t-1} = i)$. The persistence measured by $1/(1 - p_{ii})$: $p_{ii} \uparrow \implies$ persistence$\uparrow$.

- Identification of Regimes: Following Hamilton's (1989, 1994) *smoothed probability approach*, in which the probability of being state s_t at time t is given by $\pi\left(s_t \mid \Omega_T\right)$, where $\Omega_T = \{y_1, y_2, ..., y_t, ..., y_T\}$.

Forecasting

- Conditional Expectations Method

  - Given the estimation window $1975Q2 - 2005Q4$ and a forecasting horizon $h = 1, ..., 4$, the estimated parameters are used to forecast house and stock prices h-steps ahead outside the estimation window, using the smoothed transition probabilities. The h-steps ahead forecasted value of z_{t+h} based on information at time t, Ω_t, is given by

  $$E\left(z_{t+h} \mid \Omega_t\right) = \sum_{i=1}^{2} E\left[z_{t+h} \mid s_{t+h} = i, \Omega_t\right] \times p\left(s_{t+h} = i \mid \Omega_t\right),$$

  where $z_t \in y_t$.

  - The estimation window is then *updated* consecutively with one observation and the parameters are re-estimated. Again the h-steps ahead

forecasts of house and stock prices are computed outside the new estimation window.

- To evaluate the performances of in-sample and out-of-sample forecasts, we compute two widely-used measures for forecasting a variable $z_t \in y_t$, Root Mean Square Errors ($RMSE$) and Mean Absolute Errors (MAE), which are defined respectively as

$$RMSE(h) = \left[\frac{1}{T-h} \sum_{t=1}^{T-h} \left(z_{t+h} - \widehat{z}_{t+h|t} \right)^2 \right]^{1/2},$$

$$MAE(h) = \frac{1}{T-h} \sum_{t=1}^{T-h} \left| z_{t+h} - \widehat{z}_{t+h|t} \right|,$$

where $\widehat{z}_{t+h|t} \equiv E\left(z_{t+h} \mid \Omega_t \right)$.

- Simulation-based Method

  – We simulate the path of the forecasted values by repeated drawings.

- (Step 1) Estimate the model given the sample period $1975Q2 - 2005Q4$ and obtain the model parameters, transition probabilities, and variance-covariance matrix. Given the estimation results we compute the smoothed probabilities to identify the regime at the period $2005Q4$.

- (Step 2) Given the regime at the period $2005Q4$, we simulate the path of h-step ahead regimes by random drawing, $h = 1, ..., 4$.

  - We then update the data with four observations and repeat Step 1-3 to simulate the path of predicted values for the next four quarters. This procedure is repeated till the end of our sample.

A Summary of Goodness of Fit for All Eight Models

	Models	AIC
Model A	Single-regime model (FFR, SPR, TED, EFP, GDP, SRET, HRET)	11.230
Model B	Two-regime model (FFR, GDP, SRET, HRET)	13.472
Model C	Two-regime model (FFR, SPR, SRET, HRET)	12.450
Model D	Two-regime model (FFR, EFP, SRET, HRET)	10.159
Model E	Two-regime model (FFR, TED, SRET, HRET)	11.134
Model F	Two-regime model (EFP, SPR, SRET, HRET)	9.747
Model G	Two-regime model (EFP, TED, SRET, HRET)	**8.404**
Model H	Two-regime model (SPR, TED, SRET, HRET)	11.274

FFR: Federal Fund Rate; SPR: Term Spread (10-year-bond-rate - 3-month-bond-rate); TED: interbank rate – (T-bill rate); EFP: External Finance Premium: Best Lending rate - (T-bill rate); GDP: GDP growth rate; SRET: Stock Return based on S&P500; HRET: Housing Return based on OFHEO

Table 4b A Comparison of Goodness of Fit between linear versus regime-switching VAR:
AIC (model; linear VAR) / AIC (model; regime-switching VAR)

Models		Ratio of AIC
Model B	(FFR, GDP, SRET, HRET)	1.062 (14.306/13.472)
Model C	(FFR, SPR, SRET, HRET)	1.066 (13.2177/12.450)
Model D	(FFR, EFP, SRET, HRET)	**1.126** **(11.444/10.159)**
Model E	(FFR, TED, SRET, HRET)	**1.122** **(12.489/11.134)**
Model F	(EFP, SPR, SRET, HRET)	**1.105** **(10.773/9.747)**
Model G	(EFP, TED, SRET, HRET)	**1.112** **(9.346/8.404)**
Model H	(SPR, TED, SRET, HRET)	1.082 (12.201/11.274)

A Summary of In-sample Forecasting Performances (4-Quarter Ahead Forecasts)

		Stock Returns		Housing Returns	
		RMSE	MAE	RMSE	MAE
Model A	Single-regime model (FFR, SPR, TED, EFP, GDP, SRET, HRET)	7.5842	5.6699	0.8226	0.6499
Model B	Two-regime model (FFR, GDP, SRET, HRET)	7.6411	5.6640	0.8286	0.6508
Model C	Two-regime model (FFR, SPR, SRET, HRET)	**7.5103**	**5.5922**	0.7974	0.6361
Model D	Two-regime model (FFR, EFP, SRET, HRET)	7.6460	5.6561	**0.7801**	**0.6129**
Model E	Two-regime model (FFR, TED, SRET, HRET)	7.6232	5.6959	0.7984	0.6207
Model F	Two-regime model (EFP, SPR, SRET, HRET)	7.7767	5.7204	0.7940	0.6331
Model G	Two-regime model (EFP, TED, SRET, HRET)	7.7917	5.8092	0.8397	0.6468
Model H	Two-regime model (SPR, TED, SRET, HRET)	7.6169	5.7064	0.8161	0.6313

A Summary of Out-of-Sample Forecasting Performances (4-Quarter Ahead Forecasts)

