Precautionary saving and un-anchored expectations[1]

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Outline of the presentation

Recessions and the consumption/saving trade-off

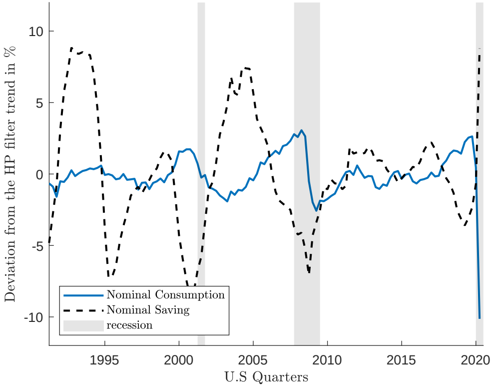

Figure 1: Nominal consumption and saving dynamic in the US (in deviation from the HP filtered trend)

Supply shocks and RANK models

1. The COVID-19 has a large **adverse supply side effect** (see Cox et al. 2020 [3]);
2. Negative supply shocks in RANK models create:
   - **Inflation** (due to supply < demand and ↑ Marginal Cost);
   - Mild ↓ **in consumption** and large ↓ **in saving**;
3. We observe a↑ **in saving** and ↓ **in consumption**.
4. RANK models do not acknowledge **precautionary saving** => we need some income risk

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HANK models and expectations

1. Assuming **idiosyncratic employment/income risk** generates **heterogeneity**;
2. Expected future marginal utility flows depend on:
   - inter-temporal optimization/discounting process (from the real rate) ;
   - future income (labour and dividends),
   - and idiosyncratic risks (unemployement).
3. This **complicates the role of households' expectations**,
4. **It is unlikely that households are able to form rational expectations** about such a complicated process which depends:
   - on idiosyncratic risk (unemployment),
   - on idiosyncratic levels (wealth),
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5. Expectation de-anchoring can lead to stagnation trap or persistent slump.

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1. A **reduced heterogeneity** NK model;
2. Where expectations:
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3. With **supply shocks** trigger drop in aggregate demand and long lasting disinflationary periods.
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Literature

The basic household set-up

The economy is populated by a continuum of agents of measure i, distributed on an interval $\jmath$ with a GHH utility function:

$$\begin{cases} U(c_t, l_t) = \frac{1}{1-\sigma}(c_t - \frac{l_t^{1+1/\varphi}}{\chi(1+1/\varphi)})^{1-\sigma} \text{ if } \sigma \neq 1; \\ U(c_t, l_t) = \log(c_t - \frac{l_t^{1+1/\varphi}}{\chi(1+1/\varphi)}) \text{ if } \sigma = 1; \end{cases} \tag{1}$$

with a budget constraint:

$$c_t^i + a_t^i = (1 - \delta + Z_t)a_{t-1}^i + 1_{e_t^i = e} l_t^i W_t, \tag{2}$$

and the employment statuses evolve following this transition matrix:

$$M_t = \begin{bmatrix} 1 - \Pi_{eu} & \Pi_{eu} \\ \Pi_{ue,t} & 1 - \Pi_{ue,t} \end{bmatrix}, \tag{3}$$

with the probability to transition from unemployment to employment comoving with respect to productivity shocks in this fashion:

$$\Pi_{ue,t} = \Pi_{ue}^{SS} + \nu \varepsilon_t^p. \tag{4}$$

Intuition behind the model

- Idiosyncratic shocks and infinite living households generate an infinite number of heterogeneous households which is computationally complex to solve,
- I pack the households in families according to their idiosyncratic employment histories $\hbar$ as in Ragot (2018) [11],
- To achieve a finite partition, I arbitrary **truncated their histories** after N periods and assume **insurance within families**,
- It leads to the creation of (number of idiosyncratic states)^N families.

The idiosyncratic structure of the model

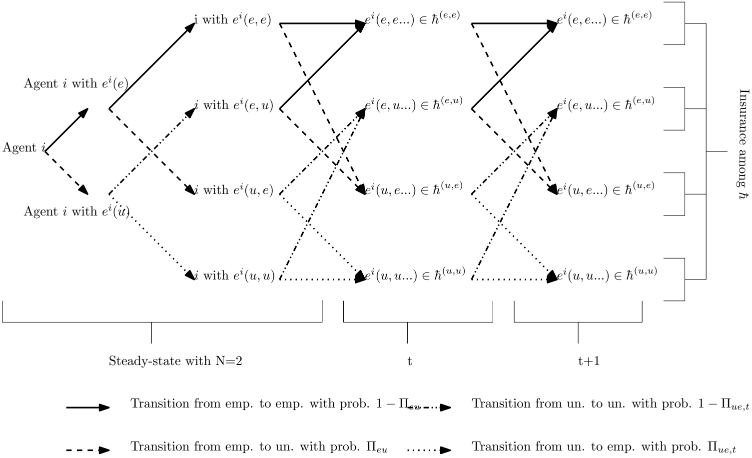

Figure 2: The idiosyncratic structure of the model if $N = 2$

The Euler equations

- The model yields a **finite number of Euler equations** in this fashion :

