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Sergey Ivashchenko and Rangan Gupta

EERI Research Paper Series No 04/2017

ISSN: 2031-4892

EERI
Economics and Econometrics Research Institute
Avenue Louise
1050 Brussels
Belgium

Tel: +32 2271 9482
Fax: +32 2271 9480
www.eeri.eu

Near-Rational Expectations: How Far are Surveys from Rationality?

Sergey Ivashchenko* and Rangan Gupta**

Abstract

New simple forms of deviation from rational expectations (RE) are suggested: temporary near-rational expectations (TNRE) and persistent near-rational expectations (PNRE). The medium-scale DSGE model was estimated with the RE, the TNRE and the PNRE. It was estimated with and without observations from the survey's expectations. The quality of the out-of-sample forecasts was estimated. It is shown that near-rational concepts produce the same advantages as learning, without its disadvantages (including the absence of 'learning expectations' reactions on policy change). The influence of the observed expectations on forecasting quality was analysed.

Keywords: DSGE; out-of-sample forecasts; survey expectations; near-rational expectations.

JEL Codes: E32; E37; E47.

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* Corresponding author. Saint Petersburg Institute for Economics and Mathematics (Russian Academy of Sciences), 36-38 Serpukhovskaya Street, Saint Petersburg, 190013, RUSSIA; Economics of Saint-Petersburg State University, 62 Chaykovskogo Street, Saint Petersburg, 191123, RUSSIA; National Research University Higher School of Economics, Soyza Pechatnikov Street, 15 Saint Petersburg, 190068, RUSSIA. Email: sergey.ivashchenko.ru@gmail.com.

** Deparment of Economics, University of Pretoria, Pretoria, 0002, SOUTH AFRICA. Email: rangan.gupta@up.ac.za.

1. Introduction

DSGE models are the key instruments of macroeconomic analysis. They are widely used by central banks and other official organisations [Tovar (2009)]. The forecasting quality of DSGE models is superior to that of autoregressive models and close to the forecasting quality of surveys [Rubaszek and Skrzypczynski (2008); Del Negro and Schorfheide (2012)]. However, there are some critics who emphasise the low forecasting quality of forecasts [Edge and Gurkaynak (2010)].

Rational expectations constitute an important assumption of DSGE models. The main version of rational expectations assumes the full information approach. However, there are modifications such as news or sticky information. There are some papers that investigate the consequences of dropping the rational expectations assumption [Ormeno and Molnar (2014); Milani and Rajbhandari (2012)]. Learning is the main alternative to rational expectations [Milani (2012)].

The motivations for learning (instead of rational expectations) are the following:

1. Assumptions of rational expectations (all agents know the structure of the model; parameters of the model; all exogenous shocks and variables of the model) are too strong (agents know more than the researcher).
2. The usage of learning allows having desirable values of parameters.
3. Models with learning fit the data and forecast better than rational DSGE models.
4. Models with learning reproduce observed expectations (from surveys) better than rational DSGE models.

The first motivation for learning over rational expectations is proffered in most of the papers that use learning [Slobodyan and Wouters (2012); Milani and Rajbhandari (2012)]. An example of the second motivation is the persistence problem. Persistence is a desirable property of the model. However, an insignificant difference of the exogenous process from the unit root is not desirable. The ‘mechanical sources’ of persistence (such as habit) are usually included in models with rational expectations, while models with learning could achieve persistence of variables with a smaller persistence of exogenous processes [Milani (2012)].

The third motivation could be divided into modification with observed and unobserved expectations. Slobodyan and Wouters (2012) show that the medium-scale model with learning could fit data better than rational DSGE models do [Slobodyan and Wouters (2012)]. However, they do not use observed expectations from some surveys.

Milani and Rajbhandari (2012) compare the forecasting performance of a small-scale DSGE model with learning and with rational expectations. The model with learning fits better than the rational version. Forecasts of inflation are better for the rational expectations model. The same is true for long-term forecasts of output growth. However, short-term forecasts of output growth are cases of where learning outperforms rational expectations. Multivariate measures of forecast quality are better for long-term rational expectations. In the case of short-term forecasts, models with learning are slightly better (depending on the forecasting quality measures and usage of the survey data). This result holds for expectations observed from surveys by the model with learning. However, the small-scale DSGE model has a weak structure (the rational expectations version has only three shocks and three state variables); therefore, additional flexibility – regardless of its source – has to be incorporated into the model, in order to improve it.

There is one paper that uses a medium-scale DSGE model and an observed inflation expectations, and this is by Ormeno and Molnar (2014). The model with learning fits slightly better in the case of unobserved inflation expectations, and much better in the case of observed inflation expectations. However, these results are sensitive to the learning algorithm: one of the optional algorithms decreases the advantage of the model for learning, and another produces an advantage over the rational expectations model.

Thus, the natural response (from rational expectations advocates) to the third motivation for learning is the following: the advantage of learning appears with additional flexibility of the models. If the model does not have enough flexibility, then any source of flexibility produces better fitting and forecasting.

The fourth motivation is related to a smaller number of papers [Milani (2012)]. Ormeno and Molnar demonstrate graphically that inflation expectations from the model with learning are closer to observed expectations than expectations from the rational version of the model are [Ormeno and Molnar (2014)]. However, this advantage disappears in the case of different learning schemes.

The learning approach has some disadvantages:

1. Learning algorithms allow the possibility of unrestricted manipulation (uncommon shocks that greatly exceed standard deviation break most learning algorithms). For example, the learning algorithm for inflation expectations would not react to a huge change in monetary policy [Ormeno and Molnar (2014)].
2. The conventional usage of learning involves a combination of the linearised model and nonlinear mechanisms of learning
3. Learning algorithms could produce explosive trajectories, despite the Blanchard-Kahn condition.
4. Conventional learning algorithms do not provide fluctuations around a rational expectations matrix. It is biased over rational expectations.

The first disadvantage is the most important one. It leads to inadequate consequences in the case of policy changes (a learning algorithm would not react to a policy change).

The detailed description of learning disadvantages is presented at section 3. We suggest a simple near-rational approach that would not have the disadvantages of learning. This suggests that agents have some unbiased estimators of rational expectations. The simple near-rational approach does not try to describe an estimator, it describes its properties.

Thus, the aim of this paper is to check whether or not a simple near-rational approach would produce the advantages of deviation from rational expectations (such as learning). The first goal was the construction of a medium-scale DSGE model that would produce a high quality of forecasts. The model should have a rich structure for lowering the influence of additional flexibility that derives from near-rational expectations (protection from excess favourable models for non-rational expectations). The second goal was to describe the near-rational expectations approach. The third goal was to estimate the forecasting ability of the model with rational and near-rational expectations. The forecasting ability was divided into a few groups: with and without observed expectations, for different horizons, forecasts of expectations, variables that have observed expectations, and other.

The remainder of the paper is organised as follows. In section 2 the DSGE models are described. Section three presents the near rational expectations algorithm in detail, as well as learning algorithms as a conventional deviation from rational expectations (including its disadvantages). In section four the dataset (including observed forecasts), estimation regimes and some estimation results is described. Section five contains measures of forecasting quality. This section gives answers about the influence of observed expectations on the forecasting quality (for variables that do or do not have observed expectations) of the DSGE model with rational and near-rational expectations. The last section comprises the 'Conclusions'.

2. The DSGE model

The DSGE model includes four types of agents: households, firms, government and the foreign sector. The structure of the model is presented in Figure 1. It includes central New-Keynesian features (for example, sticky price and adjustment costs in investment). The model is similar to Ivashchenko (2014) but has some differences within the foreign sector, taxes and some other categories.

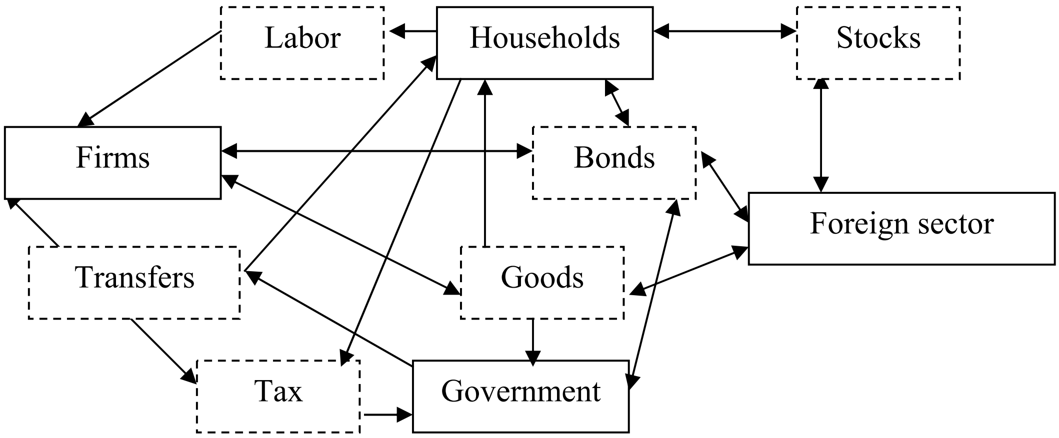


Figure.1. Structure of the DSGE model

TABLE 1. The DSGE model variables

Variable	Description	Stationary variable
$B_{F,t}$	Value of bonds bought by firms in period t	$b_{F,t} = B_{F,t} / P_t Z_t$
$B_{G,t}$	Value of bonds bought by government in period t	$b_{G,t} = B_{G,t} / P_t Z_t$
$B_{H,t}$	Value of bonds bought by households in period t	$b_{H,t} = B_{H,t} / P_t Z_t$
$B_{W,t}$	Value of bonds bought by the foreign sector in period t	$b_{W,t} = B_{W,t} / P_t Z_t$
C_t	Consumption at time t	$c_t = \ln(C_t / Z_t)$
D_t	Dividends at time t	$d_t = (C_t / Z_t)$
G_t	Government expenditure at time t	$g_t = \ln(G_t / Z_t)$
H_t	Habit at time t	$h_t = \ln(H_t / Z_t)$
I_t	Investments at time t	$i_t = \ln(I_t / Z_t)$
K_t	Capital at time t	$k_t = \ln(K_t / Z_t)$
L_t	Labour at time t	$l_t = \ln(L_t)$
M_t	Money stock in period t	$m_t = \ln\left(M_t / P_t Z_t\right)$
NX_t	Net export in period t	$nx_t = (NX_t / Z_t)$
P_t	Price of goods in period t	$p_t = \ln(P_t / P_{t-1})$
$P_{F,t}$	Price for goods of firm F in period t	$p_{F,t} = \ln(P_{F,t} / P_t)$
R_t	Interest rate in period t	$r_t = \ln(R_t)$
S_t	Price of stocks in period t	$s_t = \ln\left(S_t / P_t Z_t\right)$
$\tau_{L,t}$	Labour tax rate in period t	$\tau_{L,t} = \tau_{L,t}$
$\tau_{Y,t}$	Output tax rate in period t	$\tau_{Y,t} = \tau_{Y,t}$
$T_{TR,t}$	Transfers from government in period t	$\tau_{TR,t} = \ln\left(T_{TR,t} / P_t Z_t\right)$

W_t	Wage in period t	$w_t = \ln\left(W_t / P_t Z_t\right)$
$X_{H,t}$	Amount of stocks bought by households in period t	$x_{H,t} = X_{H,t}$
$X_{W,t}$	Amount of stocks bought by the foreign sector in period t	$x_{W,t} = X_{W,t}$
$Y_{D,t}$	Aggregate demand in period t	$y_{D,t} = \ln\left(Y_{D,t}/Z_t\right)$
$Y_{F,t}$	Output of firm F in period t	$y_{F,t} = \ln\left(Y_{F,t}/Z_t\right)$
$Z_{\alpha,t}$	Exogenous process corresponding to the elasticity of production function	$z_{\alpha,t} = Z_{\alpha,t}$
$Z_{\beta,t}$	Exogenous process corresponding to the intertemporal preferences of households	$z_{\beta,t} = \ln\left(Z_{\beta,t}/Z_{\beta,t-1}\right)$
$Z_{BF,t}$	Exogenous process corresponding to a conventional level of debt pressure	$z_{BF,t} = Z_{BF,t}$
$Z_{BH,t}$	Exogenous process corresponding to stickiness of households' bond position	$z_{BH,t} = \ln(Z_{BH,t}/Z_t^{1-\omega_C}$
$Z_{DW,t}$	Exogenous process corresponding to cash flow from the foreign part of firms	$z_{DW,t} = Z_{DW,t}/(P_t Z_t)$
$Z_{G,t}$	Exogenous process corresponding to government expenditure	$z_{G,t} = \ln\left(Z_{G,t}\right)$
$Z_{I,t}$	Exogenous process corresponding to the decreasing efficiency of investments	$z_{I,t} = \ln\left(Z_{I,t}\right)$
$Z_{L,t}$	Exogenous process corresponding to households' amount of labor	$z_{L,t} = \ln\left(Z_{L,t}/Z_t^{1-\omega_C}\right)$
$Z_{M,t}$	Exogenous process corresponding to the liquidity preferences of households	$z_{M,t} = \ln\left(Z_{M,t}/Z_t^{-\omega_C}\right)$
$Z_{NX,t}$	Exogenous process corresponding to net export	$z_{NX,t} = Z_{NX,t}$
$Z_{P,t}$	Exogenous process corresponding to the level of price stickiness	$z_{P,t} = \ln\left(Z_{P,t}\right)$
$Z_{R,t}$	Exogenous process corresponding to monetary policy	$z_{R,t} = Z_{R,t}$
$Z_{\tau,t}$	Exogenous process corresponding to the taxation policy	$z_{\tau,t} = Z_{\tau,t}$
$Z_{TR,t}$	Exogenous process corresponding to the transfers policy	$z_{TR,t} = Z_{TR,t}$
Z_t	Exogenous process corresponding to technological developments	$z_t = \ln\left(Z_t/Z_{t-1}\right)$

2.1 Households

Households maximise the expected sum of their discounted utility functions (1) with budget restrictions (2). Households do not own capital, but they can invest in domestic stocks and bonds as a means of saving money. The utility function consists of the propensity to consume, with a habit effect, the disutility of labour, money at the utility function, and the disutility of bond position deviation from the preferred level.

$$E\left(\sum_{t=0}^{\infty} Z_{\beta,t}\left(\begin{array}{l}\dfrac{\left(C_t - h_C H_{t-1}\right)^{1-\omega_C}}{1-\omega_C} - Z_{L,t}\dfrac{L_t^{1+\omega_L}}{1+\omega_L} \\ + Z_{M,t}\dfrac{M_t}{P_t} - Z_{BH,t}\left(\dfrac{B_{H,t}}{P_t Z_t} - \mu_B\right)^2\end{array}\right)\right) \rightarrow \max_{B,C,L,M,X} \quad (1)$$

$$P_t C_t + M_t + B_{H,t} + X_{H,t} S_t = (1-\tau_{L,t}) W_t L_t + M_{t-1} + R_{t-1} B_{H,t-1} + X_{H,t-1}(S_t + D_t) + T_{TR,t} \quad (2)$$

where C_t is consumption in period t, L_t is labour supply in period t, M_t is the money stock in period t, P_t is the price of goods in period t, $B_{H,t}$ is the value of bonds bought by households in period t, S_t is the price of stocks in period t, X_t is the amount of stocks bought by households in period t, τ_t is the tax rate in period t, $T_{TR,t}$ is the transfer from government in period t, R_t is the interest rate on bonds in period t, and D_t is dividends from stocks in period t.

2.2 Finished goods-producing firms

Perfectly competitive firms produce the final good Y_t using the intermediate goods $Y_{j,t}$ and the CES production technology:

$$Y_t = \left(\int_0^1 Y_{j,t}^{(\theta-1)/\theta} dj \right)^{\theta/(\theta-1)} \quad (3)$$

Profit maximisation and a zero profit condition for the finished goods producers implies the price level P_t and a demand function for the intermediate good, j:

$$Y_{j,t} = \left(\frac{P_{j,t}}{P_t} \right)^{-\theta} Y_t \quad (4)$$

$$P_t = \left(\int_0^1 P_{j,t}^{1-\theta} dj \right)^{1/(1-\theta)} \quad (5)$$

2.3 Intermediate goods-producing firms

Firms maximise their expected discounted utility function (6) with restrictions. The utility function consists of a dividends flow and two rigidities (a stickiness of bond position and price stickiness in the Rotemberg form [Lombardo and Vestin, 2008]). The firms are working in a market with monopolistic competition; therefore, they have a demand restriction (7). The budget restriction (8) and production function (9) are common. The restriction of capital evolution (10) contains investment rigidity.

$$E\left(\sum_{t=0}^{\infty}\left(\mathop{\Pi}_{k=0}^{t-1} R_k\right)^{-1}\left(\begin{array}{l} D_t - P_{F,t}Y_{F,t}\mu_{FB}\left(\dfrac{B_{F,t}}{P_t Z_t} - Z_{BF,t}\right) \\ - P_{F,t}Y_{F,t}Z_{P,t}\left(\dfrac{P_{F,t}}{P_{F,t-1}} - \overline{p}\right)^2 - P_{F,t}Y_{F,t}Z_{FWL,t}\left(\dfrac{W_t L_t}{W_{t-1}L_{t-1}} - \overline{py}\right)^2 \end{array}\right)\right) \rightarrow \max_{\substack{D,B,P,Y,\\K,I,L}} \quad (6)$$

$$Y_{F,t} = \left(\frac{P_{F,t}}{P_t}\right)^{-\theta}\left(Y_{D,t}\right) \quad (7)$$

$$D_t + P_t I_t + W_t L_t + B_{F,t} = (1-\tau_{Y,t})P_{F,t}Y_{F,t} + R_{t-1}B_{F,t-1} + Z_{DW,t} \quad (8)$$

$$Y_{F,t} = \left(Z_t L_t\right)^{Z_{\alpha,t}}\left(K_{t-1}\right)^{1-Z_{\alpha,t}} \quad (9)$$

$$K_t = (1-\delta)K_{t-1} + I_t\left(1 - Z_{I,t}\left(\frac{I_t}{I_{t-1}} - \overline{y}\right)^2\right) \quad (10)$$

where D_t is the dividends of the firm in period t, $Y_{F,t}$ is the output of firm F in period t, $P_{F,t}$ is the price for the goods of firm F in period t, I_t is the demand for investment goods in period t, $Y_{D,t}$ is the aggregate demand in period t, P_t is the price level for domestic goods in period t, $B_{F,t}$ is the value of bonds bought by the firm in period t, K_t is the amount of capital used by the firm in period t, and L_t is the amount of labour used by the firm in period t.

2.4 Government, foreign sector and balance equations

The government makes its decisions according to policy rules and budgetary restrictions. The government has the following budgetary restriction:

$$P_t G_t + T_{TR,t} + B_{G,t} = \tau_{L,t}W_t L_t + \tau_{Y,t}P_{F,t}Y_{F,t} + R_{t-1}B_{G,t-1} + M_t - M_{t-1} \quad (11)$$

The monetary policy rule is as follows:

$$\ln(R_t) = \gamma_R \ln(R_{t-1}) + (1-\gamma_R)\left(\gamma_{RP}\left(\ln\left(\frac{P_t}{P_{t-1}}\right) - \overline{p}\right) + \gamma_{RY}\left(\ln\left(\frac{Y_{D,t}}{Y_{D,t-1}}\right) - \overline{y}\right) + Z_{R,t}\right) \quad (12)$$

The fiscal policy rules are as follows:

$$\ln\left(\frac{G_t}{Y_{D,t}}\right) = \gamma_G \ln\left(\frac{G_{t-1}}{Y_{D,t-1}}\right) + (1-\gamma_G)\begin{pmatrix} Z_{G,t} + \gamma_{GB}\left(\frac{B_{G,t}}{P_t Y_{D,t}} - \overline{b_G}\exp\left(-\overline{y_D}\right)\right) + \\ + \gamma_{GY}\left(\ln\left(\frac{Y_{D,t}}{Y_{D,t-1}}\right) - \overline{y}\right) \end{pmatrix} \tag{13}$$

$$\ln\left(\frac{T_{TR,t}}{Y_{D,t}}\right) = \gamma_{TR} \ln\left(\frac{T_{TR,t-1}}{Y_{D,t-1}}\right) + (1-\gamma_{TR})\begin{pmatrix} Z_{TR,t} + \gamma_{TRB}\left(\frac{B_{G,t}}{P_t Z_t} - \overline{b_G}\exp\left(-\overline{y_D}\right)\right) + \\ + \gamma_{TRY}\left(\ln\left(\frac{Y_{D,t}}{Y_{D,t-1}}\right) - \overline{y}\right) \end{pmatrix} \tag{14}$$

$$\tau_{L,t} = \gamma_{TL}\tau_{L,t-1} + (1-\gamma_{TL})\left(\gamma_{TLB}\left(\frac{B_{G,t}}{P_t Z_t} - \overline{b_G}\exp\left(-\overline{y_D}\right)\right) + \gamma_{TLY}\left(\ln\left(\frac{Y_{D,t}}{Y_{D,t-1}}\right) - \overline{y}\right) + Z_{TL,t}\right) \tag{15}$$

$$\tau_{Y,t} = \gamma_{TY}\tau_{Y,t-1} + (1-\gamma_{TY})\left(\gamma_{TYB}\left(\frac{B_{G,t}}{P_t Z_t} - \overline{b_G}\exp\left(-\overline{y_D}\right)\right) + \gamma_{TYY}\left(\ln\left(\frac{Y_{D,t}}{Y_{D,t-1}}\right) - \overline{y}\right) + Z_{TY,t}\right) \tag{16}$$

The foreign sector is exogenous. It has a budgetary restriction (17) and is subject to exogenous rules (18)-(19).

$$NX_t P_t + B_{W,t} + X_{W,t} S_t + Z_{DW,t} = R_{t-1} B_{W,t-1} + X_{W,t-1}(S_t + D_t) \tag{17}$$

$$\left(\frac{NX_t}{Z_t}\right) = \gamma_{NX}\left(\frac{NX_{t-1}}{Z_{t-1}}\right) + (1-\gamma_{NX})\left(\gamma_{NXB}\left(\frac{B_{W,t}}{P_t Z_t} - \overline{b_W}\right) + Z_{NX,t}\right) \tag{18}$$

$$X_{W,t} = \gamma_{XW} X_{W,t-1} + (1-\gamma_{XW})\left(\gamma_{XWB}\left(\frac{B_{W,t}}{P_t Z_t} - \overline{b_W}\right) + Z_{XW,t}\right) \tag{19}$$

The three balance restrictions are as follows: each bond should be bought by someone (20), the number of stocks is equal to one (21), and aggregate demand consists of consumption, investments, government consumption and net exports (22). Formula (23) denotes how the habit is formed.

$$B_{H,t} + B_{F,t} + B_{G,t} + B_{W,t} = 0 \tag{20}$$

$$X_{H,t} + X_{W,t} = 1 \tag{21}$$

$$Y_{D,t} = C_t + I_t + G_t + NX_t \tag{22}$$

$$H_t = h_h H_{t-1} + C_t \quad (23)$$

All the exogenous processes are AR (1) with the following parameterisation:

$$z_{*,t} = \eta_{0,*,t}(1-\eta_{1,*,t}) + \eta_{1,*,t} z_{*,t-1} + \varepsilon_{*,t} \quad (24)$$

3. Near-rational expectations

Usually, we compute the approximate solution to a rational expectations problem (a system of restrictions and first-order conditions that contains expectations) with the perturbation method [Schmitt-Grohe and Uribe (2004)]. The first-order approximation of solution (26) is equivalent to the solution of a linearised rational expectations problem (25).

$$A_B x_{t-1} + A_0 x_t + A_F E_t\left(x_{t+1}\right) + A_\varepsilon \varepsilon_t = 0 \quad (25)$$

$$x_t = Q_X x_{t-1} + Q_\varepsilon \varepsilon_t \quad (26)$$

Demonstrating near-rational expectations advantages requires describing the learning approach (as the main alternative to rational expectations). The learning approach modifies the rational expectations problem to form (27), by constructing some regression, instead of rational expectations. Usually, this is the least-squared with a fixed or growing window. An alternative is estimation with forgetting, per equations (28) and (29). The *(1/w)* is called gain; *w* is called window width. Nevertheless, all mechanisms of learning produce estimation, which entails a random deviation from the true value. There are modifications of learning, depending on available regressors for the learning rule. The main case is the following: agents use the rational model (all state variables are regressors).

$$A_B x_{t-1} + A_0 x_t + A_F \Phi_{t-1} x_t + A_\varepsilon \varepsilon_t = 0 \quad (27)$$

$$\Phi_t = \Phi_{t-1} + \left(wR_t\right)^{-1} x_{t-1}\left(x_t - \Phi_{t-1} x_{t-1}\right)^T \quad (28)$$

$$R_t = R_{t-1} + \left(x_{t-1} x_{t-1}{}^T - R_{t-1}\right)/ w \quad (29)$$

This simple exercise illustrates the disadvantages of the learning approach. We computed the properties of a single-dimensional expectations problem. The formal scheme is the following: draw A_B, A_0, A_F, A_ε from a standard normal distribution (zero mean, standard deviation equal to one); choose draws that produce a unique stable solution with rational expectations (Blanchard-Kahn condition holds); generate the trajectory (10 independent trajectories with 100 000 observations each) of a model with a learning approach (OLS with fixed window and constant gain (28)-(29)). The rational trajectory was used to initialise a learning approach. The results are presented in Table 2

TABLE 2. The learning properties

		Window = 10 observation	Window = 20 observation	Window = 40 observation
OLS with fixed window	Share of explosive trajectories	30%	13%	0%
	Median(abs(E(Φ$_t$|A)-Q$_X$))	4.67%	2.62%	1.35%
	Median(abs(E(Φ$_t$|A)-Q$_X$)/std(Φ$_t$|A))	17.1	11.2	5.03
Constant gain	Share of explosive trajectories	12%	1%	0%
	Median(abs(E(Φ$_t$|A)-Q$_X$))	2.89%	1.74%	0.812%
	Median(abs(E(Φ$_t$|A)-Q$_X$)/std(Φ$_t$|A))	11.9	6.59	2.68

Thus, learning could easily produce an explosive trajectory (despite the Blanchard-Kahn condition). The probability of a explosive trajectory depends on the distance between eigenvalues. The learning approach does not take into consideration the transversability condition. It allows ‘switching’ from a stable trajectory to an explosive one. The medium- and large-scale DSGE models usually have eigenvalues that are slightly larger than one, which makes this disadvantage more important.