		Stock Returns		Housing Returns	
		RMSE	MAE	RMSE	MAE
Model A	Single-regime model (FFR, SPR, TED, EFP, GDP, SRET, HRET)	7.9841	**5.6808**	2.1292	1.8424
Model B	Two-regime model (FFR, GDP, SRET, HRET)	7.2027	5.8760	2.1303	1.8739
Model C	Two-regime model (FFR, SPR, SRET, HRET)	7.3392	6.0156	1.9161	1.7198
Model D	Two-regime model (FFR, EFP, SRET, HRET)	7.3122	5.9867	1.9977	1.7797
Model E	Two-regime model (FFR, TED, SRET, HRET)	7.0037	5.7126	2.0761	1.7754
Model F	Two-regime model (EFP, SPR, SRET, HRET)	8.2423	6.7808	**1.8184**	1.6078
Model G	Two-regime model (EFP, TED, SRET, HRET)	7.2071	5.7972	2.0430	1.7617
Model H	Two-regime model (SPR, TED, SRET, HRET)	**6.9225**	**5.6933**	**1.8284**	**1.5201**

Table 5c A Summary of Diebold and Mariano (1995) Statistics
(In-sample 4-Quarter Ahead Forecasts)

Model		Stock Returns		Housing Returns	
		MSE	MAE	MSE	MAE
A	Single-regime model (FFR, SPR, TED, EFP, GDP, SRET, HRET)	0.7318	2.478**	-0.1621	-0.4963
B	Two-regime model (FFR, GDP, SRET, HRET)	-0.1614	0.6655	-0.3220	-0.5398
C	Two-regime model (FFR, SPR, SRET, HRET)	1.1722	1.2627	0.5635	-0.1613
D	Two-regime model (FFR, EFP, SRET, HRET)	-0.2795	0.6718	1.3709	0.8491
E	Two-regime model (FFR, TED, SRET, HRET)	-0.2855	0.3332	0.9024	0.4998
F	Two-regime model (EFP, SPR, SRET, HRET)	-1.1219	-0.1338	0.7738	-0.0715
G	Two-regime model (EFP, TED, SRET, HRET)	-1.8132*	-1.2011	-0.9156	-0.7527

Note: The DM test is used to compare the forecasting ability for model H and the competing model. * Significant at 10% level of significance. ** Significant at 5% level of significance. A positive number indicates that model H is not as good as the alternative while a negative number indicates that model H out-performs the alternative model.

Table 5d A Summary of Diebold and Mariano (1995) Statistics
(Out-of-sample 4-Quarter Ahead Forecasts)

Model		Stock Returns		Housing Returns	
		MSE	MAE	MSE	MAE
A	Single-regime model (FFR, SPR, TED, EFP, GDP, SRET, HRET)	-1.1363	0.1264	-3.3408***	-32.7923***
B	Two-regime model (FFR, GDP, SRET, HRET)	-1.3610	-1.5920	-4.3774***	-17.4304***
C	Two-regime model (FFR, SPR, SRET, HRET)	-1.5381	-2.2680**	-1.1721	-2.4465**
D	Two-regime model (FFR, EFP, SRET, HRET)	-1.2888	-1.8064*	-5.6608***	-5.7929***
E	Two-regime model (FFR, TED, SRET, HRET)	-1.0822	-0.2802	-2.8926***	-30.1051***
F	Two-regime model (EFP, SPR, SRET, HRET)	-1.5901	-1.8569*	0.1079	-1.1512
G	Two-regime model (EFP, TED, SRET, HRET)	-1.0213	-0.6897	-3.5273***	-11.1494***

Note: The DM test is used to compare the forecasting ability for model H and the competing model. * Significant at 10% level of significance. ** Significant at 5% level of significance. *** Significant at 1% level of significance.

Is the forecasted Stock return within the 80% confidence interval?

	Models	Predicting 2006 based on 1975-2005	Predicting 2007 based on 1975-2006	Predicting 2008 based on 1975-2007
Model A	Single-regime model (FFR, SPR, TED, EFP, GDP, SRET, HRET)	Yes	Yes	Partly
Model B	Two-regime model (FFR, GDP, SRET, HRET)	Yes	Yes	Partly
Model C	Two-regime model (FFR, SPR, SRET, HRET)	Yes	Yes	Partly
Model D	Two-regime model (FFR, EFP, SRET, HRET)	Yes	Yes	Partly
Model E	Two-regime model (FFR, TED, SRET, HRET)	Yes	Yes	Partly
Model F	Two-regime model (EFP, SPR, SRET, HRET)	Yes	Yes	Partly
Model G	Two-regime model (EFP, TED, SRET, HRET)	Yes	Yes	Partly
Model H	**Two-regime model (SPR, TED, SRET, HRET)**	**Yes**	**Yes**	**Yes**

Is the forecasted Housing return within the 80% confidence interval?

	Models	Predicting 2006 based on 1975-2005	Predicting 2007 based on 1975-2006	**Predicting 2008 based on 1975-2007**
Model A	Single-regime model (FFR, SPR, TED, EFP, GDP, SRET, HRET)	Partly	Partly	**No**
Model B	Two-regime model (FFR, GDP, SRET, HRET)	Yes	Partly	**No**
Model C	Two-regime model (FFR, SPR, SRET, HRET)	Yes	Partly	**No**
Model D	Two-regime model (FFR, EFP, SRET, HRET)	Partly	Partly	**No**
Model E	Two-regime model (FFR, TED, SRET, HRET)	Yes	Partly	**No**
Model F	Two-regime model (EFP, SPR, SRET, HRET)	Yes	Partly	**No**
Model G	Two-regime model (EFP, TED, SRET, HRET)	Yes	Partly	**No**
Model H	Two-regime model (SPR, TED, SRET, HRET)	Yes	Partly	**No**

Table 6a: Do models forecast stock return better in the presence of housing return?