$$\xi_{\hbar} U'(c_{\hbar,t}, l_{\hbar,t}) = \beta \mathbb{E}^*_t [\frac{i_t}{\pi_{t+1}} \sum_{\tilde{\hbar} \in \mathcal{H}} \Pi^{\mathcal{E}}_{\hbar \tilde{\hbar}, t+1} \xi^{\mathcal{E}}_{\tilde{\hbar}} U'(c_{\tilde{\hbar},t+1}, l_{\tilde{\hbar},t+1})],$$

  - $\hbar \Rightarrow$ current family,
  - $\tilde{\hbar} \Rightarrow$ other history family,
  - $\mathcal{H} \Rightarrow$ set of all families,
  - $\Pi^{\mathcal{E}}_{\hbar \tilde{\hbar}, t} \Rightarrow$ probability to transition from family $\hbar$ to $\tilde{\hbar}$ in t,
  - $U' \Rightarrow$ marginal utility,
  - $c_{\hbar,t}$ and $l_{\hbar,t}$, $\Rightarrow$ individual labour and consumption quantity,
  - i_t and $\pi_t \Rightarrow$ nominal rate and inflation,
  - $\xi_{\hbar}$ preference shifter (correct for steady state distribution and non-linearity in U',
  - $\mathbb{E}^*_t$ the expectation with $* = \{RE, AL\}$.

The model

- There rest of the model is a standard DSGE model with:
  - a Cobb-Douglas production function and,
  - NK features with monopolistic competition and sticky prices. Details RANK counterpart
- Once linearised, the model boils down to:

$$A_0 + A_1 \hat{x}_{t-1} + A_2 \hat{x}_t + A_2 \mathbb{E}_t^* \hat{x}_{t+1} + A_3 \hat{z}_t = 0. \quad (5)$$

with $\hat{x}_t = [\hat{Y}_t, \hat{\pi}_t, \hat{i}_t, \hat{W}_t, ...]$ the state variables vector and $\hat{z}_t = [\varepsilon_t^r, \varepsilon_t^p]$ the exogenous shocks vector.

Solution under AL and RE (1/2)

- The model can be collapsed in it MSV fom as:

$$\hat{x}_t = A + P\hat{x}_{t-1} + Q\hat{z}_t, \tag{6}$$

with $\hat{x}_t$ the state variables vector, $\hat{z}_t$ the exogenous shocks vector. We define $\hat{x}^e_{t+1}$ the forward looking variables vector.

- Under RE we have :

$$\mathbb{E}^{RE}_t \hat{x}^e_{t+1} = \alpha + \beta\hat{x}_{t-1} + \gamma z_t, \tag{7}$$

with:

$$\begin{cases} \alpha = (I+P)A = 0 \\ \beta = P^2 \\ \gamma = PQ + \rho \end{cases}$$

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Solution under AL and RE (2/2)

- The perceived law of motion hypothesis:

$$\hat{x}^e_t = a_{t-1} + b_{t-1}\hat{x}_{t-1} + c_{t-1}z_t. \quad (8)$$

- Under AL we have :

$$\mathbb{E}^{AL}_t \hat{x}^e_{t+1} = (I + b_{t-1})a_{t-1} + b^2_{t-1}\hat{x}_{t-1} + (b_{t-1}c_{t-1} + \rho)z_t. \quad (9)$$

- The RLS updating:

$$\phi_t = \phi_{t-1} + gR^{-1}_t M_{t-1}(\hat{x}^e_t - M'_{t-1}\phi_{t-1})$$
$$R_t = R_{t-1} + g(M_{t-1}M'_{t-1} - R_{t-1})$$

with $\phi_t = [a'_t, vec(b_t, c_t)']'$ as the beliefs matrix and $M_t = \{1, x'_{t-1}, z'_t\}$ the moments matrix and $0 < g < 1$ the gain coefficient.