The second disadvantage of learning is its deviation from the rational trajectory in average. It is natural to expect that the mean of the learning coefficient should be equal to the coefficient of rational expectations. However, the experiment shows significant deviation. This comes from the nonlinear nature of learning. Equation (30) shows that the mean of learning coefficient would be equal to rational expectations without taking into account the last summand. However, the last summand is nonlinear and on average differs from zero. This produces some bias over the rational coefficient.

$$\left(A_B + A_0\Phi + A_F E\Phi_{t-1}\Phi\right)x_{t-1} + E\left(A_F\left(\Phi_{t-1} - E\Phi_{t-1}\right)\Phi x_{t-1}\right) = 0 \tag{30}$$

The disadvantages of learning became smaller in the case of a large window (small gain). The Slobodyan and Wouters parameter, with a value of 0.017-0.02, shows gains, which means a window of 50-59 observations, and 2.4-2.8 observation per parameter [Slobodyan and Wouters

(2012)]. The Milani and Rajbhandari parameter, with a value of 0.018-0.023, shows gains, which means a window of 43-56 observations and 10.9-13.9 observations per parameter [Milani and Rajbhandari (2012)]. Ormeno and Molnar have a gain parameter of 0.019-0.188, which means a window of 5-53 observations, and 2.63-2.66 observation per parameter [Ormeno and Molnar (2014)].

Thus, conventional usage of learning is a mix of linear model and nonlinear elements (that is, a methodology inconsistency). This can produce explosive trajectories for line models, despite the Blanchard-Kahn condition (especially for medium and large-scale models). It also produces some bias in the expectations of agents. This bias could be small in the case of a large learning window (small gain parameter) and usage of the true model. It produces problems for estimation (a large history and a large number of observed variables are required). There are some ways (de facto usage of extended Kalman filter) to work with these problems without changing the learning mechanism [Slobodyan and Wouters (2012)]. However, this is does not solve the problem (errors of filtering could be large in the case of notable standard deviations). If agents use the wrong model of learning, the bias becomes larger.

Near-rational expectations do not have such problems. The agents beliefs are unbiased by construction. The approach is consistent in terms of approximation order. Near-rational expectations mean adding exogenous mistakes to the rational expectations (31). The interpretation is that agents use some methods for construction of their expectations. These methods reveal rational expectations with measurement errors. In other words, agents have some unbiased estimators of rational expectations, and their errors are not correlated with the state variables of the model or other exogenous shocks. It means transformation of rational expectations problem (25) to equation (32), which has the same structure. There are two modifications of the near-rational expectations: the temporary near-rational expectations (TNRE) and the persistent near rational expectations (PNRE). The corresponding exogenous process $Z_{NR,t}$

has a zero mean and a finite variance. It is iid in the case of the TNRE and an autoregressive process in case of PNRE.

$$E_{NR,t} f(X_{t+1}) = E_t f(X_{t+1} + Z_{NR,t}) \tag{31}$$

$$A_B x_{t-1} + A_0 x_t + A_F E_t(x_{t+1}) + A_F Z_{NR,t} + A_\varepsilon \varepsilon_t = 0 \tag{32}$$

For example, the first-order condition of households with respect to amount of stocks (33) would be transformed into (34).

$$E_t \exp(z_{\beta,t} + (1-\omega_C) z_{Y,t+1}) \lambda_{HB,t+1} (d_{t+1} + \exp(s_{t+1})) = \lambda_{HB,t} \exp(s_t) \tag{33}$$

$$\begin{aligned} &E_{NR,t} \exp(z_{\beta,t} + (1-\omega_C) z_{Y,t+1}) \lambda_{HB,t+1} (d_{t+1} + \exp(s_{t+1})) = \lambda_{HB,t} \exp(s_t) = \\ &= E_t \exp(z_{\beta,t} + (1-\omega_C)(z_{Y,t+1} + z_{NRY,t}))(\lambda_{HB,t+1} + z_{NR\lambda HB,t})(d_{t+1} + z_{NRD,t} + \exp(s_{t+1} + z_{NRS,t})) \end{aligned} \tag{34}$$

The survey of professional forecasters issued by the Federal Reserve Bank of Philadelphia was the source of observed expectations. The median forecasts were used as a measure of expectations. Three expectations were observed: the real GDP growth rate (obs_{YF}), a GDP deflator (obs_{PF}) and the growth rate of nominal consumption (obs_{CF}). Equations (35)-(37) describe the relationship between the observed expectations and the model variables.

$$obs_{YF} = E_{NR,t} \ln(Y_{D,t+1} / Y_{D,t}) = E_t y_{D,t+1} + z_{NRYD,t} - y_{D,t} + E_t z_{Y,t+1} + z_{NRY,t} \tag{35}$$

$$obs_{PF} = E_{NR,t} \ln(P_{t+1} / P_t) = E_t p_{t+1} + z_{NRP,t} \tag{36}$$

$$obs_{CF} = E_{NR,t} \ln((P_{t+1} C_{t+1}) / (P_t C_t)) = E_t c_{t+1} - c_t + E_t z_{Y,t+1} + z_{NRY,t} + E_t p_{t+1} + z_{NRP,t} \tag{37}$$

The observed expectations belong to different types of expectations:

1. an expectations that appears in many equations (obs_{PF}),
2. an expectations that is closely coupled with an expectations of type 1 (obs_{YF}),
3. an expectations that does not appear in models equations (obs_{CF}).

The absence of the expected consumption in the models equations is an explanation of absence $z_{NRC,t}$ (this exogenous process would be equivalent to measurement errors) in equation (37). This is a very specific case of where near-rational expectations are equivalent to measurement errors. It is as rare as the equivalence of an exogenous shock to measurement errors. This requires two conditions: the observed variable is not state variable; the corresponding shock appears only in the equation for this observed variable.

We did not use real-time data for simplicity. However, this created two approaches to the usage of forecasts. The first involved using a forecast of one-quarter ahead. This entailed using a forecast for the same quarter as when the forecast was done (for example, a forecast that appeared in the middle of August for the third quarter was taken from the survey, and forecasts were done at the end of July). This approach could be called the 'information approach'. It implies that our model has an information advantage due to the usage of final data (for example, forecasters first have to use an estimate of GDP for the previous quarter). It also implies the informational advantage of forecasters, due to the possibility of high frequency data usage (for example, they knew interest rates in July when making a forecast for the third quarter). We did not use interest rate expectations to minimise the problem that is described in the example. The second approach involved using a two-quarters ahead forecast. This meant using a forecast for the next quarter with respect to the quarter when forecast was done (for example, a forecast for the fourth quarter was taken from a survey that appeared in middle of August, and forecasts were done at the end of July). This prevents forecasters from looking forward (usage of data from a quarter that was forecast), but creates a higher information advantage of the model. This approach could be called the 'dates approach'. The model would be estimated with the information approach and with the dates approach.

4. The estimation results.

The model was estimated with USA quarterly data from 1985Q1 until 2013Q4. The following datasets were used: nominal personal consumption expenditures growth rate (obs_C); nominal government consumption expenditures and gross investment growth rate (obs_G); nominal gross private domestic investment growth rate (obs_I); compensation of employees growth rate (obs_{WL}); three-month euro-dollar deposit rate (obs_R); GDP growth rate (obs_Y); growth rate of GDP deflator (obs_P); MSCI USA gross return (obs_{STR}); sum of personal current taxes, contributions for government social insurance and current transfer receipts from persons as a fraction of compensation of employees (obs_{taxL}); total receipts of government minus income sources from previous point as a fraction of GDP(obs_{taxY}); total expenditures of government minus nominal government consumption expenditures and gross investment growth rate (obs_{tr}). All data, barring the stock price and interest rate are from the Bureau of Economic Analysis, U.S. Department of Commerce. The interest rate comes from the FRED database of the Federal Reserve Bank of St. Louis, while the MSCI stock price is obtained from the MSCI database at: https://www.msci.com/indexes. The observed expectations obs_{PF}, obs_{YF} and obs_{CF} are described above. The DSGE model was estimated 15 times with the maximum likelihood method: with the information approach, with the dates approach, and without observed expectations; with RE, TNRE and PNRE; with measurement errors for observed expectations, and without them. The log-likelihood values are presented in Table 3. Table 4 presents the estimation results. Tables A1-A4 present the estimation results (see the Appendix).

TABLE 3. The log-likelihood of the DSGE model

	RE	TNRE	PNRE
Without observed expectations (WE)	4428.98	4477.38	4506.99
With information approach without measurement errors (IAWME)	5613.14	5989.47	6071.89
With information approach with measurement errors (IAME)	5916.62	6009.72	6082.60
With dates approach without measurement errors (DAWME)	5660.16	6115.42	6163.63
With dates approach with measurement errors (DAME)	6001.17	6139.55	6191.03

The critics of rational expectations include the high persistence of exogenous technology progress [Milani (2012)]. The suggested approaches do not produce lower persistence in the cases without observed expectations. Observed expectations produce much lower persistence with the RE (in IAME and DAME cases). Usage of the TNRE or the PNRE makes persistence even smaller (it also greatly increases the standard deviation of $\eta_{1,Y}$).

There are parameters for which the standard deviation was smaller in the case of deviation from rational expectations (for example $\eta_{0,TR}$). However, the same effect was produced by observed (with measurement errors) expectations.

TABLE 4. Some estimation results

	γ_{RP}		ε_Y		$\eta_{1,Y}$		$\eta_{0,tr}$	
	value	std	value	std	value	Std	value	Std

RE WE	$1.12x10^{+00}$	$8.65x10^{-07}$	$2.54x10^{-02}$	$2.70x10^{-03}$	$9.69x10^{-01}$	$5.23x10^{-03}$	$-2.36x10^{+00}$	$1.92x10^{+00}$
TNRE WE	$1.11x10^{+00}$	$3.53x10^{-02}$	$1.43x10^{-02}$	$3.89x10^{-03}$	$9.60x10^{-01}$	$1.12x10^{-02}$	$-2.37x10^{+00}$	$3.24x10^{-02}$
PNRE WE	$1.11x10^{+00}$	$1.82x10^{-02}$	$1.27x10^{-02}$	$2.82x10^{-03}$	$9.53x10^{-01}$	$1.19x10^{-02}$	$-2.29x10^{+00}$	$2.57x10^{-02}$
RE IAWME	$1.49x10^{+00}$	$4.19x10^{-02}$	$2.16x10^{-02}$	$2.22x10^{-03}$	$8.55x10^{-01}$	$1.54x10^{-02}$	$-2.10x10^{+00}$	$1.19x10^{+00}$
RE IAME	$1.51x10^{+00}$	$1.35x10^{-01}$	$1.29x10^{-02}$	$1.98x10^{-03}$	$7.48x10^{-01}$	$4.67x10^{-02}$	$-2.39x10^{+00}$	$1.63x10^{-02}$
TNRE IAWME	$1.40x10^{+00}$	$3.86x10^{-01}$	$7.24x10^{-03}$	$7.37x10^{-04}$	$1.97x10^{-01}$	$7.05x10^{-02}$	$-2.38x10^{+00}$	$1.60x10^{-01}$
TNRE IAME	$1.57x10^{+00}$	$2.79x10^{-01}$	$6.43x10^{-03}$	$8.93x10^{-04}$	$2.46x10^{-01}$	$1.14x10^{-01}$	$-2.32x10^{+00}$	$3.20x10^{-01}$
PNRE IAWME	$6.58x10^{-01}$	$1.08x10^{-01}$	$6.87x10^{-03}$	$7.02x10^{-04}$	$3.37x10^{-01}$	$8.16x10^{-02}$	$-1.98x10^{+00}$	$6.43x10^{-01}$
PNRE IAME	$6.67x10^{-01}$	$7.88x10^{-02}$	$5.85x10^{-03}$	$7.51x10^{-04}$	$2.42x10^{-01}$	$8.91x10^{-02}$	$-2.39x10^{+00}$	$1.02x10^{-06}$
RE DAWME	$1.12x10^{+00}$	$9.46x10^{-07}$	$1.65x10^{-02}$	$1.52x10^{-03}$	$8.71x10^{-01}$	$1.25x10^{-02}$	$-1.78x10^{+00}$	$4.87x10^{-01}$
RE DAME	$8.53x10^{-01}$	$3.42x10^{-02}$	$6.80x10^{-03}$	$7.55x10^{-04}$	$5.35x10^{-01}$	$6.02x10^{-02}$	$-1.68x10^{+00}$	$2.42x10^{-02}$
TNRE DAWME	$6.27x10^{-01}$	$9.84x10^{-02}$	$4.50x10^{-03}$	$4.34x10^{-04}$	$2.12x10^{-02}$	$1.03x10^{-01}$	$-2.15x10^{+00}$	$2.89x10^{-01}$
TNRE DAME	$8.91x10^{-01}$	$1.27x10^{-01}$	$4.30x10^{-03}$	$4.37x10^{-04}$	$2.15x10^{-02}$	$1.23x10^{-01}$	$-1.72x10^{+00}$	$2.02x10^{-01}$
PNRE DAWME	$5.35x10^{-01}$	$6.57x10^{-07}$	$4.33x10^{-03}$	$3.70x10^{-04}$	$2.68x10^{-02}$	$7.18x10^{-02}$	$-2.35x10^{+00}$	$5.19x10^{-07}$
PNRE DAME	$8.17x10^{-01}$	$1.09x10^{-01}$	$4.17x10^{-03}$	$3.96x10^{-04}$	$1.43x10^{-02}$	$1.42x10^{-01}$	$-2.34x10^{+00}$	$6.96x10^{-07}$

The parameter γ_{RP} values require some comments, because they were smaller than 1 in some cases (such values for response to inflation often produce a breach of the Blanchard-Kahn condition). However, the interaction of fiscal and monetary policy allowed a unique stable solution, with $\gamma_{RP}<1$, to exist. There are a few papers that have $\gamma_{RP}<1$ and an OLS estimation (for example, from 1991Q1 to 2013Q4) could produce $\gamma_{RP}<1$ [Hall, (2012); Ivashchenko (2014)]. However, some parameters values were insensitive to the expectations regime (for example $\eta_{0,\beta}$).

It should be noted that standard deviations of measurement errors were small (see Table 5). They were smaller than the RMSE of the smoothed expectations (in the case without observed expectations).

TABLE 5. Estimation results for standard deviation of measurement errors

	obs_{CF}		obs_{PF}		obs_{YF}	
	value	std	value	std	value	std
RE IAME	$3.57x10^{-03}$	$3.59x10^{-04}$	$1.96x10^{-03}$	$1.26x10^{-04}$	$2.43x10^{-03}$	$2.13x10^{-04}$
TNRE IAME	$1.94x10^{-03}$	$4.52x10^{-04}$	$8.80x10^{-04}$	$9.55x10^{-05}$	$3.17x10^{-04}$	$5.30x10^{-03}$
PNRE IAME	$1.18x10^{-03}$	$4.69x10^{-04}$	$7.80x10^{-04}$	$9.00x10^{-05}$	$2.32x10^{-07}$	$2.52x10^{-08}$
RE DAME	$3.55x10^{-08}$	$4.90x10^{-08}$	$2.16x10^{-03}$	$1.40x10^{-04}$	$1.83x10^{-03}$	$1.58x10^{-04}$
TNRE DAME	$0.00x10^{+00}$	$2.13x10^{-08}$	$7.52x10^{-04}$	$7.53x10^{-05}$	$0.00x10^{+00}$	$2.13x10^{-08}$
PNRE DAME	$1.86x10^{-09}$	$2.19x10^{-08}$	$7.70x10^{-04}$	$7.49x10^{-05}$	$1.60x10^{-09}$	$2.19x10^{-08}$

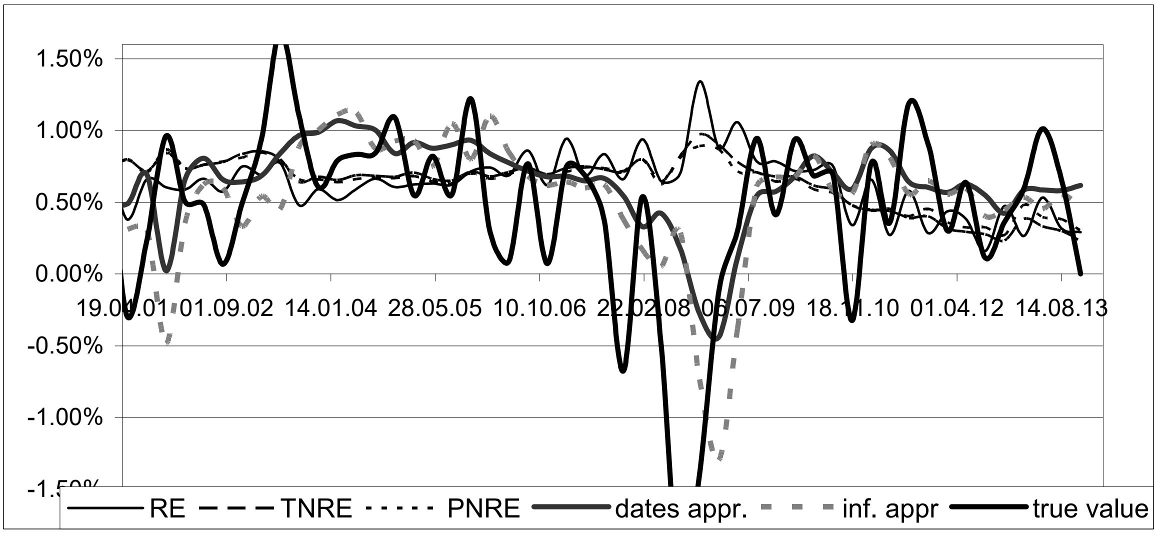
Table 6 presents a RMSE of smoothed observed expectations (over the dates approach, the information approach and true future values). The standard deviations of obs_{CF} measurement errors were at least two times smaller than RMSE. Inflation expectations measurement errors were slightly smaller than the corresponding RMSE (for rational expectations). The RMSE of obs_{CF} was about two times larger than measurement errors standard deviation (for rational expectations). The TNRE and PNRE produced smaller measurement errors standard deviation, while RMSE were slightly smaller.

Table 6. RMSE of smoothed observed expectations

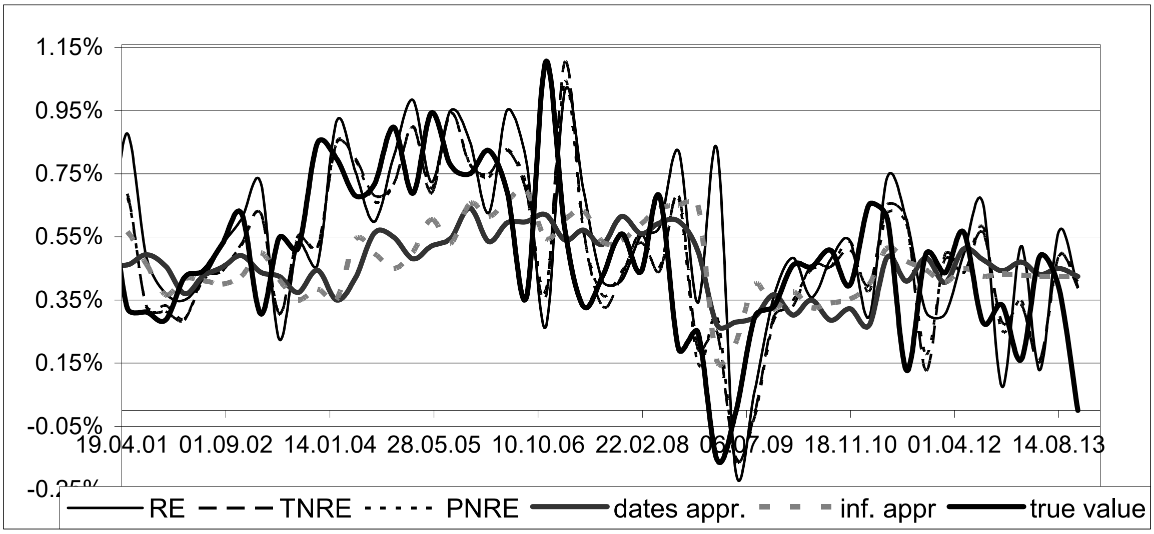
		RE	TNRE	PNRE	true value
obs_{CF}	DA	0.78%	0.79%	0.79%	0.91%
	IA	0.82%	0.82%	0.82%	0.91%
	True value	0.64%	0.62%	0.62%	0.00%
$\mathrm{obs}_{\mathrm{PF}}$	DA	0.25%	0.22%	0.21%	0.22%
	IA	0.22%	0.20%	0.19%	0.22%
	True value	0.25%	0.20%	0.20%	0.00%
obs_{YF}	DA	0.37%	0.32%	0.31%	0.55%
	IA	0.49%	0.45%	0.44%	0.60%
	True value	0.63%	0.63%	0.62%	0.00%

Pictures 2-4 present the smoothed expectations from the RE WE, TNRE WE and PNRE WE models from 2001 until 2013. True future values and observed expectations (according to IA and DA) were added for comparison. It can be seen that all smoothed expectations are close to one another. However, the smoothed expectations of the PNRE is smoother than those of the TNRE and RE models.

Picture 2. Smoothed obs_{YF} without observed expectations

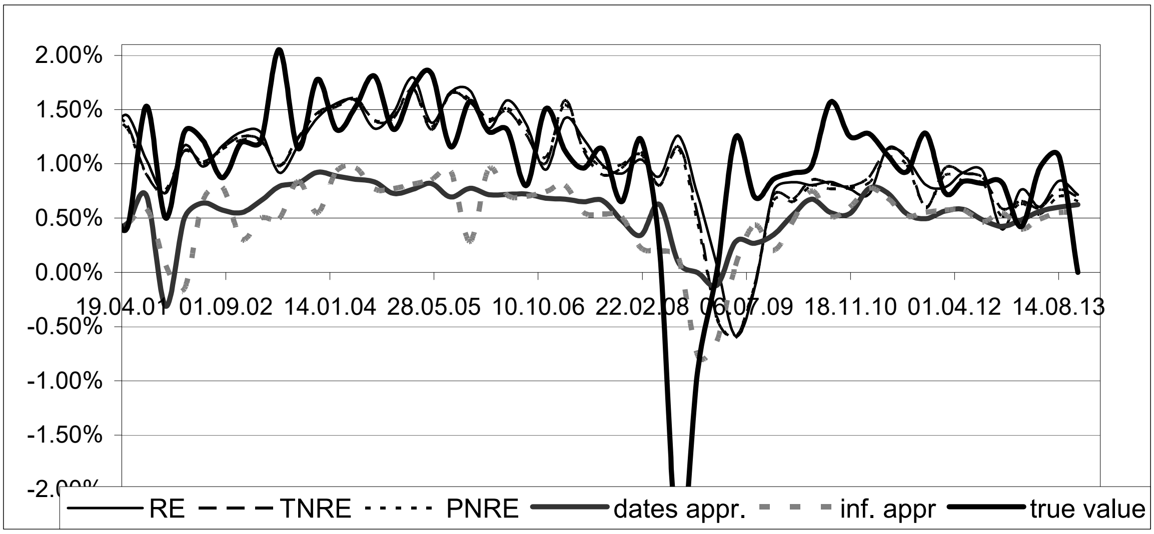


Picture 3. Smoothed obs_{PF} without observed expectations



The largest deviation of survey expectations (obs_{YF}) from the models, implying expectations, appears during the 2008-2009 crises. However, the deviation for inflation expectations was much smaller. The most interesting situation appeared with expected consumption growth: the survey expectations underestimated the growth of consumption, while the models' expectations did not. RMSE of the models' expectations was larger than the deviation of the models' expectations from the true future values.

Picture 3. Smoothed obs_{CF} without observed expectations



5. Forecasting

The forecasting quality was estimated by the root-mean-square error (RMSE) for each observed variable and forecasting horizon from quarter 1 to quarter 4. The in-sample forecasting quality is presented in Tables A5, A7 and A9 (see the Appendix). The aggregate measures of the in-sample forecasting quality is presented in Table A11 (see the Appendix). The out-of-sample forecasts are presented in Tables A6, A8 and A10, and the aggregate measures are presented in Tables 7-8. The out-of-sample forecasts were computed for the last 22 quarters. This entailed re-estimating the parameters with the dataset without the last quarter (from 1985Q1 until 2013Q3) and computing the forecasts, re-estimating without 2 quarters (from1985Q1 until 2013Q2), and so on. The last re-estimation used the dataset without 22 quarters (from 1985Q1 until 2008Q2).

The best in-sample forecasts were achieved by the VAR (1) model (VAR (1) with the dates approach, according to the mean RMSE and VAR (1) with the information approach, according to all other measures. This occurred due to the much larger number of parameters that produced over-fitting: the VAR (1) had 301 parameters (187 for the case without observed expectations); the DSGE had from 81 to 118 parameters, depending on the version; the AR (1) had 42 parameters (33 for the case without observed expectations).