	In-sample	Out-of-sample
Model B predicts stock return better than B1	No	No
Model C predicts stock return better than C1	No	No
Model D predicts stock return better than D1	No	No
Model E predicts stock return better than E1	No	**Yes**
Model F predicts stock return better than F1	No	No
Model G predicts stock return better than G1	No	No
Model H predicts stock return better than H1	No	**Yes**

Table 6b: Do models forecast housing return better in the presence of stock return?

	In-sample	Out-of-sample
Model B predicts housing return better than B2	No	No
Model C predicts housing return better than C2	**Yes**	**Yes**
Model D predicts housing return better than D2	No	No
Model E predicts housing return better than E2	**Yes**	**Yes**
Model F predicts housing return better than F2	No	No
Model G predicts housing return better than G2	No	No
Model H predicts housing return better than H2	**Yes**	**Yes**

Key: "YES" means the model is better in both RMSE and MAE criteria.

Figure 9   Simulation-Based Out-of-Sample Forecasts of Stock Returns with 80-Percent Confidence Interval (CI) from 2006Q1-2006Q4 Based on Information Available at 2005Q4

Model A: Single-Regime (FFR,SPR,TED,EFP,GDP,SRET,HRET); Model B: Two-Regime (FFR,GDP,SRET,HRET); Model C: Two-Regime (FFR,SPR,SRET,HRET); Model D: Two-Regime (FFR,EFP,SRET,HRET); Model E: Two-Regime (FFR,TED,SRET,HRET); Model F: Two-Regime (EFP,SPR,SRET,HRET); Model G: Two-Regime (EFP,TED,SRET,HRET); Model H: Two-Regime (SPR,TED,SRET,HRET)
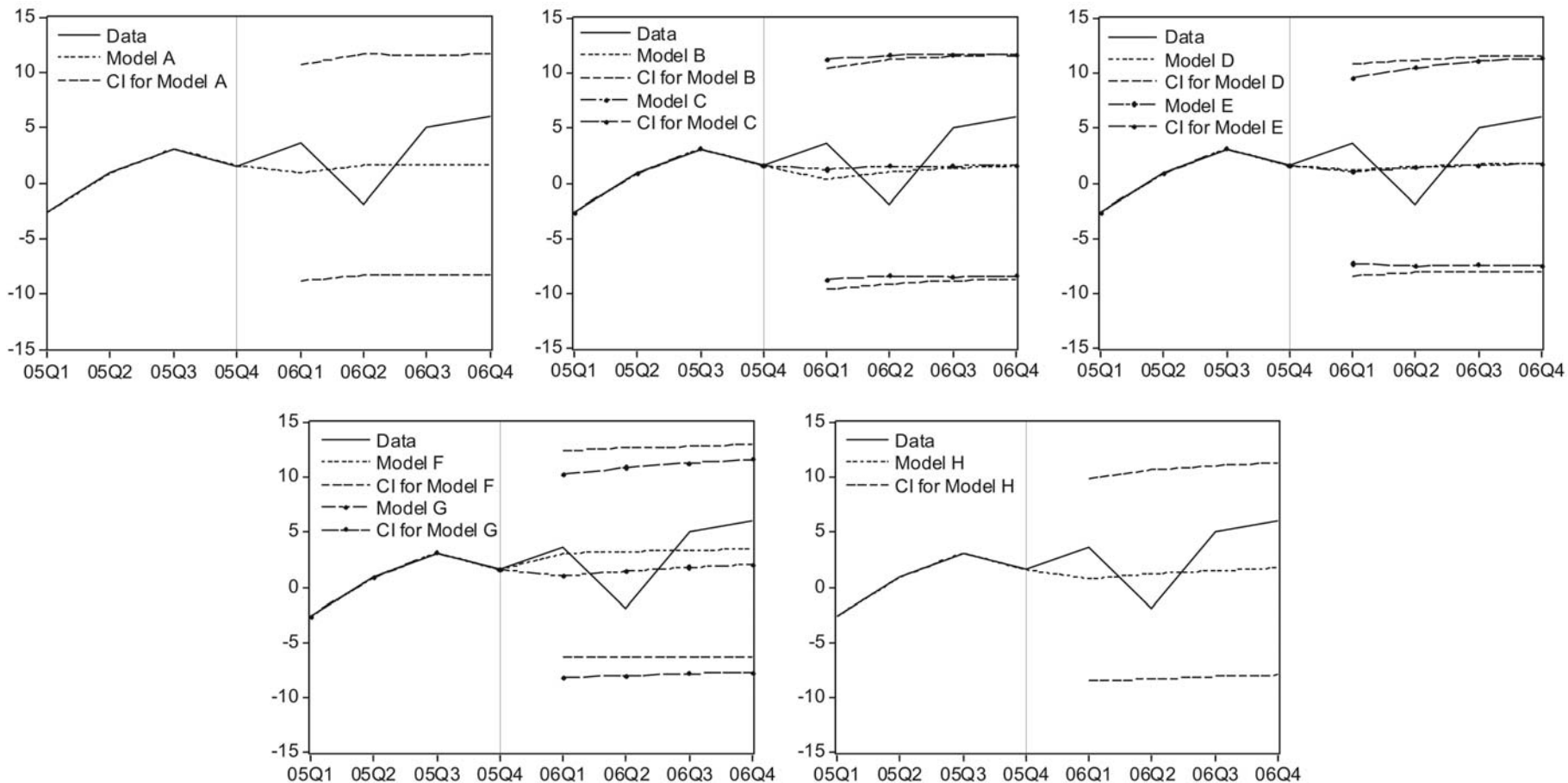
Figure 10   Simulation-Based Out-of-Sample Forecasts of Stock Returns with 80-Percent Confidence Interval (CI) from 2007Q1-2007Q4 Based on Information Available at 2006Q4