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- Under AL we have :

$$\mathbb{E}_t^{AL}\hat{x}_{t+1}^e = (I + b_{t-1})a_{t-1} + b_{t-1}^2\hat{x}_{t-1} + (b_{t-1}c_{t-1} + \rho)z_t. \tag{9}$$

- The RLS updating:

$$\phi_t = \phi_{t-1} + gR_t^{-1}M_{t-1}(\hat{x}_t^e - M_{t-1}'\phi_{t-1})$$
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Expectations in RANK and HANK

- Forward variables in the RANK model:

$$\hat{x}^{e,RANK} = [\hat{Y}_t, \hat{\pi}_t, \hat{Z}_t, \hat{L}_t, \hat{C}_t]. \tag{10}$$

- Forward variables in the HANK model:

$$\begin{aligned} \hat{x}^{e,HANK} =& [\hat{Y}_t, \hat{\pi}_t, \hat{Z}_t, \hat{l}_t, \quad \dots \\ & \hat{c}_{\hbar=1,t}, \hat{c}_{\hbar=2,t} \quad [\dots] \quad , \hat{c}_{\hbar=N,t}, \quad \dots \\ & \Pi^{\mathcal{E}}_{\hbar=1\,\tilde{\hbar}=1,t}, \Pi^{\mathcal{E}}_{\hbar=1\,\tilde{\hbar}=2,t}, \quad \dots \\ & \Pi^{\mathcal{E}}_{\hbar=2\,\tilde{\hbar}=1,t}, \Pi^{\mathcal{E}}_{\hbar=2\,\tilde{\hbar}=3,t}, \quad \dots \\ & \quad [\dots] \\ & \Pi^{\mathcal{E}}_{\hbar=N\,\tilde{\hbar}=N-1,t}, \Pi^{\mathcal{E}}_{\hbar=N\,\tilde{\hbar}=N,t}]. \end{aligned} \tag{11}$$

=> Labour supply is homogeneous thanks to GHH !

A sequential competitive equilibrium

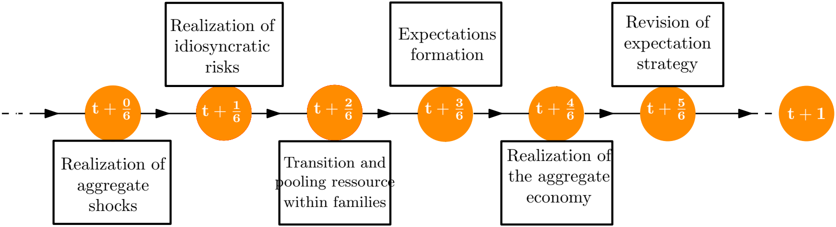


Figure 3: Intra period timing of the model

Responses to an negative supply shock

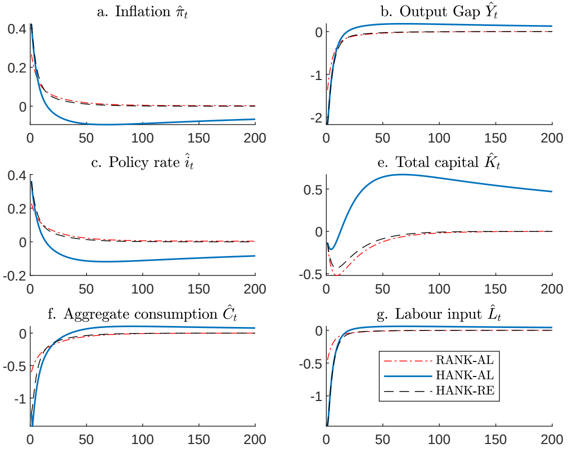
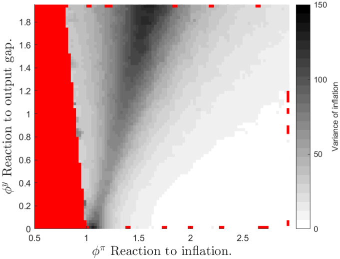
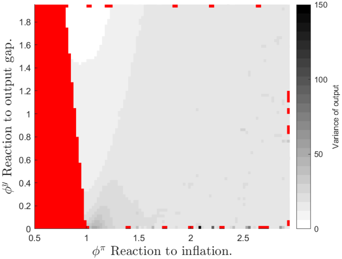


Figure 4: Response to a -1% productivity/supply shock (initialization at the REE) More Expectations dynamic MP shock