Adding observed expectations did not increase the quality of the in-sample forecast for other variables. It held for each type of expectations and each aggregate measure.

The forecasting quality of the rational expectations model without measurement errors was much worse than that produced by other models. This held for the out-of-sample forecasts, which meant that the deviation of the survey's expectations from rational expectations was essential for the model with rational expectations.

TABLE 7. The mean RMSE of the out-of-sample forecasts ex-observed expectations

.	WE	IAWME	IAME	DAWME	DAME
AR(1)	2.14%	2.14%	2.14%	2.14%	2.14%
VAR(1)	2.36%	2.19%	2.19%	2.38%	2.38%
RE	2.09%	2.33%	2.11%	2.43%	2.13%
TNRE	2.09%	2.12%	2.13%	2.16%	2.15%
PNRE	2.07%	2.05%	**2.05%**	2.08%	2.07%

The best out-of-sample forecasting quality was achieved by the PNRE model. The answer about the forecasting quality of the DSGE model depended on aggregate measure. For some combinations of the observed variable and the forecasting horizon, the DSGE model was better than AR (1); for others, the opposite was true. The DSGE model with the RE (except for cases with observed expectations without measurement errors) outperformed AR (1). The same held for the PNRE. However, the answer was not clear for the TNRE: this depended on the approach (information or dates) and the aggregate measures.

TABLE 8. The aggregate measures of out-of-sample forecasting quality

	Mean RMSE	Mean RMSE ex-expect.	RMSE of RMSE	RMSE of RMSE ex-expect.	Mean of ratio of RMSE to RMSE of AR(1)	Mean of ratio of RMSE to RMSE of AR(1) ex-expect.
AR(1)	2.14%	2.14%	3.62%	3.62%	100.00%	100.00%
VAR(1)	2.36%	2.36%	4.16%	4.16%	114.23%	114.23%
RE WE	2.09%	2.09%	3.54%	3.54%	108.04%	108.04%
TNRE WE	2.09%	2.09%	3.64%	3.64%	98.69%	98.69%
PNRE WE	2.07%	2.07%	3.56%	3.56%	**98.54%**	98.54%
AR(1) IA	1.75%	2.14%	3.21%	3.62%	100.00%	100.00%
VAR(1) IA	1.79%	2.19%	3.37%	3.80%	107.17%	107.71%
RE IAWME	1.92%	2.33%	3.35%	3.77%	129.12%	117.92%
RE IAME	1.74%	2.11%	3.14%	3.53%	109.48%	102.41%
TNRE IAWME	1.74%	2.12%	3.24%	3.65%	105.39%	101.68%
TNRE IAME	1.75%	2.13%	3.25%	3.67%	104.31%	100.88%
PNRE IAWME	1.68%	2.05%	3.12%	3.52%	100.26%	98.28%
PNRE IAME	1.68%	**2.05%**	**3.12%**	**3.52%**	99.38%	**97.65%**
AR(1) DA	1.72%	2.14%	3.21%	3.62%	100.00%	100.00%
VAR(1) DA	1.92%	2.38%	3.69%	4.16%	117.18%	117.17%
RE DAWME	1.98%	2.43%	3.28%	3.70%	155.59%	138.84%
RE DAME	1.73%	2.13%	3.17%	3.57%	113.34%	104.57%
TNRE DAWME	1.75%	2.16%	3.20%	3.60%	110.59%	107.32%
TNRE DAME	1.74%	2.15%	3.20%	3.61%	107.78%	105.19%
PNRE DAWME	1.68%	2.08%	3.15%	3.55%	103.84%	99.76%
PNRE DAME	**1.67%**	2.07%	3.13%	3.53%	101.63%	98.37%

The choice of the mean ratio of the RMSE to the RMSE of AR (1) as an aggregate measure of forecasting quality produced different answers about advance of the RE model. The DSGE model with the PNRE outperformed AR (1) in most of the cases. The TNRE outperformed AR (1) in the case without observed expectations. The RE model did not outperform AR (1) according to this aggregate measure. Thus, we can talk about the advantage of the forecasting quality of the DSGE model with the RE and the PNRE over the AR (1) and VAR (1) models (for the majority of aggregate measures), and the equivalent quality of the DSGE with the TNRE and AR (1).

Another question is about the influence of observed expectations on other variables' forecasts. The first view was for a situation with observed variables for which expectations were observed (obs_C, obs_P and obs_Y). The forecasting quality for one quarter was higher, with observed expectations in almost all situations (the exception was for inflation with the PNRE DAWME). The situation with the four-quarter forecast was different: the PNRE produced an advantage of observed expectations in 66% of the cases; for the TNRE, 50%; for the RE, 33%. The same picture emerged for the mean RMSE. Thus, observed expectations increase the short-term forecasting quality, but this effect is much smaller for long-term forecasts.

The second view is the situation with all observed variables except observed expectations. This situation depends on the type of rationality. The forecasting quality was lower with observed expectations in the case of the RE. However, this effect came from the long-term forecast and a slight improvement could be found in the short-term forecasting quality (for the cases with measurement errors). There was the same effect for the TNRE: the short-term forecasts were better (except for case of the IAME), and the long-term forecasts were worse. However, the aggregate decrease in forecasting quality was clear. The PNRE produced higher short- and long-term forecasting quality, but the improvement for long-term forecasting quality was much smaller. Thus, the usage of observed expectations increased the short-term forecasting quality and decreased the long-term forecasting quality (except for the PNRE).

The next question is about the relations among the forecasting qualities of different rationality types. The best quality of forecast was produced by the PNRE. However, the TNRE did not outperform the RE with measurement errors. This held for the mean RMSE and the RMSE for all variables and forecasting horizons. The result was different for the mean ratio of RMSE to the RMSE of AR (1).There was a large advantage for the TNRE over the RE in the case without observed expectations. This advantage became much smaller in the cases with observed expectations (for variables except, with the observed expectations advantage disappearing in the DAME and the DAWME cases). Thus, the rich DSGE model with RE could be close to the near-rational approaches if the expectations for the model could deviate from observed one.

6. Conclusions

The DSGE models are based on the rational expectations hypothesis. The main alternative is learning. It has the following advantages over rationale expectations:

1. Assumptions of rational expectations – all agents know the structure of the model; parameters of the model; all exogenous shocks and variables of the model – are too strong (agents know more than the researcher does).
2. The usage of learning allows having desirable values of parameters.
3. Models with learning fit the data and forecasts better than rational DSGE models.
4. Models with learning reproduce observed expectations (from surveys) better than rational DSGE models do.

However, learning has some disadvantages:

1. Learning algorithms allow the possibility of unrestricted manipulation.
2. The conventional usage of learning is a combination of the linearised model and nonlinear mechanism of learning.
3. Learning algorithms could produce explosive trajectories when the Blanchard-Kahn condition holds.
4. Conventional learning algorithms do not provide fluctuations around the rational expectations matrix: it is biased over rational expectations.

We suggest a simple near-rational approach that has the same advantages as learning but does not have those disadvantages. This suggests that agents have some unbiased estimators of rational expectations, but do not describe these estimators. The suggested approach describes the properties of these estimators. The near-rational expectations approaches do not have the disadvantages of learning (and have its first advantage), by construction. Especially important is the absence of the first disadvantage of learning, which produces a difference in response on policy change (expectations in models with learning would not react on a government policy change, while near-rational expectations would react).

The medium-scale DSGE model was created. It was estimated with the RE, the TNRE and the PNRE. The model was estimated with and without observed expectations. The existence of measurement errors of observed expectations was crucial for the model with the RE. However, standard deviations of measurement errors were small.

The second advantage is illustrated by the persistence of technology progress. Suggested approaches did not produce lower persistence of technology progress without observed expectations. Observed expectations produced much lower persistence for each type of expectations (except the case RE without measurement errors).

The distance between expectations from the model and those observed from the survey was smaller (with near-rational approaches) for expected inflation and growth rate. The distance for the expected growth rate of consumption was independent of the types of expectations. However, the expected growth rate of consumption from the models was much closer to the actual growth rate of consumption. Thus, the fourth advantage could be considered proved.

The models could be ordered by out-of-sample forecasting quality (from the best to the worst) as follows: the PNRE (with or without measurement errors), the RE (with measurement errors), the TNRE (with or without measurement errors), AR(1), VAR(1) and the RE (without measurement errors). However, this order is not the dominant order, and for some aggregate measures, the order could be slightly different. Thus, all the advantages of learning are reproduced by the near-rational approach.

The additional result of the article relates to the influence of observed expectations of forecasts for other variables. The analysis of the out-of-sample forecasting quality shows that observed expectations increase the short-term forecasting quality and decrease the long-term forecasting property. The influence on aggregate measures of forecasting quality depends on the type of rationality (the PNRE forecasts became better, while the opposite was true for the TNRE and the RE).

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Appendix

TABLE A1. The estimation results for the model with RE

	WE		IAWME		DAWME	
Parameter	value	std	value	std	value	std
ε_{α}	$9.87x10^{-03}$	$9.91x10^{-04}$	$2.82x10^{-02}$	$3.32x10^{-03}$	$2.27x10^{-02}$	$2.09x10^{-03}$
ε_{β}	$1.50x10^{-01}$	$1.21x10^{-02}$	$1.33x10^{-01}$	$1.15x10^{-02}$	$1.28x10^{-01}$	$1.13x10^{-02}$
ε_{BF}	$3.87x10^{+00}$	$1.37x10^{+00}$	$3.40x10^{+01}$	$2.60x10^{+00}$	$4.49x10^{+01}$	$6.36x10^{+00}$
ε_{BH}	$1.31x10^{-02}$	$1.73x10^{+00}$	$2.17x10^{-02}$	$3.11x10^{+00}$	$3.64x10^{-02}$	$4.73x10^{-02}$
ε_{DW}	$5.38x10^{+01}$	$1.61x10^{+00}$	$6.51x10^{+01}$	$3.44x10^{+00}$	$1.00x10^{+02}$	$2.49x10^{-05}$
ε_{FWL}	$2.73x10^{-04}$	$1.92x10^{+00}$	$2.73x10^{-04}$	$6.54x10^{+00}$	$2.73x10^{-04}$	$5.96x10^{+00}$
ε_{G}	$3.73x10^{-01}$	$5.06x10^{-02}$	$2.93x10^{-01}$	$1.00x10^{-01}$	$6.39x10^{-01}$	$7.39x10^{-02}$
ε_{I}	$8.24x10^{-03}$	$1.91x10^{+00}$	$8.24x10^{-03}$	$9.92x10^{+00}$	$8.24x10^{-03}$	$1.70x10^{+01}$
ε_{L}	$1.10x10^{-02}$	$1.07x10^{-02}$	$9.01x10^{-02}$	$1.59x10^{-02}$	$1.13x10^{-01}$	$2.43x10^{-02}$
ε_{M}	$6.94x10^{+00}$	$6.02x10^{-01}$	$4.48x10^{+00}$	$3.71x10^{-01}$	$4.83x10^{+00}$	$3.42x10^{-01}$
ε_{NX}	$1.49x10^{+00}$	$8.24x10^{-01}$	$8.96x10^{+00}$	$2.93x10^{+00}$	$1.21x10^{+01}$	$1.40x10^{+00}$
ε_{P}	$1.02x10^{-03}$	$1.85x10^{+00}$	$1.02x10^{-03}$	$2.18x10^{+01}$	$1.02x10^{-03}$	$9.93x10^{+01}$
ε_{R}	$1.42x10^{-02}$	$2.07x10^{-03}$	$1.59x10^{-02}$	$2.92x10^{-03}$	$1.32x10^{-02}$	$1.93x10^{-03}$
ε_{tL}	$1.08x10^{-02}$	$2.69x10^{-03}$	$1.47x10^{-01}$	$6.31x10^{-02}$	$7.87x10^{-02}$	$2.33x10^{-02}$
ε_{tr}	$2.50x10^{-01}$	$6.86x10^{-02}$	$2.33x10^{-01}$	$6.83x10^{-02}$	$2.87x10^{-01}$	$8.77x10^{-02}$
ε_{tY}	$3.01x10^{-02}$	$4.63x10^{-03}$	$4.51x10^{-02}$	$1.86x10^{-02}$	$3.15x10^{-02}$	$3.15x10^{-03}$
ε_{XW}	$2.71x10^{-01}$	$5.62x10^{-02}$	$4.81x10^{+01}$	$4.75x10^{+00}$	$6.66x10^{-01}$	$1.63x10^{-02}$
ε_{Y}	$2.54x10^{-02}$	$2.70x10^{-03}$	$2.16x10^{-02}$	$2.22x10^{-03}$	$1.65x10^{-02}$	$1.52x10^{-03}$
γ_{g}	$3.52x10^{-01}$	$7.40x10^{-02}$	$5.25x10^{-01}$	$7.21x10^{-02}$	$8.88x10^{-01}$	$8.96x10^{-04}$
γ_{gb}	$3.27x10^{+00}$	$2.13x10^{-06}$	$3.03x10^{-01}$	$3.26x10^{-01}$	$3.31x10^{+00}$	$2.37x10^{-06}$
γ_{gy}	$6.72x10^{-01}$	$2.44x10^{-01}$	$-6.25x10^{-01}$	$3.03x10^{-01}$	$-5.00x10^{+00}$	$3.21x10^{-06}$
γ_{nx}	$4.28x10^{-01}$	$1.35x10^{-01}$	$7.32x10^{-01}$	$1.23x10^{-01}$	$7.47x10^{-01}$	$3.25x10^{-02}$
γ_{nxb}	$4.07x10^{+00}$	$2.63x10^{-06}$	$5.00x10^{+00}$	$1.72x10^{-06}$	$4.24x10^{+00}$	$3.00x10^{-06}$
γ_{r}	$8.56x10^{-01}$	$3.16x10^{-02}$	$8.93x10^{-01}$	$1.79x10^{-02}$	$8.66x10^{-01}$	$1.30x10^{-02}$
γ_{rp}	$1.12x10^{+00}$	$8.65x10^{-07}$	$1.49x10^{+00}$	$4.19x10^{-02}$	$1.12x10^{+00}$	$9.46x10^{-07}$
γ_{ry}	$2.33x10^{-01}$	$1.55x10^{-01}$	$3.25x10^{-01}$	$4.18x10^{-01}$	$6.70x10^{-01}$	$8.03x10^{-02}$
γ_{tL}	$6.20x10^{-01}$	$8.01x10^{-02}$	$9.65x10^{-01}$	$1.45x10^{-02}$	$9.35x10^{-01}$	$1.55x10^{-02}$
γ_{tLb}	$-1.75x10^{+00}$	$1.21x10^{-06}$	$-6.15x10^{-01}$	$6.98x10^{-01}$	$-1.40x10^{+00}$	$1.04x10^{-06}$
γ_{tLy}	$-4.30x10^{-01}$	$2.55x10^{-01}$	$5.00x10^{+00}$	$1.72x10^{-06}$	$-7.92x10^{-01}$	$1.70x10^{-01}$
γ_{tr}	$9.20x10^{-01}$	$2.12x10^{-02}$	$9.17x10^{-01}$	$2.23x10^{-02}$	$9.38x10^{-01}$	$1.58x10^{-02}$
γ_{trb}	$5.00x10^{+00}$	$2.17x10^{-06}$	$3.23x10^{+00}$	$1.16x10^{+00}$	$5.00x10^{+00}$	$1.66x10^{-06}$
γ_{try}	$-5.00x10^{+00}$	$2.46x10^{-06}$	$-5.00x10^{+00}$	$1.97x10^{-06}$	$-5.00x10^{+00}$	$3.21x10^{-06}$
γ_{tY}	$9.45x10^{-01}$	$7.83x10^{-03}$	$9.57x10^{-01}$	$1.70x10^{-02}$	$9.13x10^{-01}$	$3.39x10^{-04}$
γ_{tYb}	$1.31x10^{+00}$	$9.68x10^{-07}$	$1.01x10^{+00}$	$8.83x10^{-02}$	$1.30x10^{+00}$	$9.91x10^{-07}$
γ_{tYy}	$1.81x10^{+00}$	$6.66x10^{-01}$	$2.57x10^{+00}$	$8.05x10^{-01}$	$5.00x10^{+00}$	$1.66x10^{-06}$
γ_{xw}	$9.86x10^{-01}$	$5.43x10^{-03}$	$9.96x10^{-01}$	$9.19x10^{-06}$	$9.97x10^{-01}$	$5.72x10^{-07}$
γ_{xwb}	$3.11x10^{-02}$	$1.04x10^{-07}$	$9.53x10^{-02}$	$2.89x10^{-02}$	$3.52x10^{-02}$	$1.05x10^{-07}$
h_{C}	$3.12x10^{-01}$	$1.16x10^{-07}$	$3.12x10^{-01}$	$6.77x10^{-08}$	$3.12x10^{-01}$	$1.04x10^{-07}$
h_{h}	$3.43x10^{-01}$	$7.06x10^{-08}$	$3.43x10^{-01}$	$7.56x10^{-08}$	$3.43x10^{-01}$	$1.28x10^{-07}$
μ_{F}	$-1.13x10^{-07}$	$7.50x10^{-01}$	$5.09x10^{-03}$	$3.09x10^{-01}$	$-2.70x10^{-03}$	$5.09x10^{-02}$
μ_{H}	$6.03x10^{+00}$	$3.87x10^{-06}$	$1.59x10^{+01}$	$3.69x10^{+00}$	$8.41x10^{+00}$	$5.85x10^{-06}$
$\eta_{0,\alpha}$	$4.25x10^{-01}$	$1.63x10^{-07}$	$4.25x10^{-01}$	$2.66x10^{-07}$	$4.25x10^{-01}$	$1.95x10^{-07}$
$\eta_{0,\beta}$	$-1.78x10^{-03}$	$4.35x10^{-08}$	$-1.78x10^{-03}$	$5.01x10^{-08}$	$-1.78x10^{-03}$	$5.54x10^{-08}$
$\eta_{0,BF}$	$-5.06x10^{-05}$	$4.64x10^{-08}$	$-1.60x10^{-03}$	$6.27x10^{-02}$	$-8.64x10^{-03}$	$4.12x10^{-02}$
$\eta_{0,BH}$	$4.99x10^{-04}$	$2.16x10^{-01}$	$-1.43x10^{-03}$	$2.98x10^{-01}$	$1.12x10^{-03}$	$5.42x10^{-02}$
$\eta_{0,DW}$	$6.99x10^{+00}$	$4.47x10^{-06}$	$6.98x10^{+00}$	$2.77x10^{-03}$	$6.99x10^{+00}$	$4.59x10^{-06}$
$\eta_{0,FWL}$	$6.21x10^{+00}$	$3.99x10^{-06}$	$5.96x10^{+00}$	$9.49x10^{-02}$	$5.92x10^{+00}$	$4.16x10^{-06}$
$\eta_{0,G}$	$-1.51x10^{+00}$	$3.69x10^{-07}$	$-1.51x10^{+00}$	$3.48x10^{-07}$	$-1.51x10^{+00}$	$5.32x10^{-07}$
$\eta_{0,I}$	$1.86x10^{+00}$	$9.04x10^{-01}$	$2.00x10^{+01}$	$5.09x10^{-06}$	$1.78x10^{+01}$	$1.68x10^{+00}$

$\eta_{0,L}$	$-1.57\times10^{+01}$	1.89×10^{-05}	$-1.57\times10^{+01}$	3.37×10^{-06}	$-1.57\times10^{+01}$	1.10×10^{-05}
$\eta_{0,M}$	$-1.34\times10^{+01}$	3.99×10^{-06}	$-1.34\times10^{+01}$	3.20×10^{-06}	$-1.34\times10^{+01}$	3.02×10^{-06}
$\eta_{0,NX}$	$1.56\times10^{+01}$	3.09×10^{-06}	$1.56\times10^{+01}$	3.10×10^{-06}	$1.56\times10^{+01}$	4.95×10^{-06}
$\eta_{0,P}$	$1.10\times10^{+01}$	7.02×10^{-06}	$1.09\times10^{+01}$	8.45×10^{-05}	$1.09\times10^{+01}$	7.14×10^{-06}
$\eta_{0,R}$	1.15×10^{-02}	3.28×10^{-08}	1.15×10^{-02}	4.52×10^{-08}	1.15×10^{-02}	4.42×10^{-08}
$\eta_{0,tL}$	3.10×10^{-01}	6.36×10^{-08}	3.10×10^{-01}	6.43×10^{-08}	3.10×10^{-01}	1.48×10^{-07}
$\eta_{0,tr}$	$-2.36\times10^{+00}$	$1.92\times10^{+00}$	$-2.10\times10^{+00}$	$1.19\times10^{+00}$	$-1.78\times10^{+00}$	4.87×10^{-01}
$\eta_{0,tY}$	1.11×10^{-01}	2.71×10^{-08}	1.11×10^{-01}	2.88×10^{-08}	1.11×10^{-01}	2.18×10^{-08}
$\eta_{0,XW}$	7.54×10^{-01}	6.47×10^{-07}	7.54×10^{-01}	7.39×10^{-07}	7.54×10^{-01}	9.26×10^{-07}
$\eta_{0,Y}$	6.86×10^{-03}	2.74×10^{-08}	6.86×10^{-03}	2.90×10^{-08}	6.86×10^{-03}	2.74×10^{-08}
$\eta_{1,\alpha}$	8.88×10^{-01}	1.06×10^{-02}	9.50×10^{-01}	5.32×10^{-03}	9.37×10^{-01}	4.73×10^{-03}
$\eta_{1,\beta}$	9.78×10^{-01}	2.24×10^{-03}	9.12×10^{-01}	8.30×10^{-03}	9.09×10^{-01}	7.72×10^{-04}
$\eta_{1,BF}$	8.81×10^{-01}	4.91×10^{-02}	8.94×10^{-01}	3.96×10^{-02}	8.67×10^{-01}	1.37×10^{-02}
$\eta_{1,BH}$	6.30×10^{-05}	$1.97\times10^{+00}$	-1.36×10^{-03}	$2.28\times10^{+00}$	8.32×10^{-04}	6.03×10^{-02}
$\eta_{1,DW}$	9.23×10^{-01}	1.07×10^{-02}	8.18×10^{-01}	6.02×10^{-02}	9.05×10^{-01}	6.40×10^{-03}
$\eta_{1,FWL}$	8.99×10^{-02}	7.29×10^{-01}	7.90×10^{-01}	$1.69\times10^{+00}$	-5.92×10^{-01}	3.48×10^{-01}
$\eta_{1,G}$	9.77×10^{-01}	3.55×10^{-03}	9.43×10^{-01}	2.05×10^{-02}	8.92×10^{-01}	1.45×10^{-02}
$\eta_{1,I}$	3.83×10^{-04}	5.93×10^{-01}	7.56×10^{-03}	4.09×10^{-01}	-9.12×10^{-05}	7.67×10^{-02}
$\eta_{1,L}$	-5.82×10^{-01}	3.86×10^{-01}	1.65×10^{-01}	7.27×10^{-02}	3.27×10^{-01}	5.98×10^{-02}
$\eta_{1,M}$	9.78×10^{-01}	1.94×10^{-03}	9.35×10^{-01}	5.82×10^{-03}	9.34×10^{-01}	1.08×10^{-03}
$\eta_{1,NX}$	-1.44×10^{-01}	2.46×10^{-01}	-3.62×10^{-01}	1.64×10^{-01}	-3.62×10^{-01}	1.27×10^{-01}
$\eta_{1,P}$	-2.60×10^{-02}	6.58×10^{-01}	-1.20×10^{-02}	5.08×10^{-01}	-7.56×10^{-02}	4.33×10^{-02}
$\eta_{1,R}$	4.42×10^{-01}	1.07×10^{-01}	3.41×10^{-01}	8.95×10^{-02}	3.72×10^{-01}	8.14×10^{-02}
$\eta_{1,tL}$	-3.38×10^{-01}	1.05×10^{-01}	-3.10×10^{-01}	9.17×10^{-02}	-3.00×10^{-01}	9.51×10^{-02}
$\eta_{1,tr}$	-1.63×10^{-01}	9.32×10^{-02}	-1.95×10^{-01}	9.36×10^{-02}	-2.60×10^{-01}	8.33×10^{-02}
$\eta_{1,tY}$	-4.10×10^{-01}	8.98×10^{-02}	-3.39×10^{-01}	9.54×10^{-02}	-1.97×10^{-01}	6.49×10^{-02}
$\eta_{1,XW}$	9.94×10^{-01}	5.27×10^{-03}	9.97×10^{-01}	3.87×10^{-07}	9.88×10^{-01}	3.01×10^{-04}
$\eta_{1,Y}$	9.69×10^{-01}	5.23×10^{-03}	8.55×10^{-01}	1.54×10^{-02}	8.71×10^{-01}	1.25×10^{-02}
ω_C	$3.25\times10^{+00}$	1.07×10^{-06}	$3.25\times10^{+00}$	9.03×10^{-07}	$3.25\times10^{+00}$	9.90×10^{-07}
ω_L	$6.55\times10^{+00}$	1.34×10^{-06}	$6.55\times10^{+00}$	1.34×10^{-06}	$6.55\times10^{+00}$	2.21×10^{-06}
δ	1.83×10^{-02}	7.98×10^{-08}	1.83×10^{-02}	8.20×10^{-08}	1.83×10^{-02}	5.20×10^{-08}
θ	$6.04\times10^{+00}$	1.91×10^{-06}	$6.04\times10^{+00}$	1.57×10^{-06}	$6.04\times10^{+00}$	1.50×10^{-06}