Model A: Single-Regime (FFR,SPR,TED,EFP,GDP,SRET,HRET); Model B: Two-Regime (FFR,GDP,SRET,HRET); Model C: Two-Regime (FFR,SPR,SRET,HRET); Model D: Two-Regime (FFR,EFP,SRET,HRET); Model E: Two-Regime (FFR,TED,SRET,HRET); Model F: Two-Regime (EFP,SPR,SRET,HRET); Model G: Two-Regime (EFP,TED,SRET,HRET); Model H: Two-Regime (SPR,TED,SRET,HRET)
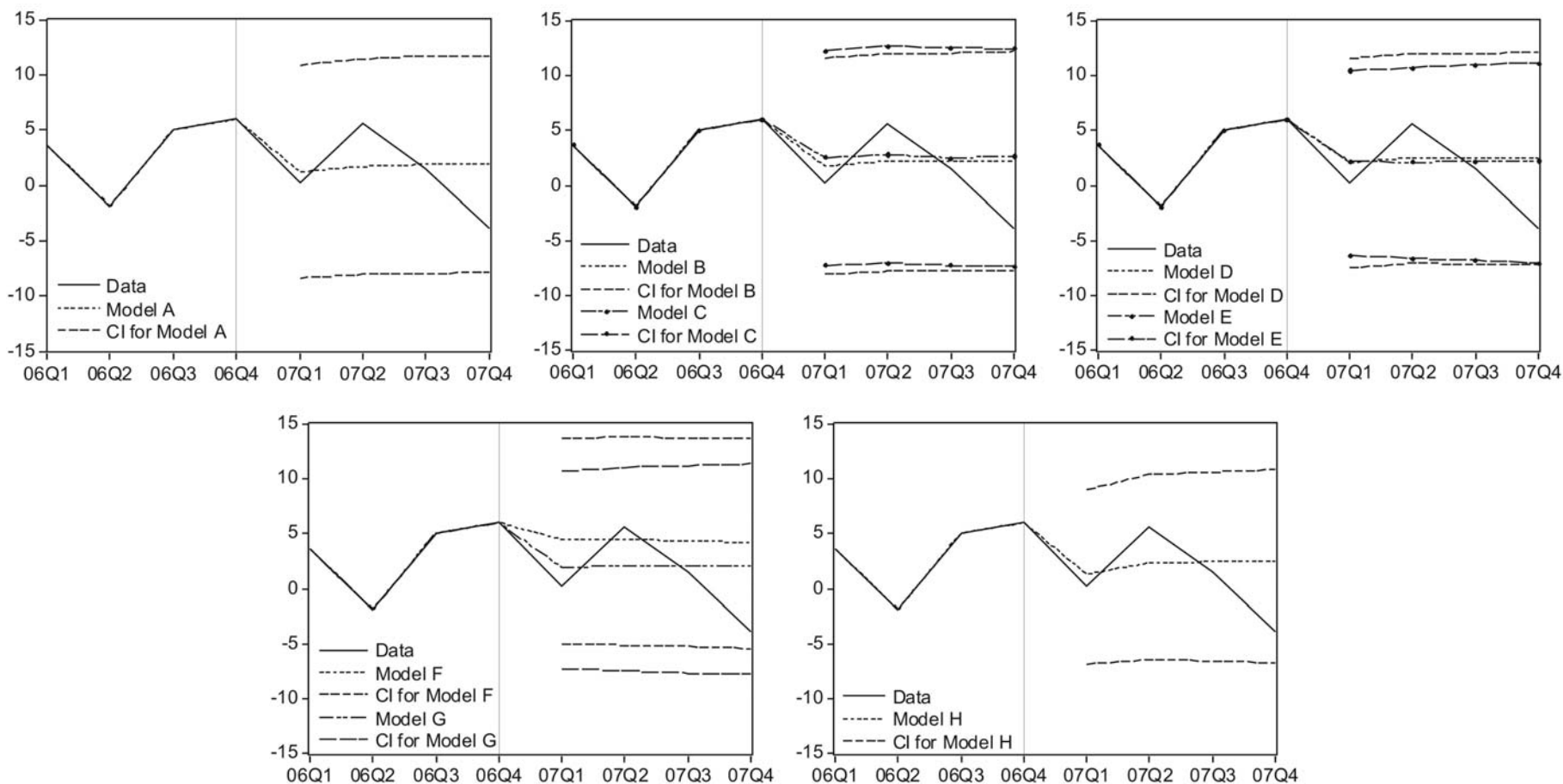
Figure 11   Simulation-Based Out-of-Sample Forecasts of Stock Returns with 80-Percent Confidence Interval (CI) from 2008Q1-2008Q3 Based on Information Available at 2007Q4