MP trade-off in the HANK AL model under IT



(a) Inflation variance in HANK AL



(b) Output variance in HANK AL

Figure 5: Variances over the MP space under RE under RANK

The shift in the monetary policy frontiers

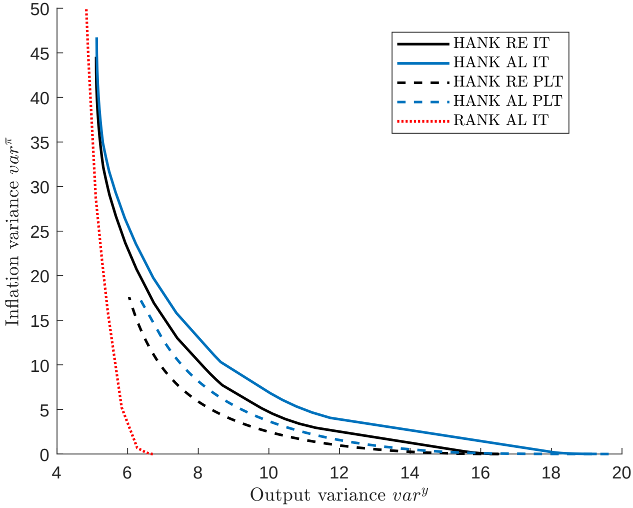


Figure 6: Monetary policy frontiers in various contexts Models' moments

Conclusion

1. **Negative supply shocks** in this model create demand shortage and are **disinflationary**,
2. **Contrary to RANK model** , **dovish** monetary policies can **mitigate the effect of AL**,
3. **PLT reduces the volatility** in the model by stabilizing the expected consumption/income channel.
4. Work in progress : **a family based RPE learning**
   - no more collinearity concern,
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Thank you for your attention.

Questions? Comments?

Literature

Supply shocks in HANK:

- Ravn and Sterk (2016) [12], Challe et al. (2017) [2], Challe (2020) [1], and Guerrieri et al. (2020) [6].

Adaptive learning in macro-models:

- Marcet and Sargent (1989) [8] Evans and Honkapohja (2001) [4] and Orphanides and Williams (2008) [9]

Non rational expectations in HANK:

- Honkapohja and Mitra (2006) [7], Radke and Wicknig (2020) [10] and Gobbi and Grazzini (2019) [5].

back

The rest of the model Back I

$$\forall \hbar \in \mathcal{H} \setminus \mathcal{C}, \xi_{\hbar} U'\left(c_{\hbar,t}, l_{\hbar,t}\right) = \tag{12}$$

$$\beta \mathbb{E}_t^* \left[\frac{i_t}{\pi_{t+1}} \sum_{\tilde{\hbar} \in \mathcal{H}} \Pi^{\mathcal{E}}_{\hbar \tilde{\hbar}, t+1} \xi^{\mathcal{E}}_{\tilde{\hbar}} U'\left(c_{\tilde{\hbar},t+1}, l_{\tilde{\hbar},t+1}\right) \right], \tag{13}$$

$$\forall \hbar \in \mathcal{C}, a_{h,t} = -\overline{a}, \tag{14}$$

$$\forall \hbar \in \mathcal{H}, l_{\hbar,t} = \left(\chi W_t 1_{e_{\hbar}=e}\right)^{\varphi}, \tag{15}$$

$$\forall \hbar \in \mathcal{H}, c_{\hbar,t} + a_{\hbar,t} = \tag{16}$$

$$(1 - \delta + Z_t) \sum_{\hbar \in \mathcal{H}} \Pi^{\mathcal{E}}_{\tilde{\hbar} \hbar, t-1} \frac{S_{\tilde{\hbar},t}}{S_{\hbar,t}} a_{\tilde{\hbar},t-1} + 1_{e_h = e} l_{\hbar,t} W_t, \tag{17}$$

$$K_t = \sum_{\hbar \in \mathcal{H}} S_{\hbar,t} a_{\hbar,t}, \tag{18}$$

The rest of the model Back II

$$L_t = \sum_{\hbar \in \mathcal{H}} S_{\hbar,t} l_{\hbar,t}, \tag{19}$$

$$C_t = \sum_{\hbar \in \mathcal{H}} S_{\hbar,t} c_{\hbar,t}, \tag{20}$$

$$0 = 1 - (1 - mc_t)\epsilon - \psi(\pi_t - 1)\pi_t + \psi\beta\mathbb{E}_t^*(\{\pi_{t+1} - 1)\pi_{t+1}\frac{Y_{t+1}}{Y_t}\}, \tag{21}$$

$$W_t = (1-\alpha)e^{\varepsilon_t^p} K_{t-1}^{\alpha} L_t^{-\alpha}, \tag{22}$$

$$Y_{j,t} = e^{\varepsilon_t^s} K_{t-1}^{\alpha} L_t^{1-\alpha}, \tag{23}$$

$$mc_t = e^{\varepsilon_t^s}(\frac{Z_t}{\alpha})^{\alpha}(\frac{W_t}{1-\alpha})^{1-\alpha}, \tag{24}$$

$$\mathbb{E}_t^* \frac{i_t}{\pi_{t+1}} = \mathbb{E}_t^* Z_{t+1} - \delta - 1, \tag{25}$$