TABLE A2. The estimation results for the model with TNRE

	WE		IAWME		DAWME	
Parameter	value	std	value	std	value	std
ε_{α}	1.13×10^{-02}	2.67×10^{-03}	3.53×10^{-02}	8.99×10^{-03}	9.70×10^{-02}	5.14×10^{-02}
ε_{β}	1.17×10^{-01}	1.43×10^{-02}	1.07×10^{-01}	1.49×10^{-02}	4.90×10^{-02}	4.12×10^{-03}
ε_{BF}	$3.23\times10^{+00}$	9.74×10^{-01}	$1.00\times10^{+02}$	1.65×10^{-05}	$5.30\times10^{+01}$	$1.92\times10^{+00}$
ε_{BH}	2.74×10^{-03}	$1.30\times10^{+00}$	1.60×10^{-03}	$3.07\times10^{+00}$	1.18×10^{-03}	4.35×10^{-01}
ε_{DW}	$5.86\times10^{+01}$	$1.50\times10^{+00}$	$4.19\times10^{+01}$	$3.57\times10^{+00}$	$1.00\times10^{+02}$	1.90×10^{-05}
ε_{FWL}	2.73×10^{-04}	$2.88\times10^{+00}$	9.77×10^{-04}	$4.84\times10^{+00}$	2.02×10^{-03}	5.22×10^{-01}
ε_{G}	3.01×10^{-01}	9.48×10^{-02}	2.09×10^{-01}	7.06×10^{-02}	2.18×10^{-01}	4.87×10^{-02}
ε_{I}	1.48×10^{-03}	$1.01\times10^{+00}$	2.15×10^{-03}	$1.14\times10^{+01}$	4.71×10^{-04}	4.25×10^{-01}
ε_{L}	$4.20\times10^{+00}$	$1.49\times10^{+00}$	3.35×10^{-04}	$1.32\times10^{+01}$	$3.66\times10^{+00}$	9.96×10^{-01}
ε_{M}	$5.85\times10^{+00}$	4.42×10^{-01}	$6.31\times10^{+00}$	9.43×10^{-01}	$1.51\times10^{+01}$	$1.39\times10^{+00}$
ε_{NRc}	2.82×10^{-01}	$2.24\times10^{+00}$	1.13×10^{-03}	$5.26\times10^{+00}$	1.58×10^{-03}	2.43×10^{-01}
ε_{NRdF}	4.32×10^{-04}	$1.82\times10^{+00}$	9.44×10^{-04}	$5.02\times10^{+00}$	6.98×10^{-03}	1.51×10^{-01}
ε_{NRiF}	5.53×10^{-02}	1.53×10^{-02}	7.82×10^{-02}	$2.53\times10^{+00}$	3.37×10^{-03}	6.72×10^{-02}
ε_{NRl}	3.10×10^{-04}	$1.42\times10^{+00}$	2.78×10^{-01}	9.22×10^{-01}	4.28×10^{-01}	5.02×10^{-01}
ε_{NRLFB}	$4.09\times10^{+00}$	$2.80\times10^{+00}$	1.05×10^{-03}	$5.83\times10^{+00}$	3.85×10^{-03}	2.18×10^{-01}
ε_{NRLFK}	2.27×10^{-01}	$1.85\times10^{+00}$	$2.61\times10^{+00}$	$8.12\times10^{+01}$	5.23×10^{-04}	2.01×10^{-01}
ε_{NRLFP}	3.29×10^{-03}	$1.48\times10^{+00}$	3.06×10^{-02}	$6.54\times10^{+00}$	1.83×10^{-03}	1.18×10^{-01}
ε_{NRLHB}	$0.00\times10^{+00}$	3.45×10^{-08}	2.33×10^{-07}	4.65×10^{-08}	3.36×10^{-10}	3.74×10^{-08}
ε_{NRp}	1.05×10^{-03}	2.46×10^{-04}	7.53×10^{-04}	8.14×10^{-05}	4.79×10^{-04}	8.92×10^{-05}

ε_{NRs}	4.17×10^{-02}	7.68×10^{-03}	5.16×10^{-02}	7.35×10^{-03}	2.02×10^{-02}	1.54×10^{-02}
ε_{NRw}	1.37×10^{-04}	3.45×10^{-08}	2.41×10^{-01}	9.83×10^{-01}	3.27×10^{-01}	6.25×10^{-01}
ε_{NRyD}	1.87×10^{-03}	$1.60\times10^{+00}$	9.38×10^{-04}	8.53×10^{-04}	3.86×10^{-08}	3.74×10^{-08}
$\varepsilon_{NRz\alpha}$	2.28×10^{-03}	$1.43\times10^{+00}$	$4.95\times10^{+01}$	$4.91\times10^{+03}$	2.03×10^{-02}	1.31×10^{-01}
ε_{NRzFWL}	7.33×10^{-03}	$1.88\times10^{+00}$	1.49×10^{-03}	$5.20\times10^{+00}$	9.06×10^{-03}	1.51×10^{-01}
ε_{NRzI}	3.55×10^{-03}	$1.65\times10^{+00}$	2.35×10^{-03}	$2.21\times10^{+03}$	8.96×10^{-02}	1.68×10^{-01}
ε_{NRzP}	1.96×10^{-03}	$1.27\times10^{+00}$	6.08×10^{-04}	$4.19\times10^{+04}$	8.98×10^{-04}	1.03×10^{-01}
ε_{NRzY}	3.56×10^{-08}	3.45×10^{-08}	2.85×10^{-03}	2.60×10^{-04}	2.04×10^{-03}	1.43×10^{-04}
ε_{NX}	$1.93\times10^{+00}$	8.41×10^{-01}	$2.17\times10^{+01}$	$6.00\times10^{+00}$	$3.47\times10^{+01}$	$1.38\times10^{+00}$
ε_{P}	1.29×10^{-01}	$2.50\times10^{+00}$	7.35×10^{-04}	$1.09\times10^{+05}$	2.35×10^{-03}	4.72×10^{-01}
ε_{R}	1.73×10^{-02}	3.55×10^{-03}	2.13×10^{-02}	4.61×10^{-03}	2.10×10^{-02}	4.39×10^{-03}
ε_{tL}	9.17×10^{-03}	1.13×10^{-03}	9.69×10^{-03}	2.09×10^{-03}	6.84×10^{-02}	2.10×10^{-02}
ε_{tr}	2.51×10^{-01}	4.53×10^{-02}	3.47×10^{-01}	1.59×10^{-01}	4.19×10^{-01}	1.72×10^{-01}
ε_{tY}	3.43×10^{-02}	4.20×10^{-03}	3.23×10^{-02}	1.23×10^{-02}	1.88×10^{-02}	4.18×10^{-03}
ε_{XW}	4.13×10^{-01}	2.02×10^{-01}	$3.23\times10^{+01}$	$3.67\times10^{+01}$	$1.00\times10^{+02}$	1.91×10^{-05}
ε_{Y}	1.43×10^{-02}	3.89×10^{-03}	7.24×10^{-03}	7.37×10^{-04}	4.50×10^{-03}	4.34×10^{-04}
γ_{g}	3.15×10^{-01}	6.26×10^{-03}	4.31×10^{-01}	7.23×10^{-02}	9.30×10^{-01}	1.85×10^{-02}
γ_{gb}	$3.15\times10^{+00}$	7.30×10^{-02}	$3.48\times10^{+00}$	3.60×10^{-01}	$1.49\times10^{+00}$	1.82×10^{-01}
γ_{gy}	5.51×10^{-01}	6.33×10^{-03}	-2.67×10^{-01}	3.14×10^{-02}	$-5.00\times10^{+00}$	9.65×10^{-07}
γ_{nx}	5.27×10^{-01}	9.54×10^{-02}	4.12×10^{-01}	1.49×10^{-01}	9.42×10^{-01}	7.42×10^{-03}
γ_{nxb}	$5.00\times10^{+00}$	1.23×10^{-06}	$5.00\times10^{+00}$	1.38×10^{-06}	3.24×10^{-01}	4.01×10^{-02}
γ_{r}	9.04×10^{-01}	1.93×10^{-02}	9.25×10^{-01}	1.41×10^{-02}	9.06×10^{-01}	2.10×10^{-02}
γ_{rp}	$1.11\times10^{+00}$	3.53×10^{-02}	$1.40\times10^{+00}$	3.86×10^{-01}	6.27×10^{-01}	9.84×10^{-02}
γ_{ry}	8.95×10^{-01}	2.05×10^{-02}	$1.08\times10^{+00}$	1.57×10^{-01}	7.43×10^{-01}	1.67×10^{-01}
γ_{tL}	5.49×10^{-01}	1.15×10^{-02}	5.96×10^{-01}	6.08×10^{-02}	9.21×10^{-01}	2.57×10^{-02}
γ_{tLb}	$-1.46\times10^{+00}$	3.47×10^{-02}	$-1.65\times10^{+00}$	2.40×10^{-01}	-8.61×10^{-02}	3.06×10^{-02}
γ_{tLy}	-3.90×10^{-01}	1.06×10^{-02}	-5.46×10^{-03}	2.89×10^{-02}	$3.29\times10^{+00}$	6.23×10^{-01}
γ_{tr}	9.20×10^{-01}	1.29×10^{-02}	9.40×10^{-01}	2.76×10^{-02}	9.50×10^{-01}	1.93×10^{-02}
γ_{trb}	$5.00\times10^{+00}$	1.23×10^{-06}	$5.00\times10^{+00}$	1.38×10^{-06}	$-2.14\times10^{+00}$	4.12×10^{-01}
γ_{try}	$-5.00\times10^{+00}$	8.66×10^{-07}	$-5.00\times10^{+00}$	1.61×10^{-06}	$-5.00\times10^{+00}$	9.65×10^{-07}
γ_{tY}	9.52×10^{-01}	4.57×10^{-03}	9.49×10^{-01}	2.06×10^{-02}	9.29×10^{-01}	1.26×10^{-02}
γ_{tYb}	$1.29\times10^{+00}$	2.55×10^{-02}	$1.37\times10^{+00}$	4.20×10^{-01}	4.82×10^{-01}	5.62×10^{-02}
γ_{tYy}	$2.53\times10^{+00}$	6.74×10^{-02}	$1.96\times10^{+00}$	4.78×10^{-01}	2.71×10^{-01}	1.40×10^{-01}
γ_{xw}	9.94×10^{-01}	3.84×10^{-03}	9.99×10^{-01}	3.11×10^{-07}	9.98×10^{-01}	2.19×10^{-07}
γ_{xwb}	1.28×10^{-01}	2.83×10^{-02}	$2.12\times10^{+00}$	$1.24\times10^{+00}$	1.78×10^{-02}	3.88×10^{-03}
h_{C}	3.12×10^{-01}	6.35×10^{-08}	3.12×10^{-01}	6.39×10^{-08}	3.12×10^{-01}	5.03×10^{-08}
h_{h}	3.43×10^{-01}	6.83×10^{-08}	3.43×10^{-01}	7.38×10^{-08}	3.43×10^{-01}	4.35×10^{-08}
μ_{F}	$-1.57\times10^{+00}$	$3.08\times10^{+00}$	-1.87×10^{-02}	1.93×10^{-01}	4.75×10^{-04}	5.88×10^{-02}
μ_{H}	$9.34\times10^{+00}$	1.42×10^{-01}	$2.42\times10^{+01}$	$2.62\times10^{+00}$	4.29×10^{-04}	1.43×10^{-07}
$\eta_{0,\alpha}$	4.25×10^{-01}	1.61×10^{-07}	4.25×10^{-01}	2.87×10^{-07}	4.25×10^{-01}	1.10×10^{-07}
$\eta_{0,\beta}$	-1.78×10^{-03}	3.03×10^{-08}	-1.78×10^{-03}	4.96×10^{-08}	-1.78×10^{-03}	2.09×10^{-08}
$\eta_{0,BF}$	-9.63×10^{-01}	2.27×10^{-02}	-4.25×10^{-03}	2.54×10^{-02}	$-2.00\times10^{+01}$	3.85×10^{-06}
$\eta_{0,BH}$	2.95×10^{-03}	3.93×10^{-03}	-8.57×10^{-03}	1.49×10^{-02}	-2.76×10^{-02}	1.34×10^{-07}
$\eta_{0,DW}$	$6.98\times10^{+00}$	6.75×10^{-03}	$6.94\times10^{+00}$	1.52×10^{-02}	$6.89\times10^{+00}$	9.33×10^{-03}
$\eta_{0,FWL}$	$7.84\times10^{+00}$	8.32×10^{-02}	$9.06\times10^{+00}$	7.13×10^{-01}	$7.69\times10^{+00}$	2.43×10^{-01}
$\eta_{0,G}$	$-1.51\times10^{+00}$	3.20×10^{-07}	$-1.51\times10^{+00}$	3.18×10^{-07}	$-1.51\times10^{+00}$	1.43×10^{-07}
$\eta_{0,I}$	$1.25\times10^{+01}$	2.67×10^{-01}	$2.00\times10^{+01}$	3.67×10^{-06}	$2.00\times10^{+01}$	3.86×10^{-06}
$\eta_{0,L}$	$-1.57\times10^{+01}$	3.04×10^{-06}	$-1.57\times10^{+01}$	2.99×10^{-06}	$-1.57\times10^{+01}$	2.16×10^{-06}
$\eta_{0,M}$	$-1.34\times10^{+01}$	3.62×10^{-06}	$-1.34\times10^{+01}$	2.96×10^{-06}	$-1.34\times10^{+01}$	3.73×10^{-06}
$\eta_{0,NX}$	$1.56\times10^{+01}$	2.98×10^{-06}	$1.56\times10^{+01}$	2.98×10^{-06}	$1.56\times10^{+01}$	3.94×10^{-06}
$\eta_{0,P}$	$1.99\times10^{+01}$	6.83×10^{-01}	$1.70\times10^{+01}$	$2.28\times10^{+00}$	$1.59\times10^{+01}$	3.80×10^{-01}
$\eta_{0,R}$	1.15×10^{-02}	3.09×10^{-08}	1.15×10^{-02}	4.02×10^{-08}	1.15×10^{-02}	2.15×10^{-08}
$\eta_{0,tL}$	3.10×10^{-01}	6.30×10^{-08}	3.10×10^{-01}	6.44×10^{-08}	3.10×10^{-01}	8.43×10^{-08}
$\eta_{0,tr}$	$-2.37\times10^{+00}$	3.24×10^{-02}	$-2.38\times10^{+00}$	1.60×10^{-01}	$-2.15\times10^{+00}$	2.89×10^{-01}

$\eta_{0,tY}$	$1.11x10^{-01}$	$2.84x10^{-08}$	$1.11x10^{-01}$	$2.75x10^{-08}$	$1.11x10^{-01}$	$3.57x10^{-08}$
$\eta_{0,XW}$	$7.54x10^{-01}$	$5.71x10^{-07}$	$7.55x10^{-01}$	$5.98x10^{-07}$	$7.55x10^{-01}$	$5.80x10^{-07}$
$\eta_{0,Y}$	$6.86x10^{-03}$	$2.68x10^{-08}$	$6.86x10^{-03}$	$2.67x10^{-08}$	$6.86x10^{-03}$	$2.51x10^{-08}$
$\eta_{1,\alpha}$	$9.04x10^{-01}$	$2.16x10^{-02}$	$9.71x10^{-01}$	$6.85x10^{-03}$	$9.99x10^{-01}$	$2.19x10^{-07}$
$\eta_{1,\beta}$	$9.78x10^{-01}$	$4.51x10^{-03}$	$9.70x10^{-01}$	$6.81x10^{-03}$	$8.06x10^{-01}$	$2.45x10^{-02}$
$\eta_{1,BF}$	$8.70x10^{-01}$	$4.70x10^{-02}$	$9.94x10^{-01}$	$8.25x10^{-04}$	$7.72x10^{-01}$	$6.36x10^{-02}$
$\eta_{1,BH}$	$4.01x10^{-02}$	$1.22x10^{+00}$	$1.10x10^{-03}$	$6.79x10^{+00}$	$-1.65x10^{-01}$	$3.01x10^{-01}$
$\eta_{1,DW}$	$9.31x10^{-01}$	$1.72x10^{-02}$	$9.33x10^{-01}$	$2.95x10^{-02}$	$9.91x10^{-01}$	$2.18x10^{-03}$
$\eta_{1,FWL}$	$-1.19x10^{-02}$	$3.17x10^{-01}$	$3.38x10^{-02}$	$5.14x10^{-01}$	$-6.84x10^{-01}$	$7.96x10^{-01}$
$\eta_{1,G}$	$9.72x10^{-01}$	$1.08x10^{-02}$	$9.48x10^{-01}$	$2.28x10^{-02}$	$4.68x10^{-01}$	$8.18x10^{-02}$
$\eta_{1,I}$	$9.28x10^{-04}$	$2.66x10^{-01}$	$1.17x10^{-03}$	$9.39x10^{-01}$	$-7.92x10^{-03}$	$2.09x10^{-01}$
$\eta_{1,L}$	$9.93x10^{-01}$	$4.61x10^{-03}$	$9.71x10^{-01}$	$2.65x10^{+01}$	$9.70x10^{-01}$	$7.75x10^{-03}$
$\eta_{1,M}$	$9.81x10^{-01}$	$3.54x10^{-03}$	$9.87x10^{-01}$	$2.10x10^{-03}$	$9.97x10^{-01}$	$2.19x10^{-07}$
$\eta_{1,NX}$	$-1.59x10^{-01}$	$1.99x10^{-01}$	$8.77x10^{-01}$	$5.38x10^{-02}$	$2.50x10^{-01}$	$8.39x10^{-02}$
$\eta_{1,P}$	$-1.42x10^{-03}$	$2.72x10^{-01}$	$-4.05x10^{-03}$	$1.00x10^{-01}$	$-2.28x10^{-04}$	$1.52x10^{-01}$
$\eta_{1,R}$	$3.47x10^{-01}$	$8.24x10^{-02}$	$3.29x10^{-01}$	$8.43x10^{-02}$	$4.41x10^{-01}$	$9.11x10^{-02}$
$\eta_{1,tL}$	$-3.09x10^{-01}$	$1.04x10^{-01}$	$-3.55x10^{-01}$	$1.03x10^{-01}$	$-2.45x10^{-01}$	$9.69x10^{-02}$
$\eta_{1,tr}$	$-1.60x10^{-01}$	$9.29x10^{-02}$	$-1.43x10^{-01}$	$9.45x10^{-02}$	$-1.40x10^{-01}$	$1.04x10^{-01}$
$\eta_{1,tY}$	$-4.01x10^{-01}$	$8.75x10^{-02}$	$-4.08x10^{-01}$	$9.48x10^{-02}$	$-5.34x10^{-01}$	$9.48x10^{-02}$
$\eta_{1,XW}$	$9.48x10^{-01}$	$4.62x10^{-02}$	$9.91x10^{-01}$	$1.40x10^{-02}$	$9.98x10^{-01}$	$2.19x10^{-07}$
$\eta_{1,Y}$	$9.60x10^{-01}$	$1.12x10^{-02}$	$1.97x10^{-01}$	$7.05x10^{-02}$	$2.12x10^{-02}$	$1.03x10^{-01}$
ω_C	$3.25x10^{+00}$	$5.83x10^{-07}$	$3.25x10^{+00}$	$1.85x10^{-06}$	$3.25x10^{+00}$	$4.64x10^{-07}$
ω_L	$6.55x10^{+00}$	$1.28x10^{-06}$	$6.55x10^{+00}$	$1.28x10^{-06}$	$6.55x10^{+00}$	$8.98x10^{-07}$
δ	$1.83x10^{-02}$	$6.35x10^{-08}$	$1.83x10^{-02}$	$7.19x10^{-08}$	$1.83x10^{-02}$	$2.92x10^{-08}$
θ	$6.04x10^{+00}$	$1.06x10^{-06}$	$6.04x10^{+00}$	$1.40x10^{-06}$	$6.04x10^{+00}$	$1.37x10^{-06}$

TABLE A3. The estimation results for the model with PNRE

	WE		IAWME		DAWME	
Parameter	value	std	value	std	value	std
ε_{α}	$1.14x10^{-02}$	$2.32x10^{-03}$	$1.24x10^{-01}$	$5.23x10^{-02}$	$1.12x10^{-01}$	$3.37x10^{-02}$
ε_{β}	$3.31x10^{-02}$	$1.24x10^{-02}$	$5.22x10^{-02}$	$4.39x10^{-03}$	$5.16x10^{-02}$	$4.03x10^{-03}$
ε_{BF}	$2.92x10^{+00}$	$1.59x10^{+00}$	$1.00x10^{+02}$	$1.88x10^{-05}$	$2.79x10^{+00}$	$8.70x10^{-01}$
ε_{BH}	$2.93x10^{-03}$	$2.27x10^{+00}$	$2.60x10^{-03}$	$3.24x10^{-01}$	$1.54x10^{-03}$	$4.40x10^{-01}$
ε_{DW}	$5.31x10^{+01}$	$2.31x10^{+00}$	$5.89x10^{+01}$	$8.36x10^{-01}$	$7.38x10^{+00}$	$9.13x10^{-01}$
ε_{FWL}	$2.73x10^{-04}$	$3.90x10^{+00}$	$1.06x10^{-03}$	$1.52x10^{-01}$	$3.46x10^{-03}$	$6.24x10^{-01}$
ε_{G}	$2.62x10^{-01}$	$1.02x10^{-01}$	$1.96x10^{-01}$	$5.65x10^{-02}$	$1.97x10^{-01}$	$2.40x10^{-02}$
ε_{I}	$3.47x10^{-03}$	$3.59x10^{+00}$	$4.71x10^{-04}$	$1.69x10^{-01}$	$1.11x10^{-03}$	$2.72x10^{-01}$
ε_{L}	$3.14x10^{+00}$	$1.42x10^{+00}$	$3.51x10^{+00}$	$7.98x10^{-01}$	$3.58x10^{+00}$	$7.89x10^{-01}$
ε_{M}	$3.17x10^{+00}$	$6.29x10^{-01}$	$9.49x10^{+00}$	$2.20x10^{+00}$	$1.71x10^{+01}$	$8.76x10^{-01}$
ε_{NRc}	$1.28x10^{-03}$	$3.41x10^{+00}$	$2.02x10^{-03}$	$2.21x10^{-01}$	$1.58x10^{-03}$	$3.41x10^{-01}$
ε_{NRdF}	$9.02x10^{-04}$	$3.97x10^{+00}$	$1.00x10^{+02}$	$1.89x10^{-05}$	$1.37x10^{-03}$	$7.77x10^{-01}$
ε_{NRiF}	$2.50x10^{-02}$	$7.61x10^{-02}$	$1.95x10^{-02}$	$1.74x10^{-02}$	$8.64x10^{-03}$	$8.13x10^{-03}$
ε_{NRl}	$2.30x10^{-04}$	$3.57x10^{-08}$	$1.53x10^{-01}$	$2.51x10^{-01}$	$4.16x10^{-01}$	$7.17x10^{-01}$
ε_{NRLFB}	$1.49x10^{+01}$	$2.34x10^{+02}$	$8.57x10^{+01}$	$1.58x10^{+00}$	$6.67x10^{-03}$	$4.41x10^{-01}$
ε_{NRLFK}	$5.18x10^{-01}$	$2.65x10^{+00}$	$2.01x10^{-05}$	$3.18x10^{-08}$	$4.31x10^{-01}$	$2.45x10^{-01}$
ε_{NRLFP}	$6.65x10^{-03}$	$4.65x10^{+00}$	$5.33x10^{-04}$	$2.38x10^{-01}$	$1.14x10^{-03}$	$6.02x10^{-01}$
ε_{NRLHB}	$0.00x10^{-00}$	$3.57x10^{-08}$	$5.27x10^{-09}$	$3.18x10^{-08}$	$3.36x10^{-10}$	$3.29x10^{-08}$
ε_{NRp}	$8.86x10^{-04}$	$2.54x10^{-04}$	$7.48x10^{-04}$	$1.09x10^{-04}$	$3.20x10^{-04}$	$6.16x10^{-05}$
ε_{NRs}	$1.64x10^{-01}$	$8.96x10^{-02}$	$1.36x10^{-01}$	$1.31x10^{-01}$	$1.35x10^{-01}$	$3.65x10^{-02}$
ε_{NRw}	$2.11x10^{+00}$	$2.49x10^{+00}$	$1.65x10^{-01}$	$2.81x10^{-01}$	$3.17x10^{-01}$	$9.42x10^{-01}$
ε_{NRyD}	$2.04x10^{-03}$	$1.07x10^{+02}$	$2.06x10^{-03}$	$5.28x10^{-04}$	$7.27x10^{-09}$	$3.29x10^{-08}$
$\varepsilon_{NRz\alpha}$	$1.84x10^{-03}$	$2.51x10^{+00}$	$1.21x10^{-04}$	$3.18x10^{-08}$	$2.60x10^{-04}$	$5.71x10^{-01}$
ε_{NRzFWL}	$8.83x10^{-03}$	$2.32x10^{+05}$	$5.48x10^{-04}$	$1.85x10^{-01}$	$8.88x10^{-03}$	$3.18x10^{-01}$
ε_{NRzI}	$3.35x10^{-03}$	$3.46x10^{+04}$	$8.77x10^{-04}$	$1.73x10^{-01}$	$1.75x10^{-01}$	$6.50x10^{-01}$
ε_{NRzP}	$2.56x10^{-03}$	$9.91x10^{+04}$	$1.03x10^{-03}$	$1.69x10^{-01}$	$8.97x10^{-04}$	$5.55x10^{-01}$