Model A: Single-Regime (FFR,SPR,TED,EFP,GDP,SRET,HRET); Model B: Two-Regime (FFR,GDP,SRET,HRET); Model C: Two-Regime (FFR,SPR,SRET,HRET); Model D: Two-Regime (FFR,EFP,SRET,HRET); Model E: Two-Regime (FFR,TED,SRET,HRET); Model F: Two-Regime (EFP,SPR,SRET,HRET); Model G: Two-Regime (EFP,TED,SRET,HRET); Model H: Two-Regime (SPR,TED,SRET,HRET)
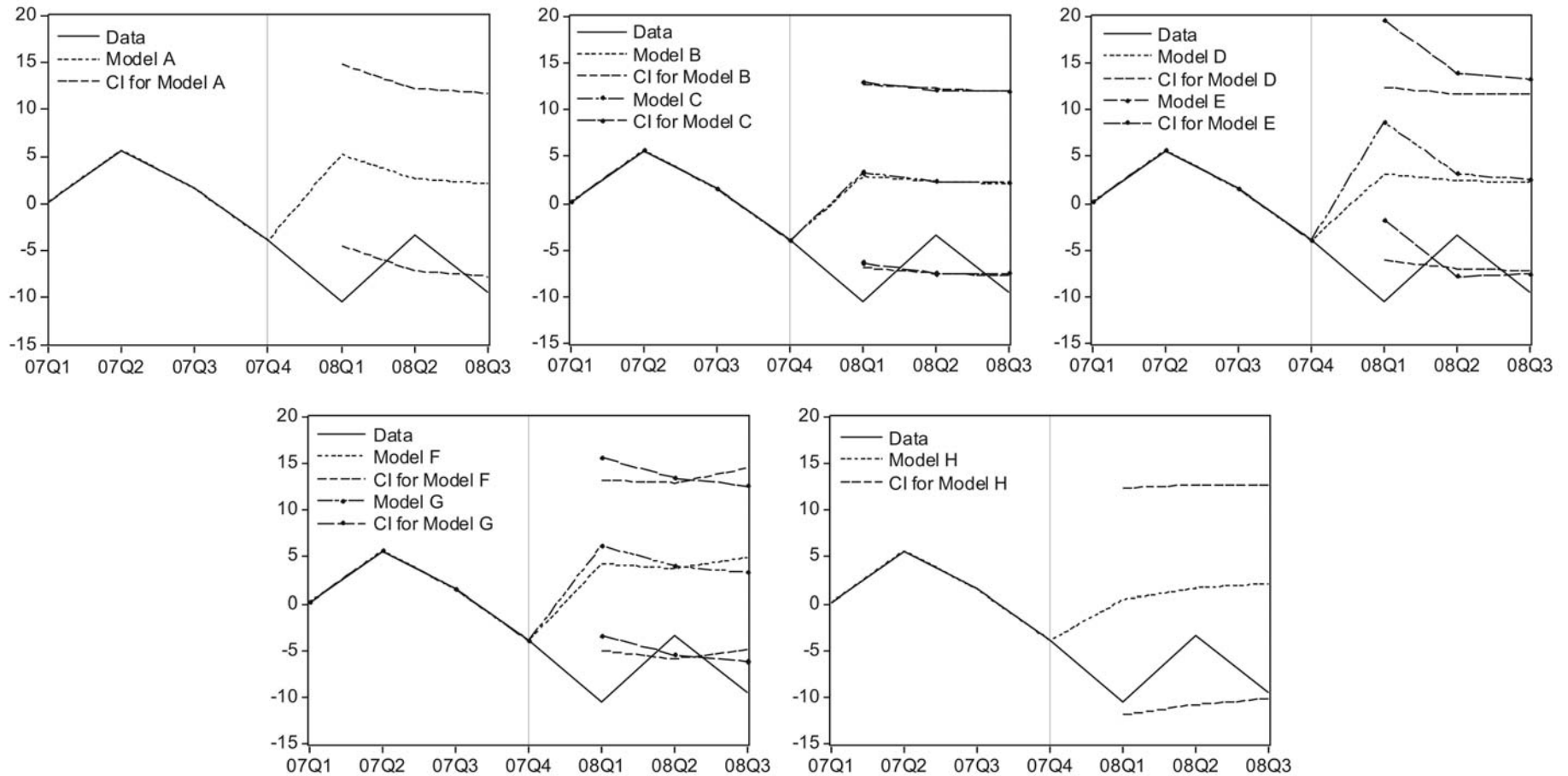
Figure 12   Simulation-Based Out-of-Sample Forecasts of Housing Returns with 80-Percent Confidence Interval (CI) from 2006Q1-2006Q4 Based on Information Available at 2005Q4

Model A: Single-Regime (FFR,SPR,TED,EFP,GDP,SRET,HRET); Model B: Two-Regime (FFR,GDP,SRET,HRET); Model C: Two-Regime (FFR,SPR,SRET,HRET); Model D: Two-Regime (FFR,EFP,SRET,HRET); Model E: Two-Regime (FFR,TED,SRET,HRET); Model F: Two-Regime (EFP,SPR,SRET,HRET); Model G: Two-Regime (EFP,TED,SRET,HRET); Model H: Two-Regime (SPR,TED,SRET,HRET)

Figure 13   Simulation-Based Out-of-Sample Forecasts of Housing Returns with 80-Percent Confidence Interval (CI) from 2007Q1-2007Q4 Based on Information Available at 2006Q4

Model A: Single-Regime (FFR,SPR,TED,EFP,GDP,SRET,HRET); Model B: Two-Regime (FFR,GDP,SRET,HRET); Model C: Two-Regime (FFR,SPR,SRET,HRET); Model D: Two-Regime (FFR,EFP,SRET,HRET); Model E: Two-Regime (FFR,TED,SRET,HRET); Model F: Two-Regime (EFP,SPR,SRET,HRET); Model G: Two-Regime (EFP,TED,SRET,HRET); Model H: Two-Regime (SPR,TED,SRET,HRET)
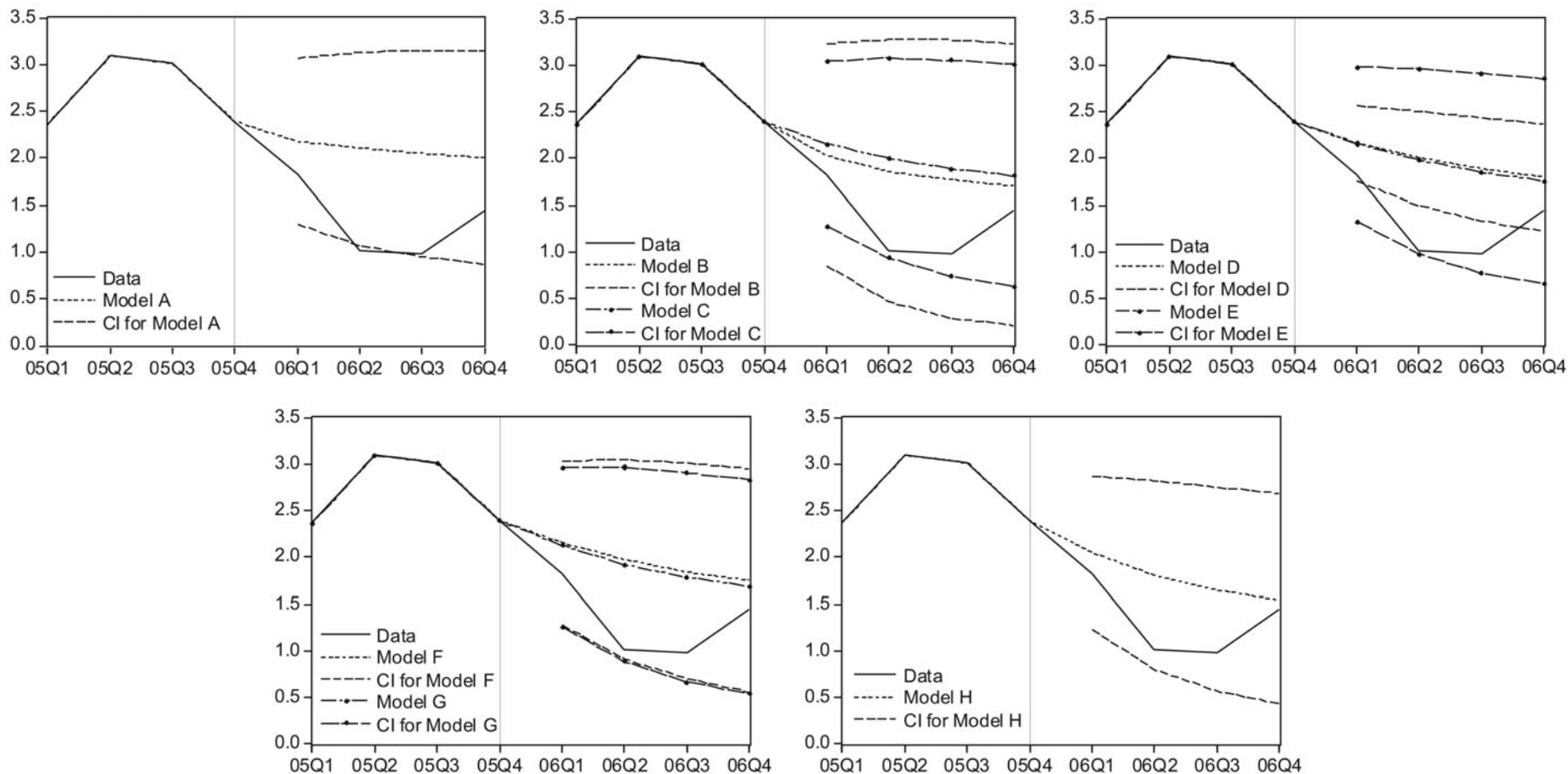
Figure 14   Simulation-Based Out-of-Sample Forecasts of Housing Returns with 80-Percent Confidence Interval (CI) from 2008Q1-2008Q3 Based on Information Available at 2007Q4