ε_{NRzY}	2.53×10^{-07}	3.57×10^{-08}	3.77×10^{-03}	3.82×10^{-04}	2.71×10^{-03}	2.43×10^{-04}
ε_{NX}	$2.07\times10^{+00}$	7.33×10^{-01}	$2.05\times10^{+01}$	$1.61\times10^{+00}$	$3.03\times10^{+01}$	$1.33\times10^{+00}$
ε_{P}	1.64×10^{-03}	$3.35\times10^{+01}$	3.18×10^{-02}	1.72×10^{-01}	2.05×10^{-03}	4.11×10^{-01}
ε_{R}	1.69×10^{-02}	3.50×10^{-03}	1.99×10^{-02}	3.93×10^{-03}	2.15×10^{-02}	3.29×10^{-03}
ε_{tL}	9.14×10^{-03}	1.18×10^{-03}	1.02×10^{-02}	3.35×10^{-03}	7.53×10^{-02}	8.47×10^{-03}
ε_{tr}	2.52×10^{-01}	6.56×10^{-02}	2.65×10^{-01}	8.43×10^{-02}	4.27×10^{-01}	4.69×10^{-02}
ε_{tY}	3.38×10^{-02}	7.65×10^{-03}	3.85×10^{-02}	8.43×10^{-03}	1.71×10^{-02}	1.89×10^{-03}
ε_{XW}	4.29×10^{-01}	2.11×10^{-01}	$2.33\times10^{+01}$	$1.61\times10^{+00}$	$7.55\times10^{+01}$	$1.06\times10^{+00}$
ε_{Y}	1.27×10^{-02}	2.82×10^{-03}	6.87×10^{-03}	7.02×10^{-04}	4.33×10^{-03}	3.70×10^{-04}
γ_{g}	3.18×10^{-01}	7.69×10^{-03}	2.38×10^{-01}	4.86×10^{-02}	9.29×10^{-01}	1.58×10^{-07}
γ_{gb}	$3.18\times10^{+00}$	5.07×10^{-02}	$1.67\times10^{+00}$	2.65×10^{-01}	$1.42\times10^{+00}$	5.93×10^{-07}
γ_{gy}	5.78×10^{-01}	1.85×10^{-02}	-4.39×10^{-03}	5.15×10^{-02}	$-4.99\times10^{+00}$	8.16×10^{-07}
γ_{nx}	5.15×10^{-01}	9.51×10^{-02}	8.83×10^{-01}	2.38×10^{-02}	9.36×10^{-01}	2.19×10^{-07}
γ_{nxb}	$5.00\times10^{+00}$	1.11×10^{-06}	2.95×10^{-01}	7.95×10^{-03}	3.18×10^{-01}	7.64×10^{-08}
γ_{r}	9.03×10^{-01}	1.92×10^{-02}	9.12×10^{-01}	1.90×10^{-02}	9.07×10^{-01}	1.56×10^{-07}
γ_{rp}	$1.11\times10^{+00}$	1.82×10^{-02}	6.58×10^{-01}	1.08×10^{-01}	5.35×10^{-01}	6.57×10^{-07}
γ_{ry}	8.65×10^{-01}	1.84×10^{-02}	8.82×10^{-01}	2.36×10^{-01}	7.69×10^{-01}	1.58×10^{-07}
γ_{tL}	5.49×10^{-01}	1.45×10^{-02}	6.17×10^{-01}	1.13×10^{-01}	9.24×10^{-01}	2.06×10^{-07}
γ_{tLb}	$-1.51\times10^{+00}$	6.26×10^{-02}	-8.92×10^{-01}	1.75×10^{-01}	1.24×10^{-01}	4.52×10^{-08}
γ_{tLy}	-3.77×10^{-01}	1.05×10^{-02}	-3.21×10^{-01}	1.47×10^{-01}	$3.22\times10^{+00}$	1.29×10^{-06}
γ_{tr}	9.20×10^{-01}	2.07×10^{-02}	9.26×10^{-01}	2.14×10^{-02}	9.50×10^{-01}	6.28×10^{-07}
γ_{trb}	$5.00\times10^{+00}$	1.11×10^{-06}	$5.00\times10^{+00}$	9.60×10^{-07}	$-3.10\times10^{+00}$	5.40×10^{-07}
γ_{try}	$-5.00\times10^{+00}$	8.89×10^{-07}	$-5.00\times10^{+00}$	9.47×10^{-07}	$-5.00\times10^{+00}$	9.52×10^{-07}
γ_{tY}	9.52×10^{-01}	1.12×10^{-02}	9.59×10^{-01}	8.94×10^{-03}	9.17×10^{-01}	1.50×10^{-07}
γ_{tYb}	$1.30\times10^{+00}$	1.74×10^{-02}	8.28×10^{-01}	1.09×10^{-01}	5.27×10^{-01}	9.75×10^{-08}
γ_{tYy}	$2.50\times10^{+00}$	3.47×10^{-02}	$2.97\times10^{+00}$	9.31×10^{-01}	6.56×10^{-01}	1.21×10^{-07}
γ_{xw}	9.93×10^{-01}	4.00×10^{-03}	9.95×10^{-01}	4.30×10^{-03}	9.93×10^{-01}	4.26×10^{-07}
γ_{xwb}	8.94×10^{-02}	3.70×10^{-02}	8.75×10^{-02}	3.93×10^{-02}	1.13×10^{-01}	3.21×10^{-08}
h_{C}	3.12×10^{-01}	6.34×10^{-08}	3.12×10^{-01}	4.70×10^{-08}	3.12×10^{-01}	6.09×10^{-08}
h_{h}	3.43×10^{-01}	6.91×10^{-08}	3.43×10^{-01}	6.08×10^{-08}	3.43×10^{-01}	6.67×10^{-08}
μ_{F}	-3.72×10^{-01}	5.87×10^{-01}	$2.11\times10^{+00}$	$2.46\times10^{+00}$	-5.41×10^{-04}	2.16×10^{-08}
μ_{H}	$1.04\times10^{+01}$	1.37×10^{-01}	1.19×10^{-04}	3.18×10^{-08}	1.02×10^{-03}	6.36×10^{-08}
$\eta_{0,\alpha}$	4.25×10^{-01}	1.05×10^{-07}	4.25×10^{-01}	1.00×10^{-07}	4.25×10^{-01}	1.10×10^{-07}
$\eta_{0,\beta}$	-1.78×10^{-03}	2.94×10^{-08}	-1.78×10^{-03}	1.85×10^{-08}	-1.78×10^{-03}	1.97×10^{-08}
$\eta_{0,BF}$	$-1.29\times10^{+00}$	1.88×10^{-02}	$-2.00\times10^{+01}$	3.74×10^{-06}	$-2.00\times10^{+01}$	3.89×10^{-06}
$\eta_{0,BH}$	1.32×10^{-02}	5.40×10^{-03}	3.93×10^{-02}	9.93×10^{-02}	-1.08×10^{-03}	3.87×10^{-08}
$\eta_{0,DW}$	$6.99\times10^{+00}$	7.11×10^{-03}	$6.92\times10^{+00}$	1.28×10^{-02}	$6.89\times10^{+00}$	1.17×10^{-06}
$\eta_{0,FWL}$	$7.44\times10^{+00}$	7.00×10^{-02}	$7.29\times10^{+00}$	3.76×10^{-01}	$7.76\times10^{+00}$	1.22×10^{-06}
$\eta_{0,G}$	$-1.51\times10^{+00}$	3.24×10^{-07}	$-1.51\times10^{+00}$	2.16×10^{-07}	$-1.51\times10^{+00}$	2.58×10^{-07}
$\eta_{0,I}$	$8.25\times10^{+00}$	7.47×10^{-02}	$9.68\times10^{+00}$	$2.06\times10^{+00}$	$1.96\times10^{+01}$	5.66×10^{-06}
$\eta_{0,L}$	$-1.57\times10^{+01}$	3.04×10^{-06}	$-1.57\times10^{+01}$	2.15×10^{-06}	$-1.57\times10^{+01}$	2.64×10^{-06}
$\eta_{0,M}$	$-1.34\times10^{+01}$	4.53×10^{-06}	$-1.34\times10^{+01}$	3.01×10^{-06}	$-1.34\times10^{+01}$	4.29×10^{-06}
$\eta_{0,NX}$	$1.56\times10^{+01}$	2.99×10^{-06}	$1.56\times10^{+01}$	7.22×10^{-07}	$1.56\times10^{+01}$	2.63×10^{-06}
$\eta_{0,P}$	$1.88\times10^{+01}$	4.74×10^{-01}	$1.47\times10^{+01}$	7.31×10^{-01}	$1.59\times10^{+01}$	2.51×10^{-06}
$\eta_{0,R}$	1.15×10^{-02}	2.75×10^{-08}	1.15×10^{-02}	1.82×10^{-08}	1.15×10^{-02}	1.96×10^{-08}
$\eta_{0,tL}$	3.10×10^{-01}	6.45×10^{-08}	3.10×10^{-01}	7.98×10^{-08}	3.10×10^{-01}	1.13×10^{-07}
$\eta_{0,tr}$	$-2.29\times10^{+00}$	2.57×10^{-02}	$-1.98\times10^{+00}$	6.43×10^{-01}	$-2.35\times10^{+00}$	5.19×10^{-07}
$\eta_{0,tY}$	1.11×10^{-01}	2.88×10^{-08}	1.11×10^{-01}	3.94×10^{-08}	1.11×10^{-01}	2.09×10^{-08}
$\eta_{0,XW}$	7.54×10^{-01}	5.73×10^{-07}	7.54×10^{-01}	6.44×10^{-07}	7.55×10^{-01}	2.87×10^{-07}
$\eta_{0,Y}$	6.86×10^{-03}	2.58×10^{-08}	6.86×10^{-03}	3.36×10^{-08}	6.86×10^{-03}	2.52×10^{-08}
$\eta_{1,\alpha}$	9.06×10^{-01}	1.74×10^{-02}	9.99×10^{-01}	1.95×10^{-07}	9.99×10^{-01}	3.09×10^{-07}
$\eta_{1,\beta}$	9.36×10^{-01}	2.58×10^{-02}	7.81×10^{-01}	3.18×10^{-02}	8.06×10^{-01}	1.87×10^{-02}
$\eta_{1,BF}$	8.73×10^{-01}	8.20×10^{-02}	9.98×10^{-01}	1.95×10^{-07}	6.42×10^{-01}	5.99×10^{-01}
$\eta_{1,BH}$	6.75×10^{-03}	$4.12\times10^{+00}$	6.07×10^{-04}	2.57×10^{-01}	-1.69×10^{-01}	5.45×10^{-01}

$\eta_{1,DW}$	9.30x10^{-01}	1.56x10^{-02}	9.92x10^{-01}	4.17x10^{-03}	8.55x10^{-01}	4.24x10^{-01}
$\eta_{1,FWL}$	1.18x10^{-01}	1.14x10^{+00}	-1.32x10^{-02}	3.93x10^{-01}	-1.63x10^{-03}	4.36x10^{-01}
$\eta_{1,G}$	9.66x10^{-01}	1.72x10^{-02}	9.57x10^{-01}	1.43x10^{-02}	4.16x10^{-01}	6.45x10^{-02}
$\eta_{1,I}$	1.24x10^{-03}	9.87x10^{-01}	-1.67x10^{-03}	4.07x10^{-01}	-6.82x10^{-03}	2.86x10^{-01}
$\eta_{1,L}$	9.90x10^{-01}	7.14x10^{-03}	9.68x10^{-01}	7.05x10^{-03}	9.70x10^{-01}	6.67x10^{-03}
$\eta_{1,M}$	9.75x10^{-01}	5.86x10^{-03}	9.96x10^{-01}	7.20x10^{-04}	9.97x10^{-01}	2.07x10^{-07}
$\eta_{1,NRc}$	-3.92x10^{-04}	3.91x10^{+00}	-1.86x10^{-03}	2.16x10^{-01}	-6.98x10^{-03}	2.37x10^{-01}
$\eta_{1,NRdF}$	5.08x10^{-04}	2.55x10^{+00}	9.86x10^{-01}	4.52x10^{-01}	1.38x10^{-03}	3.68x10^{-01}
$\eta_{1,NRiF}$	-6.26x10^{-01}	3.11x10^{-01}	-6.26x10^{-01}	3.64x10^{-01}	-7.10x10^{-01}	3.13x10^{-01}
$\eta_{1,NRl}$	1.63x10^{-03}	4.27x10^{+00}	-7.53x10^{-04}	5.36x10^{-02}	-9.42x10^{-04}	3.82x10^{-03}
$\eta_{1,NRLFB}$	1.64x10^{-03}	2.56x10^{+00}	-6.68x10^{-01}	7.83x10^{-01}	1.64x10^{-03}	1.64x10^{-01}
$\eta_{1,NRLFK}$	-6.22x10^{-01}	4.53x10^{-01}	8.75x10^{-04}	3.46x10^{-01}	8.36x10^{-01}	9.65x10^{-02}
$\eta_{1,NRLFP}$	2.70x10^{-03}	3.72x10^{+00}	-1.95x10^{-03}	1.52x10^{-01}	-3.52x10^{-04}	3.48x10^{-01}
$\eta_{1,NRLHB}$	2.43x10^{-05}	2.62x10^{+00}	8.58x10^{-02}	1.85x10^{-01}	1.73x10^{-01}	7.71x10^{-01}
$\eta_{1,NRp}$	-3.46x10^{-01}	2.02x10^{-01}	3.87x10^{-01}	1.89x10^{-01}	-4.66x10^{-01}	1.59x10^{-01}
$\eta_{1,NRs}$	9.84x10^{-01}	1.62x10^{-02}	9.77x10^{-01}	1.51x10^{-01}	9.72x10^{-01}	1.96x10^{-02}
$\eta_{1,NRw}$	1.11x10^{-03}	1.58x10^{-03}	-3.86x10^{-03}	4.55x10^{-02}	-6.32x10^{-04}	6.72x10^{-03}
$\eta_{1,NRyD}$	1.85x10^{-03}	4.48x10^{+00}	4.97x10^{-02}	1.73x10^{-01}	1.12x10^{-04}	5.47x10^{-01}
$\eta_{1,NRz\alpha}$	2.02x10^{-03}	2.03x10^{+00}	3.86x10^{-02}	2.01x10^{-01}	-5.95x10^{-04}	1.22x10^{-01}
$\eta_{1,NRzFWL}$	-1.63x10^{-04}	3.83x10^{+00}	-1.43x10^{-03}	2.33x10^{-01}	-9.96x10^{-05}	1.76x10^{-01}
$\eta_{1,NRzI}$	-1.85x10^{-04}	2.40x10^{+00}	-5.10x10^{-04}	2.29x10^{-01}	5.48x10^{-04}	1.30x10^{-01}
$\eta_{1,NRzP}$	4.87x10^{-05}	3.61x10^{+00}	1.29x10^{-03}	3.25x10^{-01}	-6.16x10^{-04}	4.47x10^{-01}
$\eta_{1,NRzY}$	-1.61x10^{-04}	2.88x10^{+00}	4.91x10^{-01}	6.12x10^{-02}	3.77x10^{-01}	4.49x10^{-02}
$\eta_{1,NX}$	-1.08x10^{-01}	1.68x10^{-01}	3.75x10^{-01}	1.08x10^{-01}	2.23x10^{-01}	4.71x10^{-02}
$\eta_{1,P}$	-2.05x10^{-04}	7.58x10^{-01}	-6.13x10^{-03}	1.42x10^{-01}	-5.41x10^{-04}	5.18x10^{-01}
$\eta_{1,R}$	3.36x10^{-01}	7.95x10^{-02}	3.76x10^{-01}	9.38x10^{-02}	4.46x10^{-01}	7.91x10^{-02}
$\eta_{1,tL}$	-3.08x10^{-01}	1.05x10^{-01}	-3.51x10^{-01}	1.24x10^{-01}	-1.79x10^{-01}	9.66x10^{-02}
$\eta_{1,tr}$	-1.57x10^{-01}	9.34x10^{-02}	-1.84x10^{-01}	2.03x10^{-01}	-1.36x10^{-01}	9.75x10^{-02}
$\eta_{1,tY}$	-4.08x10^{-01}	8.78x10^{-02}	-4.59x10^{-01}	8.99x10^{-02}	-4.75x10^{-01}	9.44x10^{-02}
$\eta_{1,XW}$	9.71x10^{-01}	2.97x10^{-02}	9.94x10^{-01}	4.24x10^{-03}	9.98x10^{-01}	2.07x10^{-07}
$\eta_{1,Y}$	9.53x10^{-01}	1.19x10^{-02}	3.37x10^{-01}	8.16x10^{-02}	2.68x10^{-02}	7.18x10^{-02}
ω_C	3.25x10^{+00}	5.73x10^{-07}	3.25x10^{+00}	4.60x10^{-07}	3.25x10^{+00}	5.46x10^{-07}
ω_L	6.55x10^{+00}	1.28x10^{-06}	6.55x10^{+00}	9.11x10^{-07}	6.55x10^{+00}	1.15x10^{-06}
δ	1.83x10^{-02}	4.91x10^{-08}	1.83x10^{-02}	3.93x10^{-08}	1.83x10^{-02}	2.54x10^{-08}
θ	6.04x10^{+00}	1.05x10^{-06}	6.04x10^{+00}	6.19x10^{-06}	6.04x10^{+00}	6.15x10^{-07}

TABLE A4. The estimation results for the model with measurement errors

	RE IAME		RE DAME		TNRE IAME	
Parameter	value	std	value	std	value	std
ε_{α}	1.22x10^{-02}	9.19x10^{-03}	1.92x10^{-01}	4.22x10^{-02}	3.33x10^{-02}	1.06x10^{-02}
ε_{β}	2.12x10^{-01}	2.68x10^{-02}	5.30x10^{-02}	4.48x10^{-03}	1.03x10^{-01}	1.70x10^{-02}
ε_{BF}	1.00x10^{+02}	2.11x10^{-05}	5.49x10^{+01}	1.38x10^{+00}	1.00x10^{+02}	2.52x10^{-05}
ε_{BH}	7.19x10^{-02}	2.47x10^{+00}	8.30x10^{-04}	1.42x10^{+00}	2.47x10^{-03}	5.18x10^{-01}
ε_{DW}	9.14x10^{+01}	2.34x10^{+00}	1.00x10^{+02}	1.81x10^{-05}	4.05x10^{+01}	1.76x10^{+00}
ε_{FWL}	1.01x10^{-03}	1.99x10^{+00}	2.37x10^{-03}	2.55x10^{+00}	9.77x10^{-04}	8.22x10^{-01}
ε_{G}	2.86x10^{-01}	9.88x10^{-02}	2.19x10^{-01}	3.39x10^{-02}	1.94x10^{-01}	5.85x10^{-02}
ε_{I}	1.31x10^{-03}	1.95x10^{+00}	5.20x10^{-03}	1.63x10^{+00}	2.65x10^{-03}	3.27x10^{-01}
ε_{L}	1.56x10^{+01}	1.96x10^{+00}	1.92x10^{+00}	4.08x10^{-01}	2.38x10^{+00}	1.30x10^{+00}
ε_{M}	7.79x10^{+00}	1.18x10^{+00}	4.23x10^{+01}	1.35x10^{+00}	5.67x10^{+00}	8.78x10^{-01}
ε_{NRc}	-	-	-	-	3.35x10^{-02}	8.43x10^{-01}
ε_{NRdF}	-	-	-	-	1.13x10^{-03}	4.62x10^{-01}
ε_{NRiF}	-	-	-	-	7.74x10^{-02}	9.09x10^{-02}
ε_{NRl}	-	-	-	-	2.47x10^{-01}	1.08x10^{+00}
ε_{NRLFB}	-	-	-	-	5.45x10^{-04}	8.13x10^{-01}
ε_{NRLFK}	-	-	-	-	2.73x10^{+00}	1.93x10^{+00}

ε_{NRLFP}	-	-	-	-	1.07×10^{-02}	4.01×10^{-01}
ε_{NRLHB}	-	-	-	-	2.70×10^{-09}	7.41×10^{-08}
ε_{NRp}	-	-	-	-	1.71×10^{-09}	7.41×10^{-08}
ε_{NRs}	-	-	-	-	5.31×10^{-02}	7.33×10^{-03}
ε_{NRw}	-	-	-	-	2.48×10^{-01}	$1.08\times10^{+00}$
ε_{NRyD}	-	-	-	-	3.80×10^{-04}	4.68×10^{-03}
$\varepsilon_{NRz\alpha}$	-	-	-	-	$5.60\times10^{+01}$	$1.95\times10^{+00}$
ε_{NRzFWL}	-	-	-	-	3.55×10^{-03}	4.35×10^{-01}
ε_{NRzI}	-	-	-	-	4.16×10^{-05}	7.41×10^{-08}
ε_{NRzP}	-	-	-	-	7.29×10^{-04}	4.43×10^{-01}
ε_{NRzY}	-	-	-	-	2.81×10^{-03}	2.64×10^{-04}
ε_{NX}	$2.46\times10^{+01}$	$1.71\times10^{+00}$	$2.67\times10^{+01}$	$1.99\times10^{+00}$	$2.28\times10^{+01}$	$1.94\times10^{+00}$
ε_{P}	6.97×10^{-04}	$2.08\times10^{+00}$	1.37×10^{-02}	$2.37\times10^{+00}$	4.12×10^{-03}	9.60×10^{-01}
ε_{R}	2.24×10^{-02}	3.77×10^{-03}	1.92×10^{-02}	4.22×10^{-03}	2.16×10^{-02}	4.58×10^{-03}
ε_{tL}	1.97×10^{-02}	2.32×10^{-03}	1.90×10^{-01}	7.72×10^{-02}	9.74×10^{-03}	2.41×10^{-03}
ε_{tr}	3.42×10^{-01}	4.31×10^{-02}	4.30×10^{-01}	7.77×10^{-02}	3.44×10^{-01}	1.52×10^{-01}
ε_{tY}	3.96×10^{-02}	6.74×10^{-03}	1.70×10^{-02}	3.55×10^{-03}	3.30×10^{-02}	5.86×10^{-03}
ε_{XW}	$5.92\times10^{+01}$	$2.08\times10^{+00}$	$1.00\times10^{+02}$	1.81×10^{-05}	$4.20\times10^{+01}$	$1.94\times10^{+00}$
ε_{Y}	1.29×10^{-02}	1.98×10^{-03}	6.80×10^{-03}	7.55×10^{-04}	6.43×10^{-03}	8.93×10^{-04}
obs_{CF}	3.57×10^{-03}	3.59×10^{-04}	3.55×10^{-08}	4.90×10^{-08}	1.94×10^{-03}	4.52×10^{-04}
obs_{PF}	1.96×10^{-03}	1.26×10^{-04}	2.16×10^{-03}	1.40×10^{-04}	8.80×10^{-04}	9.55×10^{-05}
obs_{YF}	2.43×10^{-03}	2.13×10^{-04}	1.83×10^{-03}	1.58×10^{-04}	3.17×10^{-04}	5.30×10^{-03}
γ_{g}	5.71×10^{-01}	6.34×10^{-03}	9.35×10^{-01}	8.83×10^{-03}	4.12×10^{-01}	4.84×10^{-02}
γ_{gb}	$4.87\times10^{+00}$	4.15×10^{-02}	$1.39\times10^{+00}$	2.57×10^{-02}	$3.25\times10^{+00}$	1.91×10^{-01}
γ_{gy}	-2.03×10^{-01}	4.30×10^{-03}	$-5.00\times10^{+00}$	1.37×10^{-06}	-2.73×10^{-01}	4.85×10^{-02}
γ_{nx}	9.10×10^{-01}	1.56×10^{-02}	9.15×10^{-01}	1.27×10^{-02}	4.16×10^{-01}	1.15×10^{-01}
γ_{nxb}	$3.42\times10^{+00}$	9.91×10^{-01}	3.36×10^{-01}	9.05×10^{-03}	$5.00\times10^{+00}$	1.44×10^{-06}
γ_{r}	9.27×10^{-01}	6.26×10^{-03}	9.14×10^{-01}	1.76×10^{-02}	9.27×10^{-01}	1.30×10^{-02}
γ_{rp}	$1.51\times10^{+00}$	1.35×10^{-01}	8.53×10^{-01}	3.42×10^{-02}	$1.57\times10^{+00}$	2.79×10^{-01}
γ_{ry}	$1.20\times10^{+00}$	1.16×10^{-02}	9.14×10^{-01}	8.77×10^{-07}	$1.13\times10^{+00}$	7.90×10^{-02}
γ_{tL}	7.82×10^{-01}	1.40×10^{-02}	9.72×10^{-01}	1.10×10^{-02}	5.96×10^{-01}	7.65×10^{-02}
γ_{tLb}	$-2.13\times10^{+00}$	4.04×10^{-02}	3.07×10^{-01}	8.38×10^{-03}	$-1.65\times10^{+00}$	1.81×10^{-01}
γ_{tLy}	8.57×10^{-02}	8.44×10^{-04}	$4.90\times10^{+00}$	5.26×10^{-02}	-4.26×10^{-02}	1.36×10^{-02}
γ_{tr}	9.39×10^{-01}	4.27×10^{-03}	9.50×10^{-01}	9.13×10^{-03}	9.39×10^{-01}	2.67×10^{-02}
γ_{trb}	$5.00\times10^{+00}$	1.70×10^{-06}	$-1.55\times10^{+00}$	4.06×10^{-02}	$5.00\times10^{+00}$	1.44×10^{-06}
γ_{try}	$-5.00\times10^{+00}$	1.83×10^{-06}	$-4.97\times10^{+00}$	4.99×10^{-06}	$-5.00\times10^{+00}$	3.38×10^{-06}
γ_{tY}	9.60×10^{-01}	5.88×10^{-03}	9.24×10^{-01}	1.26×10^{-02}	9.51×10^{-01}	8.53×10^{-03}
γ_{tYb}	$2.23\times10^{+00}$	1.05×10^{-01}	4.59×10^{-01}	1.62×10^{-02}	$1.39\times10^{+00}$	1.14×10^{-01}
γ_{tYy}	$3.05\times10^{+00}$	2.15×10^{-02}	6.56×10^{-01}	9.64×10^{-03}	$2.09\times10^{+00}$	2.10×10^{-01}
γ_{xw}	9.98×10^{-01}	3.63×10^{-07}	9.98×10^{-01}	2.67×10^{-07}	9.99×10^{-01}	2.90×10^{-07}
γ_{xwb}	5.61×10^{-01}	2.41×10^{-01}	1.78×10^{-02}	1.07×10^{-03}	$2.52\times10^{+00}$	8.81×10^{-01}
h_{C}	3.12×10^{-01}	6.84×10^{-08}	3.12×10^{-01}	6.80×10^{-08}	3.12×10^{-01}	1.10×10^{-07}
h_{h}	3.43×10^{-01}	8.33×10^{-08}	3.43×10^{-01}	7.22×10^{-08}	3.43×10^{-01}	1.57×10^{-07}
μ_{F}	-3.90×10^{-01}	2.55×10^{-01}	-6.20×10^{-04}	2.70×10^{-03}	-1.31×10^{-02}	1.98×10^{-01}
μ_{H}	$1.91\times10^{+00}$	2.03×10^{-02}	1.15×10^{-03}	3.24×10^{-03}	$1.74\times10^{+01}$	$1.58\times10^{+00}$
$\eta_{0,\alpha}$	4.25×10^{-01}	1.82×10^{-07}	4.25×10^{-01}	1.67×10^{-07}	4.25×10^{-01}	1.78×10^{-07}
$\eta_{0,\beta}$	-1.78×10^{-03}	4.56×10^{-08}	-1.78×10^{-03}	2.36×10^{-08}	-1.78×10^{-03}	4.73×10^{-08}
$\eta_{0,BF}$	-2.41×10^{-03}	1.06×10^{-03}	$-1.96\times10^{+01}$	1.09×10^{-01}	-4.25×10^{-03}	2.41×10^{-02}
$\eta_{0,BH}$	-2.57×10^{-02}	4.47×10^{-03}	-6.95×10^{-02}	9.21×10^{-08}	-1.78×10^{-02}	1.85×10^{-02}
$\eta_{0,DW}$	$6.94\times10^{+00}$	2.14×10^{-02}	$6.92\times10^{+00}$	1.37×10^{-02}	$6.93\times10^{+00}$	8.73×10^{-03}
$\eta_{0,FWL}$	$9.05\times10^{+00}$	8.12×10^{-02}	$7.54\times10^{+00}$	9.44×10^{-02}	$9.07\times10^{+00}$	4.08×10^{-01}
$\eta_{0,G}$	$-1.51\times10^{+00}$	3.71×10^{-07}	$-1.51\times10^{+00}$	3.32×10^{-07}	$-1.51\times10^{+00}$	1.48×10^{-06}
$\eta_{0,I}$	$2.00\times10^{+01}$	4.88×10^{-06}	$2.00\times10^{+01}$	3.76×10^{-06}	$2.00\times10^{+01}$	5.56×10^{-06}
$\eta_{0,L}$	$-1.57\times10^{+01}$	7.82×10^{-06}	$-1.57\times10^{+01}$	4.21×10^{-07}	$-1.57\times10^{+01}$	3.63×10^{-05}

$\eta_{0,M}$	$-1.34\times10^{+01}$	6.02×10^{-06}	$-1.34\times10^{+01}$	3.21×10^{-06}	$-1.34\times10^{+01}$	3.94×10^{-05}
$\eta_{0,NX}$	$1.56\times10^{+01}$	3.35×10^{-06}	$1.56\times10^{+01}$	3.16×10^{-06}	$1.56\times10^{+01}$	5.36×10^{-06}
$\eta_{0,P}$	$1.98\times10^{+01}$	2.59×10^{-01}	$1.95\times10^{+01}$	1.34×10^{-01}	$1.71\times10^{+01}$	7.01×10^{-01}
$\eta_{0,R}$	1.15×10^{-02}	3.15×10^{-08}	1.15×10^{-02}	2.72×10^{-08}	1.15×10^{-02}	3.47×10^{-08}
$\eta_{0,tL}$	3.10×10^{-01}	6.13×10^{-08}	3.10×10^{-01}	6.30×10^{-08}	3.10×10^{-01}	1.96×10^{-07}
$\eta_{0,tr}$	$-2.39\times10^{+00}$	1.63×10^{-02}	$-1.68\times10^{+00}$	2.42×10^{-02}	$-2.32\times10^{+00}$	3.20×10^{-01}
$\eta_{0,tY}$	1.11×10^{-01}	3.01×10^{-08}	1.11×10^{-01}	2.79×10^{-08}	1.11×10^{-01}	5.36×10^{-08}
$\eta_{0,XW}$	7.55×10^{-01}	6.06×10^{-07}	7.54×10^{-01}	5.69×10^{-07}	7.55×10^{-01}	6.42×10^{-07}
$\eta_{0,Y}$	6.86×10^{-03}	2.46×10^{-08}	6.86×10^{-03}	2.76×10^{-08}	6.86×10^{-03}	2.45×10^{-08}
$\eta_{1,\alpha}$	9.46×10^{-01}	3.53×10^{-02}	9.99×10^{-01}	2.67×10^{-07}	9.76×10^{-01}	9.13×10^{-03}
$\eta_{1,\beta}$	9.86×10^{-01}	2.70×10^{-03}	7.38×10^{-01}	3.13×10^{-02}	9.72×10^{-01}	7.65×10^{-03}
$\eta_{1,BF}$	9.94×10^{-01}	9.16×10^{-04}	7.70×10^{-01}	5.30×10^{-02}	9.95×10^{-01}	7.79×10^{-04}
$\eta_{1,BH}$	9.97×10^{-01}	3.63×10^{-07}	2.45×10^{-03}	$2.08\times10^{+00}$	2.13×10^{-03}	8.86×10^{-01}
$\eta_{1,DW}$	9.85×10^{-01}	8.00×10^{-03}	9.92×10^{-01}	1.42×10^{-03}	9.45×10^{-01}	3.01×10^{-02}
$\eta_{1,FWL}$	3.25×10^{-03}	$1.64\times10^{+00}$	3.84×10^{-02}	3.47×10^{-01}	-2.19×10^{-03}	4.02×10^{-01}
$\eta_{1,G}$	9.46×10^{-01}	2.34×10^{-02}	4.33×10^{-01}	6.79×10^{-02}	9.46×10^{-01}	1.90×10^{-02}
$\eta_{1,I}$	4.07×10^{-04}	8.72×10^{-01}	-7.56×10^{-04}	3.34×10^{-01}	2.93×10^{-03}	1.74×10^{-01}
$\eta_{1,L}$	9.96×10^{-01}	1.52×10^{-03}	9.43×10^{-01}	1.03×10^{-02}	9.77×10^{-01}	2.03×10^{-02}
$\eta_{1,M}$	9.87×10^{-01}	2.25×10^{-03}	9.98×10^{-01}	2.67×10^{-07}	9.86×10^{-01}	2.34×10^{-03}
$\eta_{1,NX}$	2.74×10^{-01}	9.38×10^{-02}	3.02×10^{-01}	8.26×10^{-02}	8.78×10^{-01}	2.75×10^{-02}
$\eta_{1,P}$	1.35×10^{-03}	4.60×10^{-01}	1.31×10^{-03}	2.30×10^{-01}	-1.21×10^{-03}	1.05×10^{-01}
$\eta_{1,R}$	3.43×10^{-01}	8.54×10^{-02}	3.47×10^{-01}	7.86×10^{-02}	3.18×10^{-01}	8.53×10^{-02}
$\eta_{1,tL}$	-3.63×10^{-01}	9.99×10^{-02}	-2.66×10^{-01}	8.95×10^{-02}	-3.48×10^{-01}	1.04×10^{-01}
$\eta_{1,tr}$	-1.45×10^{-01}	9.32×10^{-02}	-1.27×10^{-01}	9.45×10^{-02}	-1.43×10^{-01}	9.56×10^{-02}
$\eta_{1,tY}$	-4.59×10^{-01}	8.48×10^{-02}	-5.56×10^{-01}	9.15×10^{-02}	-4.15×10^{-01}	8.90×10^{-02}
$\eta_{1,XW}$	9.95×10^{-01}	1.29×10^{-03}	9.98×10^{-01}	2.67×10^{-07}	9.92×10^{-01}	4.26×10^{-03}
$\eta_{1,Y}$	7.48×10^{-01}	4.67×10^{-02}	5.35×10^{-01}	6.02×10^{-02}	2.46×10^{-01}	1.14×10^{-01}
ω_C	$3.25\times10^{+00}$	2.70×10^{-06}	$3.25\times10^{+00}$	1.89×10^{-07}	$3.25\times10^{+00}$	1.20×10^{-05}
ω_L	$6.55\times10^{+00}$	1.42×10^{-06}	$6.55\times10^{+00}$	8.48×10^{-07}	$6.55\times10^{+00}$	2.27×10^{-06}
δ	1.83×10^{-02}	6.51×10^{-08}	1.83×10^{-02}	4.65×10^{-08}	1.83×10^{-02}	1.34×10^{-07}
θ	$6.04\times10^{+00}$	2.15×10^{-06}	$6.04\times10^{+00}$	1.45×10^{-06}	$6.04\times10^{+00}$	2.38×10^{-06}

TABLE A4 (continued). The estimation results for the model with measurement errors

	TNRE DAME		PNRE IAME		PNRE DAME	
Parameter	value	std	value	std	value	std
ε_α	9.99×10^{-02}	4.22×10^{-02}	1.42×10^{-01}	4.46×10^{-02}	1.01×10^{-01}	3.16×10^{-02}
ε_β	4.68×10^{-02}	4.02×10^{-03}	4.90×10^{-02}	4.30×10^{-03}	4.83×10^{-02}	4.21×10^{-03}
ε_{BF}	$4.80\times10^{+01}$	$2.03\times10^{+00}$	$1.00\times10^{+02}$	1.90×10^{-05}	$3.83\times10^{+00}$	8.30×10^{-01}
ε_{BH}	1.28×10^{-02}	1.72×10^{-01}	5.26×10^{-03}	$1.15\times10^{+00}$	5.95×10^{-04}	8.56×10^{-01}
ε_{DW}	$1.00\times10^{+02}$	2.02×10^{-05}	$6.01\times10^{+01}$	$1.13\times10^{+00}$	7.06×10^{-05}	2.19×10^{-08}
ε_{FWL}	2.02×10^{-03}	3.67×10^{-01}	5.72×10^{-04}	$1.05\times10^{+00}$	2.77×10^{-03}	3.88×10^{-01}
ε_G	2.10×10^{-01}	3.93×10^{-02}	1.96×10^{-01}	4.47×10^{-02}	1.71×10^{-01}	2.14×10^{-02}
ε_I	4.56×10^{-03}	6.54×10^{-01}	2.06×10^{-03}	7.83×10^{-01}	2.67×10^{-02}	4.13×10^{-01}
ε_L	$3.72\times10^{+00}$	9.24×10^{-01}	$3.93\times10^{+00}$	9.59×10^{-01}	$3.87\times10^{+00}$	4.25×10^{-01}
ε_M	$8.57\times10^{+00}$	$1.01\times10^{+00}$	$1.02\times10^{+01}$	$1.16\times10^{+00}$	$7.50\times10^{+00}$	8.63×10^{-01}
ε_{NRc}	1.05×10^{-03}	1.65×10^{-01}	2.02×10^{-03}	$1.15\times10^{+00}$	1.58×10^{-03}	4.46×10^{-01}
ε_{NRdF}	1.13×10^{-03}	3.20×10^{-01}	$1.00\times10^{+02}$	1.90×10^{-05}	1.67×10^{-05}	2.19×10^{-08}
ε_{NRiF}	6.43×10^{-06}	2.13×10^{-08}	2.44×10^{-02}	1.32×10^{-02}	1.46×10^{-02}	1.56×10^{-02}
ε_{NRl}	3.30×10^{-01}	3.90×10^{-01}	1.50×10^{-01}	8.34×10^{-01}	3.03×10^{-01}	$1.14\times10^{+00}$
ε_{NRLFB}	6.88×10^{-03}	1.19×10^{-01}	7.34×10^{-02}	$1.16\times10^{+00}$	1.03×10^{-01}	6.33×10^{-01}
ε_{NRLFK}	1.04×10^{-04}	2.13×10^{-08}	3.59×10^{-06}	2.52×10^{-08}	3.64×10^{-01}	1.86×10^{-01}
ε_{NRLFP}	1.28×10^{-03}	2.35×10^{-01}	1.89×10^{-03}	$1.11\times10^{+00}$	2.34×10^{-02}	4.74×10^{-01}
ε_{NRLHB}	3.36×10^{-10}	2.13×10^{-08}	3.29×10^{-10}	2.52×10^{-08}	3.36×10^{-10}	2.19×10^{-08}
ε_{NRp}	3.21×10^{-09}	2.13×10^{-08}	2.75×10^{-09}	2.52×10^{-08}	3.03×10^{-10}	2.19×10^{-08}
ε_{NRs}	2.25×10^{-02}	1.45×10^{-02}	1.40×10^{-01}	6.45×10^{-02}	1.43×10^{-01}	5.28×10^{-02}

ε_{NRw}	$3.66x10^{-01}$	$5.50x10^{-01}$	$1.60x10^{-01}$	$7.82x10^{-01}$	$3.37x10^{-01}$	$1.03x10^{+00}$
ε_{NRyD}	$9.08x10^{-09}$	$2.13x10^{-08}$	$1.59x10^{-03}$	$5.28x10^{-04}$	$1.57x10^{-09}$	$2.19x10^{-08}$
$\varepsilon_{NRz\alpha}$	$8.29x10^{-04}$	$3.00x10^{-01}$	$5.61x10^{-04}$	$1.17x10^{+00}$	$8.58x10^{-04}$	$6.59x10^{-01}$
ε_{NRzFWL}	$1.27x10^{-02}$	$1.15x10^{-01}$	$5.48x10^{-04}$	$1.18x10^{+00}$	$2.24x10^{-03}$	$8.95x10^{-01}$
ε_{NRzI}	$8.58x10^{-02}$	$1.52x10^{-01}$	$8.77x10^{-04}$	$1.18x10^{+00}$	$2.55x10^{+00}$	$1.29x10^{+00}$
ε_{NRzP}	$1.90x10^{-03}$	$3.45x10^{-01}$	$1.03x10^{-03}$	$1.18x10^{+00}$	$8.97x10^{-04}$	$8.79x10^{-01}$
ε_{NRzY}	$2.04x10^{-03}$	$1.45x10^{-04}$	$3.69x10^{-03}$	$3.55x10^{-04}$	$2.70x10^{-03}$	$2.55x10^{-04}$
ε_{NX}	$3.32x10^{+01}$	$1.70x10^{+00}$	$1.98x10^{+01}$	$1.16x10^{+00}$	$2.45x10^{+01}$	$1.50x10^{+00}$
ε_{P}	$4.69x10^{-03}$	$4.79x10^{-01}$	$3.70x10^{-02}$	$1.18x10^{+00}$	$1.24x10^{-03}$	$6.11x10^{-01}$
ε_{R}	$2.05x10^{-02}$	$4.57x10^{-03}$	$2.03x10^{-02}$	$2.75x10^{-03}$	$2.10x10^{-02}$	$3.37x10^{-03}$
ε_{tL}	$7.49x10^{-02}$	$1.97x10^{-02}$	$1.02x10^{-02}$	$1.16x10^{-03}$	$8.63x10^{-02}$	$1.32x10^{-02}$
ε_{tr}	$4.12x10^{-01}$	$1.53x10^{-01}$	$2.69x10^{-01}$	$2.86x10^{-02}$	$4.26x10^{-01}$	$4.78x10^{-02}$
ε_{tY}	$1.52x10^{-02}$	$4.06x10^{-03}$	$3.79x10^{-02}$	$3.21x10^{-03}$	$9.93x10^{-03}$	$1.43x10^{-03}$
ε_{XW}	$1.00x10^{+02}$	$2.02x10^{-05}$	$3.07x10^{+01}$	$1.18x10^{+00}$	$1.00x10^{+02}$	$1.81x10^{-05}$
ε_{Y}	$4.30x10^{-03}$	$4.37x10^{-04}$	$5.85x10^{-03}$	$7.51x10^{-04}$	$4.17x10^{-03}$	$3.96x10^{-04}$
obs_{CF}	$0.00x10^{+00}$	$2.13x10^{-08}$	$1.18x10^{-03}$	$4.69x10^{-04}$	$1.86x10^{-09}$	$2.19x10^{-08}$
obs_{PF}	$7.52x10^{-04}$	$7.53x10^{-05}$	$7.80x10^{-04}$	$9.00x10^{-05}$	$7.70x10^{-04}$	$7.49x10^{-05}$
obs_{YF}	$0.00x10^{+00}$	$2.13x10^{-08}$	$2.32x10^{-07}$	$2.52x10^{-08}$	$1.60x10^{-09}$	$2.19x10^{-08}$
γ_{g}	$9.27x10^{-01}$	$1.57x10^{-02}$	$2.36x10^{-01}$	$9.30x10^{-08}$	$9.13x10^{-01}$	$1.93x10^{-07}$
γ_{gb}	$1.46x10^{+00}$	$1.03x10^{-01}$	$1.67x10^{+00}$	$2.88x10^{-07}$	$1.30x10^{+00}$	$3.76x10^{-07}$
γ_{gy}	$-5.00x10^{+00}$	$9.64x10^{-07}$	$-2.59x10^{-02}$	$4.76x10^{-08}$	$-5.00x10^{+00}$	$8.63x10^{-07}$
γ_{nx}	$9.43x10^{-01}$	$8.08x10^{-03}$	$8.80x10^{-01}$	$1.73x10^{-07}$	$9.19x10^{-01}$	$8.70x10^{-07}$
γ_{nxb}	$3.26x10^{-01}$	$2.25x10^{-02}$	$2.90x10^{-01}$	$6.04x10^{-08}$	$2.96x10^{-01}$	$1.81x10^{-07}$
γ_{r}	$9.09x10^{-01}$	$2.26x10^{-02}$	$9.12x10^{-01}$	$1.69x10^{-07}$	$9.10x10^{-01}$	$3.27x10^{-07}$
γ_{rp}	$8.91x10^{-01}$	$1.27x10^{-01}$	$6.67x10^{-01}$	$7.88x10^{-02}$	$8.17x10^{-01}$	$1.09x10^{-01}$
γ_{ry}	$8.24x10^{-01}$	$2.96x10^{-01}$	$8.89x10^{-01}$	$1.54x10^{-07}$	$8.29x10^{-01}$	$3.63x10^{-07}$
γ_{tL}	$9.29x10^{-01}$	$1.85x10^{-02}$	$6.16x10^{-01}$	$3.28x10^{-07}$	$9.35x10^{-01}$	$2.21x10^{-07}$
γ_{tLb}	$-9.08x10^{-03}$	$9.55x10^{-03}$	$-8.98x10^{-01}$	$3.61x10^{-07}$	$5.66x10^{-01}$	$1.74x10^{-07}$
γ_{tLy}	$3.45x10^{+00}$	$2.95x10^{-01}$	$-2.98x10^{-01}$	$6.97x10^{-08}$	$3.62x10^{+00}$	$6.98x10^{-07}$
γ_{tr}	$9.50x10^{-01}$	$1.81x10^{-02}$	$9.27x10^{-01}$	$1.56x10^{-07}$	$9.51x10^{-01}$	$2.46x10^{-07}$
γ_{trb}	$-2.82x10^{+00}$	$6.08x10^{-01}$	$5.00x10^{+00}$	$1.56x10^{-06}$	$-5.00x10^{+00}$	$8.11x10^{-07}$
γ_{try}	$-5.00x10^{+00}$	$9.63x10^{-07}$	$-5.00x10^{+00}$	$1.33x10^{-06}$	$-5.00x10^{+00}$	$1.64x10^{-06}$
γ_{tY}	$9.14x10^{-01}$	$1.92x10^{-02}$	$9.58x10^{-01}$	$2.11x10^{-07}$	$8.66x10^{-01}$	$1.33x10^{-07}$
γ_{tYb}	$4.66x10^{-01}$	$4.15x10^{-02}$	$8.16x10^{-01}$	$1.58x10^{-07}$	$5.87x10^{-01}$	$1.82x10^{-07}$
γ_{tYy}	$2.87x10^{-02}$	$4.51x10^{-02}$	$2.83x10^{+00}$	$9.67x10^{-07}$	$3.58x10^{-01}$	$7.20x10^{-08}$
γ_{xw}	$9.98x10^{-01}$	$2.07x10^{-07}$	$9.95x10^{-01}$	$4.15x10^{-07}$	$9.91x10^{-01}$	$9.62x10^{-07}$
γ_{xwb}	$2.04x10^{-02}$	$3.87x10^{-03}$	$1.13x10^{-01}$	$2.76x10^{-08}$	$3.32x10^{-01}$	$1.54x10^{-07}$
h_{C}	$3.12x10^{-01}$	$6.98x10^{-08}$	$3.12x10^{-01}$	$5.59x10^{-08}$	$3.12x10^{-01}$	$6.13x10^{-08}$
h_{h}	$3.43x10^{-01}$	$7.63x10^{-08}$	$3.43x10^{-01}$	$6.13x10^{-08}$	$3.43x10^{-01}$	$6.70x10^{-08}$
μ_{F}	$8.93x10^{-04}$	$3.84x10^{-02}$	$3.30x10^{+00}$	$5.38x10^{-07}$	$1.97x10^{-03}$	$9.60x10^{-08}$
μ_{H}	$8.15x10^{-04}$	$1.91x10^{-03}$	$4.96x10^{-04}$	$3.27x10^{-08}$	$9.37x10^{-04}$	$8.53x10^{-08}$
$\eta_{0,\alpha}$	$4.25x10^{-01}$	$9.82x10^{-08}$	$4.25x10^{-01}$	$9.80x10^{-08}$	$4.25x10^{-01}$	$1.06x10^{-07}$
$\eta_{0,\beta}$	$-1.78x10^{-03}$	$2.35x10^{-08}$	$-1.78x10^{-03}$	$2.15x10^{-08}$	$-1.78x10^{-03}$	$2.56x10^{-08}$
$\eta_{0,BF}$	$-2.00x10^{+01}$	$3.85x10^{-06}$	$-2.00x10^{+01}$	$3.35x10^{-06}$	$-2.00x10^{+01}$	$3.42x10^{-06}$
$\eta_{0,BH}$	$-6.48x10^{-02}$	$2.07x10^{-02}$	$3.54x10^{-02}$	$4.30x10^{-08}$	$-7.43x10^{-03}$	$3.82x10^{-08}$
$\eta_{0,DW}$	$6.88x10^{+00}$	$8.45x10^{-03}$	$6.91x10^{+00}$	$1.17x10^{-06}$	$6.89x10^{+00}$	$1.07x10^{-06}$
$\eta_{0,FWL}$	$8.01x10^{+00}$	$2.86x10^{-01}$	$7.32x10^{+00}$	$1.20x10^{-06}$	$8.05x10^{+00}$	$1.84x10^{-06}$
$\eta_{0,G}$	$-1.51x10^{+00}$	$1.32x10^{-07}$	$-1.51x10^{+00}$	$2.67x10^{-07}$	$-1.51x10^{+00}$	$2.60x10^{-07}$
$\eta_{0,I}$	$2.00x10^{+01}$	$4.12x10^{-06}$	$9.34x10^{+00}$	$9.84x10^{-07}$	$2.00x10^{+01}$	$3.42x10^{-06}$
$\eta_{0,L}$	$-1.57x10^{+01}$	$6.99x10^{-07}$	$-1.57x10^{+01}$	$2.24x10^{-06}$	$-1.57x10^{+01}$	$2.15x10^{-06}$
$\eta_{0,M}$	$-1.34x10^{+01}$	$3.48x10^{-06}$	$-1.34x10^{+01}$	$3.25x10^{-06}$	$-1.34x10^{+01}$	$3.69x10^{-06}$
$\eta_{0,NX}$	$1.56x10^{+01}$	$3.24x10^{-06}$	$1.56x10^{+01}$	$2.31x10^{-06}$	$1.56x10^{+01}$	$2.14x10^{-06}$
$\eta_{0,P}$	$1.62x10^{+01}$	$7.36x10^{-01}$	$1.48x10^{+01}$	$2.38x10^{-06}$	$1.62x10^{+01}$	$3.91x10^{-06}$
$\eta_{0,R}$	$1.15x10^{-02}$	$2.76x10^{-08}$	$1.15x10^{-02}$	$2.15x10^{-08}$	$1.15x10^{-02}$	$2.51x10^{-08}$