Model A: Single-Regime (FFR,SPR,TED,EFP,GDP,SRET,HRET); Model B: Two-Regime (FFR,GDP,SRET,HRET); Model C: Two-Regime (FFR,SPR,SRET,HRET); Model D: Two-Regime (FFR,EFP,SRET,HRET); Model E: Two-Regime (FFR,TED,SRET,HRET); Model F: Two-Regime (EFP,SPR,SRET,HRET); Model G: Two-Regime (EFP,TED,SRET,HRET); Model H: Two-Regime (SPR,TED,SRET,HRET)
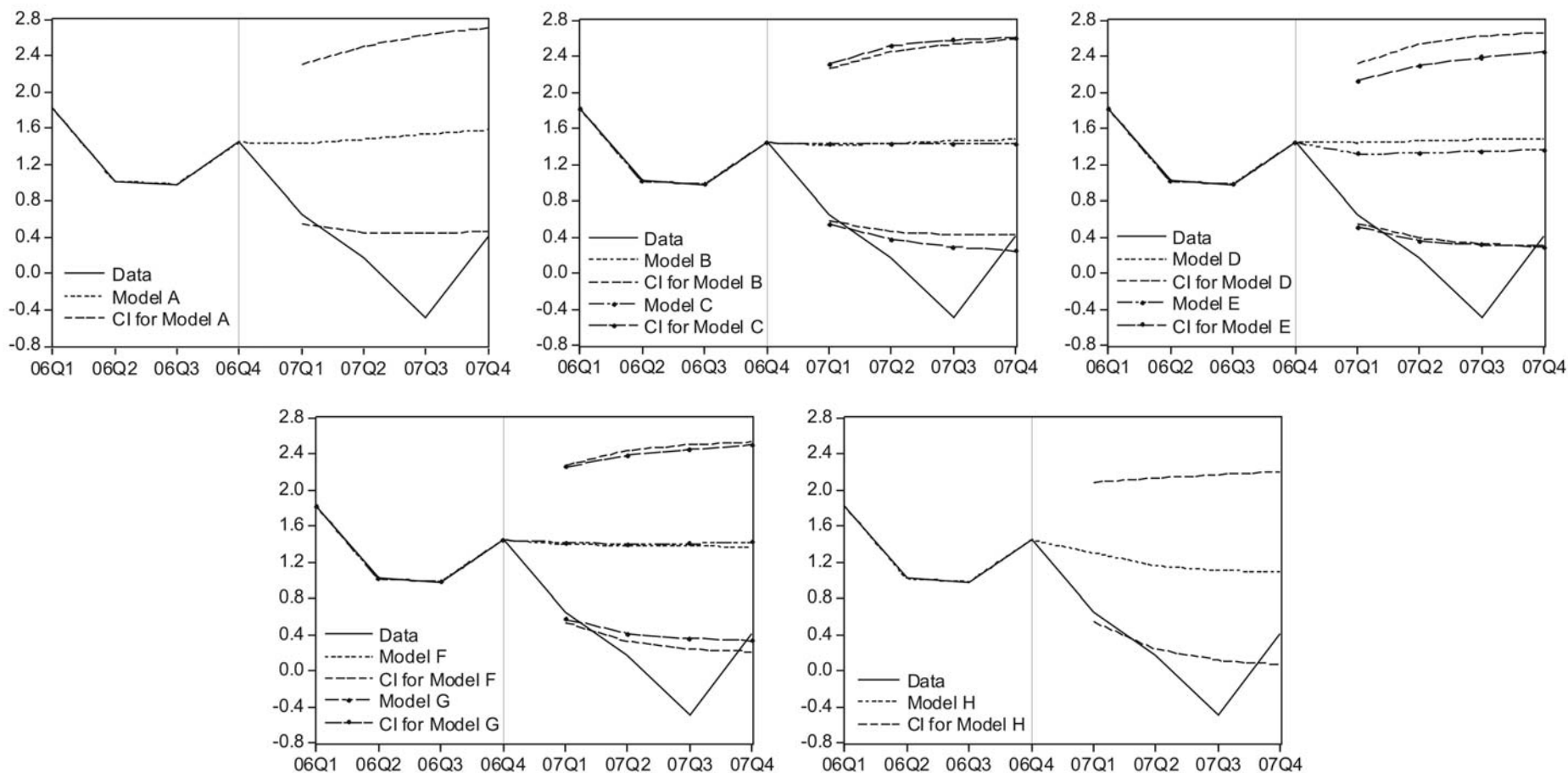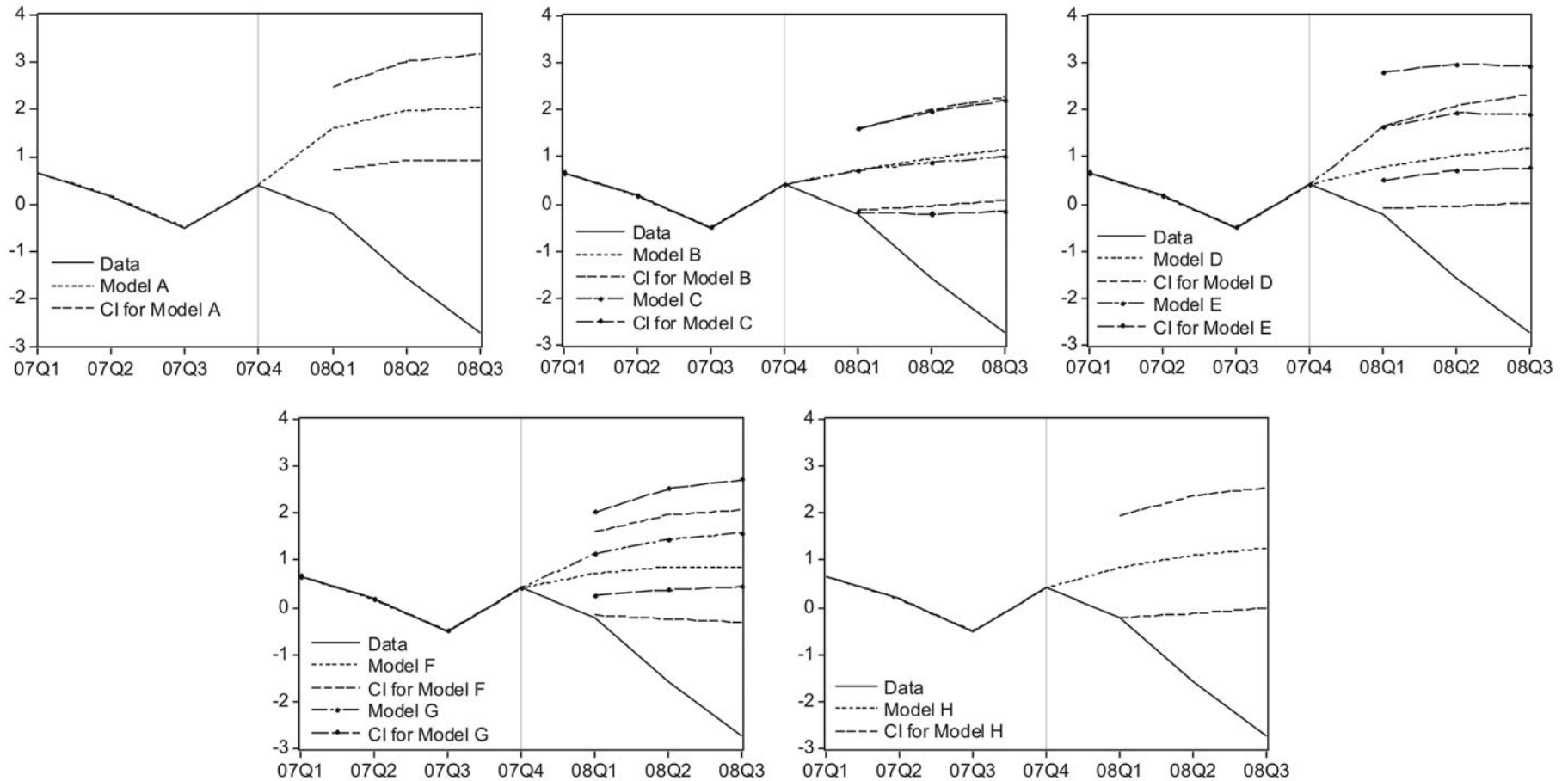
Conclusion

- A regime-switching SVAR model captures the "system dynamics" of the asset prices and financial market variables (Term Spread; TED are important)

- Linear VAR model with all variables *not* good enough

- Structural Change seems to occur in 2008

- NEED MORE AND BETTER models

Table 10a: A Summary of In-sample Forecasting Performances (4-Quarter Ahead Forecasts)

		Stock Returns		Housing Returns	
		RMSE	MAE	RMSE	MAE
Model B	Two-regime model (FFR, GDP, SRET, HRET)	7.6411	5.6640	0.8286	0.6508
Model B1	Two-regime model (FFR, GDP, SRET)	7.7030	5.6441	/	/
Model B2	Two-regime model (FFR, GDP, HRET)	/	/	0.8205	0.6444

		Stock Returns		Housing Returns	
		RMSE	MAE	RMSE	MAE
Model C	Two-regime model (FFR, SPR, SRET, HRET)	7.5103	5.5922	0.7974	0.6361
Model C1	Two-regime model (FFR, SPR, SRET)	7.5674	5.5665	/	/
Model C2	Two-regime model (FFR, SPR, HRET)	/	/	0.8126	0.6488

		Stock Returns		Housing Returns	
		RMSE	MAE	RMSE	MAE
Model D	Two-regime model (FFR, EFP, SRET, HRET)	7.6460	5.6561	0.7801	0.6129
Model D1	Two-regime model (FFR, EFP, SRET)	7.6261	5.6389	/	/
Model D2	Two-regime model (FFR, EFP, HRET)	/	/	0.7725	0.6068

		Stock Returns		Housing Returns	
		RMSE	MAE	RMSE	MAE
Model E	Two-regime model (FFR, TED, SRET, HRET)	7.6232	5.6959	0.7984	0.6207
Model E1	Two-regime model (FFR, TED, SRET)	7.6309	5.6751	/	/
Model E2	Two-regime model (FFR, TED, HRET)	/	/	0.8004	0.6237

		Stock Returns		Housing Returns	
		RMSE	MAE	RMSE	MAE
Model F	Two-regime model (EFP, SPR, SRET, HRET)	7.7767	5.7204	0.7940	0.6331
Model F1	Two-regime model (EFP, SPR, SRET)	7.7579	5.7245	/	/
Model F2	Two-regime model (EFP, SPR, HRET)	/	/	0.7976	0.6272

		Stock Returns		Housing Returns	
		RMSE	MAE	RMSE	MAE
Model G	Two-regime model (EFP, TED, SRET, HRET)	7.7917	5.8092	0.8397	0.6468
Model G1	Two-regime model (EFP, TED, SRET)	7.7226	5.7090	/	/
Model G2	Two-regime model (EFP, TED, HRET)	/	/	0.8387	0.6441

		Stock Returns		Housing Returns	
		RMSE	MAE	RMSE	MAE
Model H	Two-regime model (SPR, TED, SRET, HRET)	7.6169	5.7064	0.8161	0.6313
Model H1	Two-regime model (SPR, TED, SRET)	7.6332	5.6946	/	/
Model H2	Two-regime model (SPR, TED, HRET)	/	/	0.8263	0.6479

Table 10b: A Summary of Out-of-sample Forecasting Performances (4-Quarter Ahead Forecasts)

		Stock Returns		Housing Returns	
		RMSE	MAE	RMSE	MAE
Model B	Two-regime model (FFR, GDP, SRET, HRET)	7.2027	5.8760	2.1303	1.8739
Model B1	Two-regime model (FFR, GDP, SRET)	7.1082	5.8411	/	/
Model B2	Two-regime model (FFR, GDP, HRET)	/	/	2.1220	1.8478

		Stock Returns		Housing Returns	
		RMSE	MAE	RMSE	MAE
Model C	Two-regime model (FFR, SPR, SRET, HRET)	7.3392	6.0156	1.9161	1.7198
Model C1	Two-regime model (FFR, SPR, SRET)	7.1075	5.8296	/	/
Model C2	Two-regime model (FFR, SPR, HRET)	/	/	1.9379	1.7388

		Stock Returns		Housing Returns	
		RMSE	MAE	RMSE	MAE
Model D	Two-regime model (FFR, EFP, SRET, HRET)	7.3122	5.9867	1.9977	1.7797
Model D1	Two-regime model (FFR, EFP, SRET)	7.1105	5.8246	/	/
Model D2	Two-regime model (FFR, EFP, HRET)	/	/	1.9793	1.7648

		Stock Returns		Housing Returns	
		RMSE	MAE	RMSE	MAE
Model E	Two-regime model (FFR, TED, SRET, HRET)	7.0037	5.7126	2.0761	1.7754
Model E1	Two-regime model (FFR, TED, SRET)	7.2950	5.9108	/	/
Model E2	Two-regime model (FFR, TED, HRET)	/	/	2.0820	1.7832

		Stock Returns		Housing Returns	
		RMSE	MAE	RMSE	MAE
Model F	Two-regime model (EFP, SPR, SRET, HRET)	8.2423	6.7808	1.8184	1.6078
Model F1	Two-regime model (EFP, SPR, SRET)	7.9820	6.5703	/	/
Model F2	Two-regime model (EFP, SPR, HRET)	/	/	1.7998	1.5891

		Stock Returns		Housing Returns	
		RMSE	MAE	RMSE	MAE
Model G	Two-regime model (EFP, TED, SRET, HRET)	7.2071	5.7972	2.0430	1.7617
Model G1	Two-regime model (EFP, TED, SRET)	7.1682	5.7683	/	/
Model G2	Two-regime model (EFP, TED, HRET)	/	/	2.0199	1.7586

		Stock Returns		Housing Returns	
		RMSE	MAE	RMSE	MAE
Model H	Two-regime model (SPR, TED, SRET, HRET)	6.9225	5.6933	1.8284	1.5201
Model H1	Two-regime model (SPR, TED, SRET)	7.1912	5.8319	/	/
Model H2	Two-regime model (SPR, TED, HRET)	/	/	1.8508	1.5642