$\eta_{0,tL}$	3.10x10^{-01}	6.42x10^{-08}	3.10x10^{-01}	9.98x10^{-08}	3.10x10^{-01}	7.16x10^{-08}
$\eta_{0,tr}$	-1.72x10^{+00}	2.02x10^{-01}	-2.39x10^{+00}	1.02x10^{-06}	-2.34x10^{+00}	6.96x10^{-07}
$\eta_{0,tY}$	1.11x10^{-01}	3.19x10^{-08}	1.11x10^{-01}	3.24x10^{-08}	1.11x10^{-01}	3.55x10^{-08}
$\eta_{0,XW}$	7.55x10^{-01}	5.70x10^{-07}	7.54x10^{-01}	2.93x10^{-07}	7.55x10^{-01}	2.28x10^{-07}
$\eta_{0,Y}$	6.86x10^{-03}	2.80x10^{-08}	6.86x10^{-03}	2.70x10^{-08}	6.86x10^{-03}	3.03x10^{-08}
$\eta_{1,\alpha}$	9.99x10^{-01}	2.07x10^{-07}	9.99x10^{-01}	2.58x10^{-07}	9.99x10^{-01}	2.29x10^{-07}
$\eta_{1,\beta}$	8.13x10^{-01}	2.26x10^{-02}	7.94x10^{-01}	2.56x10^{-02}	8.09x10^{-01}	2.08x10^{-02}
$\eta_{1,BF}$	7.93x10^{-01}	5.72x10^{-02}	9.98x10^{-01}	2.46x10^{-07}	7.25x10^{-01}	2.04x10^{-01}
$\eta_{1,BH}$	-9.19x10^{-01}	1.32x10^{+00}	5.08x10^{-03}	1.15x10^{+00}	4.36x10^{-02}	3.54x10^{-01}
$\eta_{1,DW}$	9.91x10^{-01}	1.53x10^{-03}	9.93x10^{-01}	3.03x10^{-03}	6.40x10^{-02}	4.51x10^{-01}
$\eta_{1,FWL}$	7.81x10^{-01}	1.26x10^{+00}	7.57x10^{-03}	1.65x10^{-01}	-6.38x10^{-04}	1.84x10^{-01}
$\eta_{1,G}$	4.69x10^{-01}	7.72x10^{-02}	9.58x10^{-01}	1.06x10^{-02}	4.57x10^{-01}	6.33x10^{-02}
$\eta_{1,I}$	-1.42x10^{-03}	2.23x10^{-01}	-6.32x10^{-04}	2.42x10^{-01}	3.64x10^{-04}	3.99x10^{-01}
$\eta_{1,L}$	9.71x10^{-01}	6.83x10^{-03}	9.72x10^{-01}	6.15x10^{-03}	9.72x10^{-01}	3.44x10^{-03}
$\eta_{1,M}$	9.96x10^{-01}	4.62x10^{-04}	9.97x10^{-01}	2.46x10^{-07}	9.96x10^{-01}	4.58x10^{-04}
$\eta_{1,NRc}$	-	-	-3.64x10^{-03}	1.17x10^{+00}	-4.32x10^{-03}	3.50x10^{-01}
$\eta_{1,NRdF}$	-	-	9.84x10^{-01}	1.35x10^{-01}	1.60x10^{-04}	1.74x10^{-01}
$\eta_{1,NRiF}$	-	-	-6.27x10^{-01}	2.17x10^{-01}	-6.87x10^{-01}	5.34x10^{-01}
$\eta_{1,NRl}$	-	-	3.84x10^{-03}	5.04x10^{-02}	7.17x10^{-04}	7.45x10^{-03}
$\eta_{1,NRLFB}$	-	-	-7.44x10^{-01}	1.18x10^{+00}	-5.23x10^{-04}	1.86x10^{-01}
$\eta_{1,NRLFK}$	-	-	-2.22x10^{-04}	1.17x10^{+00}	8.81x10^{-01}	6.71x10^{-02}
$\eta_{1,NRLFP}$	-	-	-1.94x10^{-03}	1.18x10^{+00}	-7.08x10^{-05}	3.33x10^{-01}
$\eta_{1,NRLHB}$	-	-	2.99x10^{-01}	3.23x10^{-07}	1.40x10^{-01}	2.78x10^{-01}
$\eta_{1,NRp}$	-	-	8.94x10^{-01}	1.10x10^{-06}	8.14x10^{-01}	9.23x10^{-01}
$\eta_{1,NRs}$	-	-	9.79x10^{-01}	4.08x10^{-02}	9.75x10^{-01}	2.21x10^{-02}
$\eta_{1,NRw}$	-	-	-4.50x10^{-04}	3.95x10^{-02}	7.12x10^{-04}	6.14x10^{-03}
$\eta_{1,NRyD}$	-	-	-1.57x10^{-02}	1.85x10^{-01}	2.11x10^{-03}	2.96x10^{-01}
$\eta_{1,NRz\alpha}$	-	-	-1.57x10^{-01}	1.18x10^{+00}	3.87x10^{-04}	1.99x10^{-01}
$\eta_{1,NRzFWL}$	-	-	-1.70x10^{-03}	1.18x10^{+00}	4.33x10^{-04}	3.67x10^{-01}
$\eta_{1,NRzI}$	-	-	-5.24x10^{-04}	1.12x10^{+00}	2.53x10^{-03}	2.57x10^{-01}
$\eta_{1,NRzP}$	-	-	1.85x10^{-03}	1.17x10^{+00}	4.69x10^{-03}	6.16x10^{-01}
$\eta_{1,NRzY}$	-	-	4.20x10^{-01}	6.64x10^{-02}	3.69x10^{-01}	4.51x10^{-02}
$\eta_{1,NX}$	2.04x10^{-01}	1.04x10^{-01}	3.66x10^{-01}	4.48x10^{-02}	2.51x10^{-01}	5.37x10^{-02}
$\eta_{1,P}$	-2.03x10^{-04}	2.28x10^{-01}	-4.62x10^{-03}	2.19x10^{-01}	1.55x10^{-03}	3.63x10^{-01}
$\eta_{1,R}$	4.11x10^{-01}	9.62x10^{-02}	3.82x10^{-01}	7.68x10^{-02}	4.15x10^{-01}	8.76x10^{-02}
$\eta_{1,tL}$	-2.60x10^{-01}	1.05x10^{-01}	-3.47x10^{-01}	9.64x10^{-02}	-1.97x10^{-01}	1.47x10^{-01}
$\eta_{1,tr}$	-1.56x10^{-01}	1.16x10^{-01}	-1.80x10^{-01}	9.46x10^{-02}	-1.49x10^{-01}	1.02x10^{-01}
$\eta_{1,tY}$	-5.34x10^{-01}	9.43x10^{-02}	-4.56x10^{-01}	8.31x10^{-02}	-4.93x10^{-01}	1.12x10^{-01}
$\eta_{1,XW}$	9.98x10^{-01}	2.07x10^{-07}	9.95x10^{-01}	6.08x10^{-04}	9.98x10^{-01}	2.52x10^{-07}
$\eta_{1,Y}$	2.15x10^{-02}	1.23x10^{-01}	2.42x10^{-01}	8.91x10^{-02}	1.43x10^{-02}	1.42x10^{-01}
ω_C	3.25x10^{+00}	2.19x10^{-07}	3.25x10^{+00}	5.83x10^{-07}	3.25x10^{+00}	5.11x10^{-07}
ω_L	6.55x10^{+00}	2.66x10^{-07}	6.55x10^{+00}	1.03x10^{-06}	6.55x10^{+00}	8.89x10^{-07}
δ	1.83x10^{-02}	2.53x10^{-08}	1.83x10^{-02}	2.44x10^{-08}	1.83x10^{-02}	2.53x10^{-08}
θ	6.04x10^{+00}	1.32x10^{-06}	6.04x10^{+00}	1.95x10^{-06}	6.04x10^{+00}	9.16x10^{-07}

TABLE A5. RMSE of in-sample forecasts of the models with information approach

Variable-horizon	AR (1)	VAR (1)	RE IAWME	RE IAME	TNRE IAWME	TNRE IAME	PNRE IAWME	PNRE IAME
obs_C(t+1)	0.59%	0.50%	0.96%	0.83%	0.95%	0.91%	0.88%	0.86%
obs_G(t+1)	0.85%	0.73%	0.88%	0.91%	0.87%	0.85%	0.86%	0.85%
obs_I(t+1)	2.93%	1.93%	4.98%	2.95%	3.03%	2.98%	3.09%	3.06%
obs_P(t+1)	0.18%	0.16%	0.22%	0.20%	0.22%	0.20%	0.22%	0.20%
obs_R(t+1)	0.13%	0.10%	0.12%	0.12%	0.12%	0.12%	0.12%	0.12%
obs_{STR}(t+1)	8.61%	7.62%	8.72%	8.86%	9.38%	9.45%	8.65%	8.67%
obs_{taxL}(t+1)	0.71%	0.61%	0.67%	0.66%	0.65%	0.65%	0.62%	0.62%

obs_{taxY}(t+1)	0.25%	0.23%	0.25%	0.23%	0.23%	0.23%	0.23%	0.23%
obs_{tr}(t+1)	2.27%	2.04%	2.29%	2.36%	2.30%	2.31%	2.27%	2.27%
obs_{WL}(t+1)	0.82%	0.56%	2.07%	1.13%	0.95%	0.94%	0.76%	0.74%
obs_{Y}(t+1)	0.54%	0.46%	0.60%	0.57%	0.58%	0.58%	0.59%	0.59%
obs_{PF}(t+1)	0.10%	0.08%	0.42%	0.18%	0.11%	0.11%	0.10%	0.10%
obs_{YF}(t+1)	0.27%	0.18%	0.31%	0.29%	0.35%	0.35%	0.31%	0.32%
obs_{CF}(t+1)	0.28%	0.23%	0.51%	0.47%	0.37%	0.40%	0.34%	0.34%
obs_{C}(t+2)	0.62%	0.58%	1.10%	0.85%	0.92%	0.89%	0.84%	0.82%
obs_{G}(t+2)	0.87%	0.76%	0.98%	0.97%	0.91%	0.89%	0.87%	0.87%
obs_{I}(t+2)	3.06%	2.67%	3.61%	3.16%	3.17%	3.13%	3.21%	3.20%
obs_{P}(t+2)	0.19%	0.17%	0.39%	0.22%	0.23%	0.21%	0.24%	0.22%
obs_{R}(t+2)	0.21%	0.16%	0.20%	0.19%	0.21%	0.20%	0.21%	0.21%
obs_{STR}(t+2)	8.64%	8.19%	8.73%	8.90%	8.68%	8.67%	8.67%	8.68%
obs_{taxL}(t+2)	0.83%	0.67%	0.80%	0.82%	0.78%	0.78%	0.73%	0.73%
obs_{taxY}(t+2)	0.29%	0.27%	0.32%	0.28%	0.28%	0.28%	0.28%	0.28%
obs_{tr}(t+2)	2.35%	2.27%	2.44%	2.40%	2.33%	2.34%	2.31%	2.32%
obs_{WL}(t+2)	0.84%	0.73%	2.57%	1.15%	0.97%	0.97%	0.82%	0.82%
obs_{Y}(t+2)	0.57%	0.54%	0.60%	0.60%	0.61%	0.61%	0.61%	0.61%
obs_{PF}(t+2)	0.13%	0.11%	0.25%	0.20%	0.13%	0.13%	0.13%	0.13%
obs_{YF}(t+2)	0.33%	0.27%	0.33%	0.35%	0.37%	0.37%	0.37%	0.38%
obs_{CF}(t+2)	0.31%	0.26%	0.53%	0.47%	0.39%	0.42%	0.35%	0.37%
obs_{C}(t+3)	0.63%	0.59%	1.26%	1.01%	0.99%	0.97%	0.88%	0.86%
obs_{G}(t+3)	0.87%	0.77%	0.93%	1.00%	0.93%	0.90%	0.87%	0.87%
obs_{I}(t+3)	3.13%	2.87%	3.40%	3.15%	3.20%	3.16%	3.24%	3.22%
obs_{P}(t+3)	0.21%	0.19%	0.26%	0.23%	0.24%	0.23%	0.25%	0.23%
obs_{R}(t+3)	0.28%	0.22%	0.28%	0.26%	0.28%	0.28%	0.28%	0.28%
obs_{STR}(t+3)	8.67%	8.53%	8.72%	8.91%	8.68%	8.68%	8.67%	8.68%
obs_{taxL}(t+3)	1.00%	0.79%	1.00%	1.05%	0.98%	0.98%	0.90%	0.90%
obs_{taxY}(t+3)	0.35%	0.33%	0.40%	0.35%	0.33%	0.33%	0.34%	0.34%
obs_{tr}(t+3)	2.38%	2.31%	2.35%	2.37%	2.34%	2.34%	2.32%	2.32%
obs_{WL}(t+3)	0.86%	0.77%	1.02%	1.15%	0.98%	0.98%	0.84%	0.84%
obs_{Y}(t+3)	0.60%	0.55%	0.59%	0.62%	0.62%	0.62%	0.62%	0.62%
obs_{PF}(t+3)	0.15%	0.13%	0.27%	0.20%	0.14%	0.14%	0.15%	0.14%
obs_{YF}(t+3)	0.35%	0.31%	0.35%	0.37%	0.38%	0.38%	0.39%	0.39%
obs_{CF}(t+3)	0.32%	0.28%	0.60%	0.52%	0.42%	0.44%	0.40%	0.42%
obs_{C}(t+4)	0.65%	0.61%	1.28%	1.04%	0.98%	0.97%	0.83%	0.81%
obs_{G}(t+4)	0.88%	0.78%	0.92%	1.02%	0.94%	0.91%	0.88%	0.87%
obs_{I}(t+4)	3.14%	2.98%	3.36%	3.17%	3.17%	3.15%	3.19%	3.19%
obs_{P}(t+4)	0.22%	0.20%	0.30%	0.25%	0.26%	0.24%	0.26%	0.25%
obs_{R}(t+4)	0.35%	0.26%	0.35%	0.33%	0.35%	0.34%	0.35%	0.35%
obs_{STR}(t+4)	8.70%	8.64%	8.73%	8.92%	8.70%	8.69%	8.69%	8.70%
obs_{taxL}(t+4)	1.17%	0.86%	1.20%	1.30%	1.19%	1.19%	1.08%	1.09%
obs_{taxY}(t+4)	0.41%	0.38%	0.49%	0.40%	0.38%	0.38%	0.39%	0.39%
obs_{tr}(t+4)	2.39%	2.35%	2.39%	2.39%	2.36%	2.36%	2.36%	2.36%
obs_{WL}(t+4)	0.87%	0.79%	1.20%	1.17%	0.98%	0.98%	0.85%	0.85%
obs_{Y}(t+4)	0.60%	0.58%	0.61%	0.64%	0.62%	0.62%	0.62%	0.62%
obs_{PF}(t+4)	0.16%	0.13%	0.26%	0.21%	0.16%	0.15%	0.16%	0.15%
obs_{YF}(t+4)	0.36%	0.33%	0.36%	0.38%	0.38%	0.38%	0.40%	0.40%
obs_{CF}(t+4)	0.32%	0.29%	0.59%	0.52%	0.43%	0.44%	0.42%	0.43%
mean of RMSE	1.39%	1.27%	1.60%	1.49%	1.45%	1.45%	1.42%	1.41%
RMSE of RMSE	2.58%	2.43%	2.73%	2.67%	2.65%	2.65%	2.60%	2.60%
mean of RMSE ex expect.	1.70%	1.55%	1.92%	1.80%	1.77%	1.76%	1.72%	1.72%
RMSE of RMSE _ ex expect.	2.91%	2.74%	3.08%	3.00%	2.99%	2.98%	2.93%	2.93%

median of RMSE	0.60%	0.55%	0.64%	0.65%	0.63%	0.63%	0.62%	0.62%
median of RMSE ex expect.	0.83%	0.64%	0.97%	0.99%	0.93%	0.91%	0.84%	0.83%

TABLE A6. RMSE of out-of-sample forecasts of the models with information approach

Variable-horizon	AR (1)	VAR (1)	RE IAWME	RE IAME	TNRE IAWME	TNRE IAME	PNRE IAWME	PNRE IAME
obs_{C}(t+1)	0.97%	0.88%	0.79%	0.90%	0.90%	0.98%	0.85%	0.89%
obs_{G}(t+1)	1.18%	1.17%	1.11%	1.12%	1.12%	1.11%	1.12%	1.10%
obs_{I}(t+1)	4.40%	3.27%	5.79%	4.12%	4.09%	4.11%	4.29%	4.29%
obs_{P}(t+1)	0.22%	0.23%	0.20%	0.24%	0.21%	0.20%	0.20%	0.20%
obs_{R}(t+1)	0.09%	0.16%	0.11%	0.09%	0.11%	0.11%	0.12%	0.12%
obs_{STR}(t+1)	12.64%	12.66%	12.62%	12.19%	13.69%	13.89%	12.15%	12.16%
obs_{taxL}(t+1)	0.79%	0.90%	0.84%	0.78%	0.75%	0.76%	0.73%	0.73%
obs_{taxY}(t+1)	0.47%	0.49%	0.45%	0.41%	0.42%	0.42%	0.41%	0.41%
obs_{tr}(t+1)	2.82%	2.64%	3.14%	3.03%	2.93%	2.91%	2.80%	2.71%
obs_{WL}(t+1)	1.44%	0.89%	2.68%	1.24%	1.21%	1.20%	1.07%	1.06%
obs_{Y}(t+1)	0.75%	0.82%	0.71%	0.74%	0.82%	0.81%	0.84%	0.84%
obs_{PF}(t+1)	0.12%	0.12%	0.36%	0.19%	0.12%	0.11%	0.11%	0.11%
obs_{YF}(t+1)	0.39%	0.31%	0.40%	0.43%	0.55%	0.55%	0.46%	0.46%
obs_{CF}(t+1)	0.31%	0.36%	0.48%	0.39%	0.44%	0.42%	0.42%	0.40%
obs_{C}(t+2)	1.10%	1.07%	1.03%	1.02%	1.00%	1.00%	0.98%	0.95%
obs_{G}(t+2)	1.32%	1.11%	1.36%	1.39%	1.32%	1.28%	1.22%	1.21%
obs_{I}(t+2)	5.00%	4.54%	5.65%	4.68%	4.84%	4.88%	4.92%	4.92%
obs_{P}(t+2)	0.25%	0.25%	0.39%	0.26%	0.26%	0.24%	0.25%	0.24%
obs_{R}(t+2)	0.15%	0.26%	0.19%	0.15%	0.19%	0.18%	0.21%	0.21%
obs_{STR}(t+2)	12.14%	13.22%	12.45%	12.15%	12.03%	11.99%	12.05%	12.06%
obs_{taxL}(t+2)	1.21%	1.17%	1.25%	1.13%	1.07%	1.08%	0.99%	1.00%
obs_{taxY}(t+2)	0.45%	0.52%	0.56%	0.45%	0.44%	0.44%	0.44%	0.44%
obs_{tr}(t+2)	2.73%	2.62%	3.08%	2.91%	2.72%	2.72%	2.65%	2.63%
obs_{WL}(t+2)	1.39%	1.34%	2.18%	1.39%	1.31%	1.32%	1.31%	1.31%
obs_{Y}(t+2)	0.86%	0.87%	0.80%	0.83%	0.86%	0.86%	0.88%	0.87%
obs_{PF}(t+2)	0.16%	0.14%	0.33%	0.22%	0.14%	0.14%	0.15%	0.14%
obs_{YF}(t+2)	0.56%	0.54%	0.52%	0.56%	0.59%	0.59%	0.58%	0.58%
obs_{CF}(t+2)	0.40%	0.48%	0.54%	0.51%	0.47%	0.49%	0.44%	0.45%
obs_{C}(t+3)	0.71%	0.75%	0.90%	0.81%	0.80%	0.81%	0.62%	0.62%
obs_{G}(t+3)	1.35%	1.05%	1.35%	1.47%	1.36%	1.31%	1.20%	1.19%
obs_{I}(t+3)	4.72%	4.60%	5.05%	4.41%	4.59%	4.58%	4.59%	4.59%
obs_{P}(t+3)	0.27%	0.28%	0.39%	0.31%	0.27%	0.26%	0.27%	0.26%
obs_{R}(t+3)	0.21%	0.33%	0.29%	0.21%	0.27%	0.26%	0.30%	0.29%
obs_{STR}(t+3)	8.83%	9.96%	8.87%	8.63%	8.62%	8.64%	8.67%	8.67%
obs_{taxL}(t+3)	1.45%	1.38%	1.61%	1.43%	1.36%	1.37%	1.19%	1.19%
obs_{taxY}(t+3)	0.48%	0.62%	0.62%	0.51%	0.48%	0.48%	0.48%	0.48%
obs_{tr}(t+3)	2.37%	2.69%	2.32%	2.19%	2.18%	2.17%	2.12%	2.07%
obs_{WL}(t+3)	1.44%	1.37%	1.59%	1.35%	1.34%	1.34%	1.34%	1.35%
obs_{Y}(t+3)	0.63%	0.72%	0.62%	0.64%	0.61%	0.62%	0.62%	0.62%
obs_{PF}(t+3)	0.17%	0.15%	0.32%	0.22%	0.15%	0.13%	0.15%	0.14%
obs_{YF}(t+3)	0.53%	0.61%	0.53%	0.55%	0.54%	0.54%	0.53%	0.53%
obs_{CF}(t+3)	0.31%	0.39%	0.55%	0.46%	0.42%	0.42%	0.37%	0.37%
obs_{C}(t+4)	0.52%	0.52%	0.83%	0.75%	0.79%	0.78%	0.50%	0.48%
obs_{G}(t+4)	1.34%	1.02%	1.31%	1.50%	1.38%	1.32%	1.18%	1.17%
obs_{I}(t+4)	3.56%	3.88%	4.04%	3.36%	3.35%	3.32%	3.29%	3.30%
obs_{P}(t+4)	0.28%	0.30%	0.40%	0.32%	0.27%	0.27%	0.27%	0.27%
obs_{R}(t+4)	0.26%	0.41%	0.37%	0.27%	0.34%	0.32%	0.38%	0.37%
obs_{STR}(t+4)	7.65%	9.06%	7.59%	7.30%	7.43%	7.51%	7.47%	7.48%

$obs_{taxL}(t+4)$	1.63%	1.59%	1.90%	1.73%	1.65%	1.67%	1.41%	1.41%
$obs_{taxY}(t+4)$	0.47%	0.66%	0.78%	0.53%	0.50%	0.50%	0.48%	0.49%
$obs_{tr}(t+4)$	2.42%	2.58%	2.30%	2.32%	2.23%	2.23%	2.21%	2.19%
$obs_{WL}(t+4)$	0.91%	0.89%	1.52%	1.14%	0.91%	0.93%	0.86%	0.86%
$obs_{Y}(t+4)$	0.41%	0.58%	0.50%	0.49%	0.43%	0.43%	0.42%	0.42%
$obs_{PF}(t+4)$	0.15%	0.11%	0.28%	0.20%	0.13%	0.12%	0.13%	0.12%
$obs_{YF}(t+4)$	0.34%	0.41%	0.36%	0.38%	0.31%	0.32%	0.30%	0.31%
$obs_{CF}(t+4)$	0.17%	0.22%	0.47%	0.40%	0.39%	0.38%	0.27%	0.27%
mean of RMSE	1.75%	1.79%	1.92%	1.74%	1.74%	1.75%	1.68%	**1.68%**
RMSE of RMSE	3.21%	3.37%	3.35%	3.14%	3.24%	3.25%	3.12%	**3.12%**
mean of RMSE ex expect.	2.14%	2.19%	2.33%	2.11%	2.12%	2.13%	2.05%	**2.05%**
RMSE of RMSE ex expect.	3.62%	3.80%	3.77%	3.53%	3.65%	3.67%	3.52%	**3.52%**
median of RMSE	0.73%	0.78%	0.79%	0.76%	0.79%	0.80%	0.68%	**0.67%**
median of RMSE ex expect.	1.14%	**0.96%**	1.18%	1.12%	1.03%	1.04%	0.98%	0.98%

TABLE A7. RMSE of in-sample forecasts of the models with dates approach

Variable-horizon	AR (1)	VAR (1)	RE DAWME	RE DAME	TNRE DAWME	TNRE DAME	PNRE DAWME	PNRE DAME
$obs_{C}(t+1)$	0.59%	0.48%	0.91%	0.91%	0.92%	0.91%	0.90%	0.89%
$obs_{G}(t+1)$	0.85%	0.73%	1.15%	0.87%	0.92%	0.89%	0.86%	0.86%
$obs_{I}(t+1)$	2.93%	1.93%	5.77%	3.03%	3.05%	3.05%	3.05%	3.05%
$obs_{P}(t+1)$	0.18%	0.16%	0.22%	0.20%	0.22%	0.21%	0.22%	0.21%
$obs_{R}(t+1)$	0.13%	0.10%	0.13%	0.12%	0.12%	0.12%	0.12%	0.12%
$obs_{STR}(t+1)$	8.61%	7.66%	8.78%	8.65%	8.67%	8.68%	8.66%	8.65%
$obs_{taxL}(t+1)$	0.71%	0.62%	0.68%	0.68%	0.68%	0.67%	0.68%	0.67%
$obs_{taxY}(t+1)$	0.25%	0.23%	0.38%	0.26%	0.25%	0.25%	0.24%	0.23%
$obs_{tr}(t+1)$	2.27%	2.03%	2.27%	2.39%	2.38%	2.37%	2.32%	2.29%
$obs_{WL}(t+1)$	0.82%	0.57%	2.35%	0.83%	0.78%	0.79%	0.76%	0.74%
$obs_{Y}(t+1)$	0.54%	0.47%	0.55%	0.57%	0.58%	0.58%	0.58%	0.58%
$obs_{PF}(t+1)$	0.09%	0.08%	0.45%	0.19%	0.09%	0.09%	0.09%	0.09%
$obs_{YF}(t+1)$	0.18%	0.14%	0.31%	0.23%	0.26%	0.26%	0.21%	0.21%
$obs_{CF}(t+1)$	0.17%	0.14%	0.45%	0.25%	0.26%	0.25%	0.25%	0.24%
$obs_{C}(t+2)$	0.62%	0.58%	1.09%	0.88%	0.85%	0.85%	0.84%	0.85%
$obs_{G}(t+2)$	0.87%	0.76%	1.36%	0.95%	1.06%	1.02%	0.91%	0.91%
$obs_{I}(t+2)$	3.06%	2.72%	3.88%	3.20%	3.21%	3.22%	3.20%	3.19%
$obs_{P}(t+2)$	0.19%	0.17%	0.40%	0.22%	0.24%	0.22%	0.24%	0.22%
$obs_{R}(t+2)$	0.21%	0.17%	0.23%	0.20%	0.20%	0.20%	0.20%	0.20%
$obs_{STR}(t+2)$	8.64%	8.27%	8.80%	8.68%	8.65%	8.65%	8.66%	8.66%
$obs_{taxL}(t+2)$	0.83%	0.66%	0.89%	0.82%	0.82%	0.81%	0.81%	0.79%
$obs_{taxY}(t+2)$	0.29%	0.27%	0.68%	0.35%	0.34%	0.33%	0.29%	0.28%
$obs_{tr}(t+2)$	2.35%	2.30%	2.43%	2.43%	2.42%	2.41%	2.36%	2.34%
$obs_{WL}(t+2)$	0.84%	0.73%	2.99%	0.87%	0.84%	0.84%	0.84%	0.82%
$obs_{Y}(t+2)$	0.57%	0.55%	0.68%	0.61%	0.61%	0.61%	0.61%	0.61%
$obs_{PF}(t+2)$	0.11%	0.10%	0.26%	0.20%	0.11%	0.11%	0.11%	0.11%
$obs_{YF}(t+2)$	0.22%	0.20%	0.26%	0.26%	0.27%	0.27%	0.26%	0.26%
$obs_{CF}(t+2)$	0.19%	0.17%	0.49%	0.25%	0.26%	0.25%	0.25%	0.25%
$obs_{C}(t+3)$	0.63%	0.59%	1.25%	0.97%	0.87%	0.87%	0.86%	0.86%
$obs_{G}(t+3)$	0.87%	0.77%	1.56%	0.98%	1.12%	1.07%	0.91%	0.91%
$obs_{I}(t+3)$	3.13%	2.93%	3.60%	3.20%	3.23%	3.22%	3.23%	3.21%
$obs_{P}(t+3)$	0.21%	0.19%	0.27%	0.23%	0.25%	0.23%	0.25%	0.23%
$obs_{R}(t+3)$	0.28%	0.22%	0.31%	0.27%	0.28%	0.28%	0.28%	0.28%
$obs_{STR}(t+3)$	8.67%	8.59%	8.75%	8.68%	8.67%	8.67%	8.68%	8.67%

obs_{taxL}(t+3)	1.00%	0.79%	1.24%	1.00%	1.01%	0.99%	0.98%	0.96%
obs_{taxY}(t+3)	0.35%	0.33%	1.03%	0.46%	0.45%	0.43%	0.35%	0.34%
obs_{tr}(t+3)	2.38%	2.32%	2.40%	2.43%	2.44%	2.44%	2.35%	2.35%
obs_{WL}(t+3)	0.86%	0.77%	1.13%	0.89%	0.85%	0.86%	0.86%	0.84%
obs_{Y}(t+3)	0.60%	0.56%	0.64%	0.62%	0.62%	0.62%	0.62%	0.61%
obs_{PF}(t+3)	0.13%	0.11%	0.28%	0.20%	0.14%	0.12%	0.14%	0.12%
obs_{YF}(t+3)	0.23%	0.22%	0.28%	0.27%	0.28%	0.27%	0.27%	0.27%
obs_{CF}(t+3)	0.20%	0.18%	0.53%	0.29%	0.30%	0.29%	0.30%	0.29%
obs_{C}(t+4)	0.65%	0.61%	1.28%	0.92%	0.83%	0.84%	0.83%	0.83%
obs_{G}(t+4)	0.88%	0.78%	1.75%	0.99%	1.16%	1.11%	0.91%	0.91%
obs_{I}(t+4)	3.14%	3.00%	3.39%	3.18%	3.21%	3.20%	3.21%	3.18%
obs_{P}(t+4)	0.22%	0.20%	0.30%	0.25%	0.27%	0.25%	0.27%	0.25%
obs_{R}(t+4)	0.35%	0.27%	0.39%	0.34%	0.34%	0.34%	0.34%	0.34%
obs_{STR}(t+4)	8.70%	8.62%	8.74%	8.69%	8.70%	8.69%	8.70%	8.69%
obs_{taxL}(t+4)	1.17%	0.89%	1.59%	1.19%	1.20%	1.17%	1.15%	1.12%
obs_{taxY}(t+4)	0.41%	0.38%	1.46%	0.60%	0.60%	0.58%	0.42%	0.40%
obs_{tr}(t+4)	2.39%	2.35%	2.55%	2.46%	2.46%	2.47%	2.37%	2.36%
obs_{WL}(t+4)	0.87%	0.79%	1.34%	0.91%	0.87%	0.87%	0.86%	0.85%
obs_{Y}(t+4)	0.60%	0.58%	0.64%	0.63%	0.62%	0.62%	0.62%	0.62%
obs_{PF}(t+4)	0.14%	0.12%	0.28%	0.22%	0.14%	0.13%	0.15%	0.13%
obs_{YF}(t+4)	0.24%	0.23%	0.27%	0.28%	0.28%	0.28%	0.28%	0.28%
obs_{CF}(t+4)	0.20%	0.19%	0.55%	0.30%	0.33%	0.32%	0.33%	0.32%
mean of RMSE	1.37%	1.26%	1.73%	1.44%	1.44%	1.43%	1.41%	1.40%
RMSE of RMSE	2.58%	2.44%	2.83%	2.61%	2.61%	2.61%	2.60%	2.60%
mean of RMSE ex expect.	1.70%	1.56%	2.10%	1.76%	1.77%	1.76%	1.74%	1.73%
RMSE of RMSE ex expect.	2.91%	2.75%	3.18%	2.94%	2.94%	2.94%	2.93%	2.93%
median of RMSE	0.60%	0.56%	0.90%	0.66%	0.65%	0.65%	0.65%	0.64%
median of RMSE ex expect.	0.83%	0.64%	1.25%	0.88%	0.85%	0.86%	0.85%	0.84%

TABLE A8. RMSE of out-of-sample forecasts of the models with dates approach

Variable-horizon	AR (1)	VAR (1)	RE DAWME	RE DAME	TNRE DAWME	TNRE DAME	PNRE DAWME	PNRE DAME
obs_{C}(t+1)	0.97%	0.88%	0.78%	0.78%	0.96%	0.96%	0.96%	0.95%
obs_{G}(t+1)	1.18%	1.16%	1.26%	1.11%	1.17%	1.11%	1.04%	1.01%
obs_{I}(t+1)	4.40%	3.28%	5.99%	4.28%	4.39%	4.45%	4.42%	4.37%
obs_{P}(t+1)	0.22%	0.23%	0.21%	0.24%	0.21%	0.20%	0.22%	0.21%
obs_{R}(t+1)	0.09%	0.17%	0.13%	0.10%	0.12%	0.11%	0.12%	0.12%
obs_{STR}(t+1)	12.64%	13.81%	11.66%	12.13%	12.50%	12.56%	12.53%	12.20%
obs_{taxL}(t+1)	0.79%	0.91%	0.83%	0.82%	0.81%	0.81%	0.77%	0.78%
obs_{taxY}(t+1)	0.47%	0.51%	0.56%	0.46%	0.48%	0.47%	0.43%	0.44%
obs_{tr}(t+1)	2.82%	2.82%	2.68%	3.05%	3.00%	3.02%	2.98%	2.83%
obs_{WL}(t+1)	1.44%	0.96%	2.65%	1.08%	1.13%	1.14%	1.06%	1.06%
obs_{Y}(t+1)	0.75%	0.84%	0.68%	0.80%	0.83%	0.83%	0.84%	0.84%
obs_{PF}(t+1)	0.09%	0.09%	0.41%	0.19%	0.09%	0.08%	0.08%	0.08%
obs_{YF}(t+1)	0.22%	0.22%	0.39%	0.31%	0.36%	0.36%	0.28%	0.28%
obs_{CF}(t+1)	0.18%	0.24%	0.46%	0.22%	0.24%	0.24%	0.24%	0.23%
obs_{C}(t+2)	1.10%	1.22%	0.97%	0.90%	0.92%	0.92%	0.94%	0.94%
obs_{G}(t+2)	1.32%	1.09%	1.96%	1.32%	1.45%	1.35%	1.15%	1.12%
obs_{I}(t+2)	5.00%	4.75%	5.39%	4.91%	5.04%	5.03%	4.98%	4.94%
obs_{P}(t+2)	0.25%	0.25%	0.43%	0.26%	0.25%	0.23%	0.26%	0.23%
obs_{R}(t+2)	0.15%	0.27%	0.25%	0.19%	0.21%	0.20%	0.20%	0.20%
obs_{STR}(t+2)	12.14%	14.67%	11.67%	12.15%	12.13%	12.12%	12.17%	12.07%

obs_{taxL}(t+2)	1.21%	1.25%	1.29%	1.19%	1.17%	1.17%	1.14%	1.15%
obs_{taxY}(t+2)	0.45%	0.55%	0.95%	0.56%	0.60%	0.58%	0.47%	0.48%
obs_{tr}(t+2)	2.73%	2.87%	2.91%	2.93%	2.80%	2.81%	2.70%	2.64%
obs_{WL}(t+2)	1.39%	1.41%	2.87%	1.33%	1.32%	1.31%	1.36%	1.33%
obs_{Y}(t+2)	0.86%	0.96%	0.93%	0.85%	0.87%	0.87%	0.87%	0.87%
obs_{PF}(t+2)	0.11%	0.11%	0.27%	0.21%	0.11%	0.09%	0.11%	0.10%
obs_{YF}(t+2)	0.32%	0.36%	0.41%	0.36%	0.39%	0.39%	0.37%	0.37%
obs_{CF}(t+2)	0.21%	0.25%	0.39%	0.25%	0.26%	0.26%	0.26%	0.26%
obs_{C}(t+3)	0.71%	0.85%	0.77%	0.60%	0.63%	0.63%	0.62%	0.62%
obs_{G}(t+3)	1.35%	1.05%	2.25%	1.39%	1.54%	1.43%	1.12%	1.10%
obs_{I}(t+3)	4.72%	5.75%	5.09%	4.59%	4.69%	4.66%	4.64%	4.60%
obs_{P}(t+3)	0.27%	0.28%	0.35%	0.31%	0.26%	0.25%	0.27%	0.25%
obs_{R}(t+3)	0.21%	0.36%	0.38%	0.27%	0.30%	0.29%	0.29%	0.29%
obs_{STR}(t+3)	8.83%	10.93%	8.63%	8.80%	8.75%	8.75%	8.35%	8.66%
obs_{taxL}(t+3)	1.45%	1.54%	1.73%	1.46%	1.44%	1.43%	1.40%	1.40%
obs_{taxY}(t+3)	0.48%	0.67%	1.41%	0.65%	0.71%	0.68%	0.48%	0.47%
obs_{tr}(t+3)	2.37%	2.76%	2.28%	2.36%	2.37%	2.40%	2.25%	2.22%
obs_{WL}(t+3)	1.44%	1.46%	1.37%	1.29%	1.35%	1.33%	1.39%	1.36%
obs_{Y}(t+3)	0.63%	0.95%	0.69%	0.61%	0.62%	0.62%	0.62%	0.62%
obs_{PF}(t+3)	0.14%	0.13%	0.29%	0.21%	0.13%	0.12%	0.14%	0.12%
obs_{YF}(t+3)	0.30%	0.39%	0.38%	0.33%	0.36%	0.36%	0.35%	0.34%
obs_{CF}(t+3)	0.20%	0.25%	0.40%	0.26%	0.25%	0.24%	0.26%	0.25%
obs_{C}(t+4)	0.52%	0.71%	0.71%	0.49%	0.49%	0.49%	0.48%	0.48%
obs_{G}(t+4)	1.34%	1.03%	2.53%	1.44%	1.66%	1.54%	1.09%	1.06%
obs_{I}(t+4)	3.56%	4.76%	3.75%	3.36%	3.44%	3.42%	3.38%	3.34%
obs_{P}(t+4)	0.28%	0.30%	0.39%	0.32%	0.28%	0.26%	0.28%	0.27%
obs_{R}(t+4)	0.26%	0.47%	0.49%	0.34%	0.37%	0.35%	0.36%	0.36%
obs_{STR}(t+4)	7.65%	9.36%	7.94%	7.68%	7.56%	7.57%	7.39%	7.47%
obs_{taxL}(t+4)	1.63%	1.86%	2.23%	1.66%	1.64%	1.62%	1.58%	1.57%
obs_{taxY}(t+4)	0.47%	0.71%	2.06%	0.86%	0.96%	0.91%	0.48%	0.48%
obs_{tr}(t+4)	2.42%	2.53%	2.67%	2.51%	2.40%	2.44%	2.25%	2.23%
obs_{WL}(t+4)	0.91%	0.99%	1.47%	0.95%	0.85%	0.86%	0.89%	0.88%
obs_{Y}(t+4)	0.41%	0.79%	0.51%	0.42%	0.43%	0.43%	0.43%	0.42%
obs_{PF}(t+4)	0.13%	0.11%	0.27%	0.20%	0.13%	0.11%	0.13%	0.11%
obs_{YF}(t+4)	0.20%	0.29%	0.25%	0.24%	0.27%	0.27%	0.26%	0.25%
obs_{CF}(t+4)	0.14%	0.22%	0.37%	0.24%	0.21%	0.21%	0.22%	0.22%
mean of RMSE	1.72%	1.92%	1.98%	1.73%	1.75%	1.74%	1.68%	1.67%
RMSE of RMSE	3.21%	3.69%	3.28%	3.17%	3.20%	3.20%	3.15%	3.13%
mean of RMSE ex expect.	2.14%	2.38%	2.43%	2.13%	2.16%	2.15%	2.08%	2.07%
RMSE of RMSE ex expect.	3.62%	4.16%	3.70%	3.57%	3.60%	3.61%	3.55%	3.53%
median of RMSE	0.73%	0.87%	0.88%	0.79%	0.82%	0.82%	0.70%	0.70%
median of RMSE ex expect.	1.14%	1.01%	1.39%	1.01%	1.04%	1.04%	1.00%	0.98%

TABLE A9. RMSE of in-sample forecasts of the models without observed expectations

Variable-horizon	AR (1)	VAR (1)	RE WE	TNRE WE	PNRE WE
obs_{C}(t+1)	0.59%	0.52%	0.66%	0.62%	0.61%
obs_{G}(t+1)	0.85%	0.76%	0.84%	0.80%	0.79%
obs_{I}(t+1)	2.93%	2.00%	2.87%	2.79%	2.80%
obs_{P}(t+1)	0.18%	0.16%	0.25%	0.19%	0.19%
obs_{R}(t+1)	0.13%	0.10%	0.13%	0.13%	0.13%
obs_{STR}(t+1)	8.61%	7.94%	8.64%	9.16%	8.62%
obs_{taxL}(t+1)	0.71%	0.63%	0.63%	0.63%	0.63%

obs_{taxY}(t+1)	0.25%	0.23%	0.24%	0.23%	0.23%
obs_{tr}(t+1)	2.27%	2.05%	2.24%	2.28%	2.27%
obs_{WL}(t+1)	0.82%	0.57%	0.86%	0.82%	0.81%
obs_{Y}(t+1)	0.54%	0.47%	0.69%	0.64%	0.63%
obs_{C}(t+2)	0.62%	0.59%	0.63%	0.61%	0.61%
obs_{G}(t+2)	0.87%	0.78%	0.82%	0.78%	0.79%
obs_{I}(t+2)	3.06%	2.70%	3.16%	3.14%	3.12%
obs_{P}(t+2)	0.19%	0.18%	0.26%	0.21%	0.20%
obs_{R}(t+2)	0.21%	0.16%	0.22%	0.21%	0.21%
obs_{STR}(t+2)	8.64%	8.28%	8.67%	8.64%	8.66%
obs_{taxL}(t+2)	0.83%	0.69%	0.72%	0.72%	0.72%
obs_{taxY}(t+2)	0.29%	0.27%	0.29%	0.28%	0.28%
obs_{tr}(t+2)	2.35%	2.30%	2.33%	2.34%	2.34%
obs_{WL}(t+2)	0.84%	0.74%	0.92%	0.86%	0.85%
obs_{Y}(t+2)	0.57%	0.55%	0.64%	0.63%	0.62%
obs_{C}(t+3)	0.63%	0.59%	0.69%	0.66%	0.66%
obs_{G}(t+3)	0.87%	0.78%	0.82%	0.78%	0.79%
obs_{I}(t+3)	3.13%	2.91%	3.21%	3.18%	3.17%
obs_{P}(t+3)	0.21%	0.19%	0.27%	0.23%	0.22%
obs_{R}(t+3)	0.28%	0.22%	0.31%	0.29%	0.29%
obs_{STR}(t+3)	8.67%	8.52%	8.69%	8.67%	8.67%
obs_{taxL}(t+3)	1.00%	0.82%	0.88%	0.89%	0.89%
obs_{taxY}(t+3)	0.35%	0.33%	0.35%	0.34%	0.34%
obs_{tr}(t+3)	2.38%	2.32%	2.32%	2.34%	2.34%
obs_{WL}(t+3)	0.86%	0.77%	0.91%	0.87%	0.87%
obs_{Y}(t+3)	0.60%	0.56%	0.64%	0.62%	0.61%
obs_{C}(t+4)	0.65%	0.61%	0.68%	0.65%	0.66%
obs_{G}(t+4)	0.88%	0.80%	0.82%	0.78%	0.79%
obs_{I}(t+4)	3.14%	2.98%	3.20%	3.16%	3.15%
obs_{P}(t+4)	0.22%	0.20%	0.29%	0.24%	0.24%
obs_{R}(t+4)	0.35%	0.27%	0.39%	0.36%	0.35%
obs_{STR}(t+4)	8.70%	8.57%	8.72%	8.69%	8.70%
obs_{taxL}(t+4)	1.17%	0.93%	1.05%	1.04%	1.04%
obs_{taxY}(t+4)	0.41%	0.38%	0.39%	0.38%	0.38%
obs_{tr}(t+4)	2.39%	2.35%	2.35%	2.36%	2.36%
obs_{WL}(t+4)	0.87%	0.79%	0.96%	0.90%	0.89%
obs_{Y}(t+4)	0.60%	0.58%	0.64%	0.62%	0.61%
mean of RMSE	1.70%	1.57%	1.71%	1.70%	1.68%
RMSE of RMSE	2.91%	2.77%	2.92%	2.94%	2.91%
median of RMSE	0.83%	0.66%	0.77%	0.75%	0.76%

TABLE A10. RMSE of out-of-sample forecasts of the models without observed expectations

Variable-horizon	AR (1)	VAR (1)	RE WE	TNRE WE	PNRE WE
obs_{C}(t+1)	0.97%	0.94%	1.07%	1.02%	1.03%
obs_{G}(t+1)	1.18%	1.20%	1.05%	0.95%	0.96%
obs_{I}(t+1)	4.40%	3.10%	4.36%	4.30%	4.33%
obs_{P}(t+1)	0.22%	0.24%	0.33%	0.23%	0.21%
obs_{R}(t+1)	0.09%	0.15%	0.14%	0.12%	0.12%
obs_{STR}(t+1)	12.64%	13.93%	12.14%	13.50%	12.14%
obs_{taxL}(t+1)	0.79%	0.84%	0.70%	0.75%	0.75%
obs_{taxY}(t+1)	0.47%	0.49%	0.42%	0.40%	0.42%
obs_{tr}(t+1)	2.82%	2.58%	2.65%	2.84%	2.88%
obs_{WL}(t+1)	1.44%	0.94%	1.28%	1.21%	1.16%
obs_{Y}(t+1)	0.75%	0.83%	1.10%	0.93%	0.94%
obs_{C}(t+2)	1.10%	1.15%	1.01%	0.99%	0.99%

$obs_G(t+2)$	1.32%	1.11%	1.01%	0.90%	0.94%
$obs_I(t+2)$	5.00%	4.61%	4.93%	4.86%	4.87%
$obs_P(t+2)$	0.25%	0.26%	0.36%	0.27%	0.25%
$obs_R(t+2)$	0.15%	0.26%	0.27%	0.20%	0.21%
$obs_{STR}(t+2)$	12.14%	14.56%	12.12%	12.05%	12.14%
$obs_{taxL}(t+2)$	1.21%	1.20%	0.91%	0.96%	0.95%
$obs_{taxY}(t+2)$	0.45%	0.54%	0.44%	0.43%	0.44%
$obs_{tr}(t+2)$	2.73%	2.81%	2.75%	2.83%	2.77%
$obs_{WL}(t+2)$	1.39%	1.40%	1.51%	1.38%	1.37%
$obs_Y(t+2)$	0.86%	0.95%	0.96%	0.89%	0.90%
$obs_C(t+3)$	0.71%	0.82%	0.69%	0.67%	0.68%
$obs_G(t+3)$	1.35%	1.05%	1.02%	0.91%	0.95%
$obs_I(t+3)$	4.72%	5.31%	4.66%	4.59%	4.60%
$obs_P(t+3)$	0.27%	0.28%	0.37%	0.31%	0.28%
$obs_R(t+3)$	0.21%	0.34%	0.40%	0.28%	0.29%
$obs_{STR}(t+3)$	8.83%	11.21%	8.72%	8.79%	8.96%
$obs_{taxL}(t+3)$	1.45%	1.51%	1.07%	1.13%	1.13%
$obs_{taxY}(t+3)$	0.48%	0.64%	0.49%	0.47%	0.48%
$obs_{tr}(t+3)$	2.37%	2.77%	2.13%	2.19%	2.17%
$obs_{WL}(t+3)$	1.44%	1.42%	1.44%	1.37%	1.39%
$obs_Y(t+3)$	0.63%	0.88%	0.69%	0.62%	0.63%
$obs_C(t+4)$	0.52%	0.62%	0.50%	0.51%	0.52%
$obs_G(t+4)$	1.34%	1.04%	1.01%	0.87%	0.91%
$obs_I(t+4)$	3.56%	4.56%	3.40%	3.31%	3.31%
$obs_P(t+4)$	0.28%	0.29%	0.38%	0.31%	0.30%
$obs_R(t+4)$	0.26%	0.44%	0.51%	0.35%	0.36%
$obs_{STR}(t+4)$	7.65%	9.73%	7.59%	7.67%	7.86%
$obs_{taxL}(t+4)$	1.63%	1.80%	1.22%	1.28%	1.29%
$obs_{taxY}(t+4)$	0.47%	0.69%	0.48%	0.46%	0.46%
$obs_{tr}(t+4)$	2.42%	2.64%	2.23%	2.30%	2.27%
$obs_{WL}(t+4)$	0.91%	0.96%	1.05%	0.95%	0.91%
$obs_Y(t+4)$	0.41%	0.74%	0.46%	0.42%	0.42%
mean of RMSE	2.14%	2.36%	2.09%	2.09%	2.07%
RMSE of RMSE	3.62%	4.16%	3.54%	3.64%	3.56%
median of RMSE	1.14%	1.00%	1.02%	0.94%	0.94%

TABLE A11. The aggregate measures of the in-sample forecasting quality

	mean RMSE	mean RMSE ex expect.	RMSE of RMSE	RMSE of RMSE ex expect.	mean of ratio RMSE to RMSE of AR (1)	mean of ratio RMSE to RMSE of AR (1) ex expect.
AR(1)	1.70%	1.70%	2.91%	2.91%	100.00%	100.00%
VAR(1)	1.57%	1.57%	2.77%	2.77%	89.62%	89.62%
RE WE	1.71%	1.71%	2.92%	2.92%	104.32%	104.32%
TNRE WE	1.70%	1.70%	2.94%	2.94%	99.64%	99.64%
PNRE WE	1.68%	1.68%	2.91%	2.91%	98.84%	98.84%
AR(1) IA	1.39%	1.70%	2.58%	2.91%	100.00%	100.00%
VAR(1) IA	1.27%	**1.55%**	**2.43%**	**2.74%**	**87.20%**	**88.02%**
RE IAWME	1.60%	1.92%	2.73%	3.08%	135.76%	125.32%
RE IAME	1.49%	1.80%	2.67%	3.00%	116.06%	109.95%
TNRE IAWME	1.45%	1.77%	2.65%	2.99%	109.42%	108.03%
TNRE IAME	1.45%	1.76%	2.65%	2.98%	108.39%	106.39%
PNRE IAWME	1.42%	1.72%	2.60%	2.93%	105.72%	104.10%
PNRE IAME	1.41%	1.72%	2.60%	2.93%	104.85%	103.02%
AR(1) DA	1.37%	1.70%	2.58%	2.91%	100.00%	100.00%
VAR(1) DA	**1.26%**	1.56%	2.44%	2.75%	88.52%	88.57%
RE DAWME	1.73%	2.10%	2.83%	3.18%	167.24%	150.83%

RE DAME	1.44%	1.76%	2.61%	2.94%	117.08%	109.26%
TNRE DAWME	1.44%	1.77%	2.61%	2.94%	113.77%	110.26%
TNRE DAME	1.43%	1.76%	2.61%	2.94%	111.69%	108.64%
PNRE DAWME	1.41%	1.74%	2.60%	2.93%	109.58%	105.78%
PNRE DAME	1.40%	1.73%	2.60%	2.93%	107.38%	104.07%