The rest of the model Back III

$$i_t - \bar{i} = \phi^{\pi}(\pi_t - \overline{\pi}) + \phi^{y}(\frac{Y_t - \overline{Y}}{\overline{Y}}) + \varepsilon^r_t, \tag{26}$$

$$\varepsilon^r_t = \rho^r \varepsilon^r_{t-1} + \vartheta^r_t, \tag{27}$$

$$\varepsilon^p_t = \rho^p \varepsilon^p_{t-1} + \vartheta^p_t. \tag{28}$$

The RANK model Back I

$$U_t'(C_t, L_t) = \beta \mathbb{E}_t^*[\frac{i_t}{\pi_{t+1}} U_{t+1}'(C_{t+1}, L_{t+1})], \tag{29}$$

$$L_t = (\chi W_t)^{\varphi}, \tag{30}$$

$$C_t + K_t = Y_t + (1-\delta)K_{t-1} - \frac{\psi}{2}(\pi_t - 1)^2, \tag{31}$$

$$0 = 1 - (1 - mc_t)\epsilon - \psi(\pi_t - 1)\pi_t + \psi\beta\mathbb{E}_t^*(\{\pi_{t+1} - 1)\pi_{t+1}\frac{Y_{t+1}}{Y_t}\}, \tag{32}$$

$$W_t = (1-\alpha)e^{\varepsilon_t^p} K_{t-1}^{\alpha} L_t^{-\alpha}, \tag{33}$$

$$Y_{j,t} = e^{\varepsilon_t^s} t - 1^{\alpha} L_t^{1-\alpha}, \tag{34}$$

$$mc_t = \frac{1}{e^{\varepsilon_t^s}}(\frac{Z_t}{\alpha})^{\alpha}(\frac{W_t}{1-\alpha})^{1-\alpha}, \tag{35}$$

$$\mathbb{E}_t^* \frac{i_t}{\pi_{t+1}} = \mathbb{E}_t^* Z_{t+1} - \delta - 1, \tag{36}$$

The RANK model Back II

$$i_t - \bar{i} = \phi^\pi(\pi_t - \overline{\pi}) + \phi^y(\frac{Y_t - \overline{Y}}{\overline{Y}}) + \varepsilon_t^r, \tag{37}$$

$$\varepsilon_t^r = \rho^r \varepsilon_{t-1}^r + \vartheta_t^r, \tag{38}$$

$$\varepsilon_t^p = \rho^p \varepsilon_{t-1}^p + \vartheta_t^p. \tag{39}$$

Responses to an negative supply shock

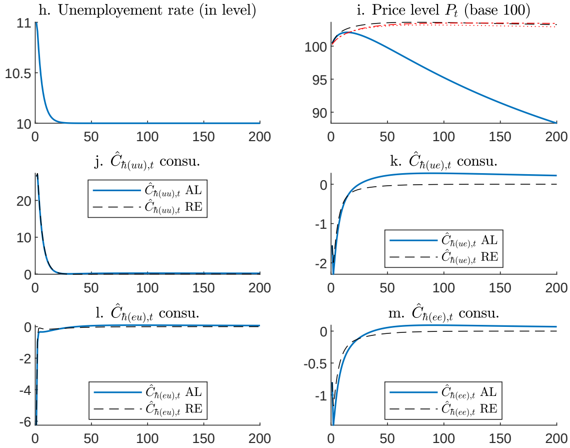


Figure 7: Response to a -1% supply shock Back

Expectations and supply shock 1/3

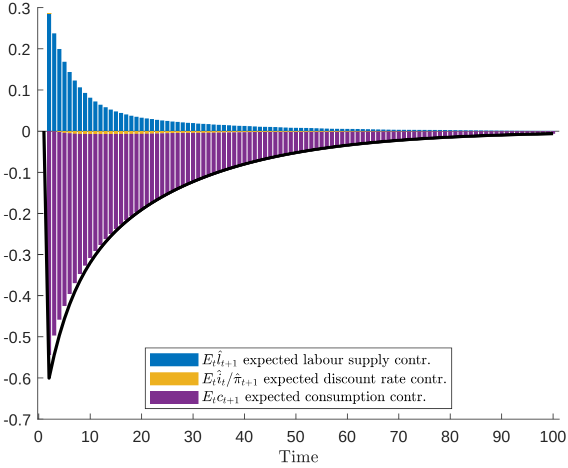


Figure 8: Household expectations of the representative household under AL

Expectations and supply shock 2/3

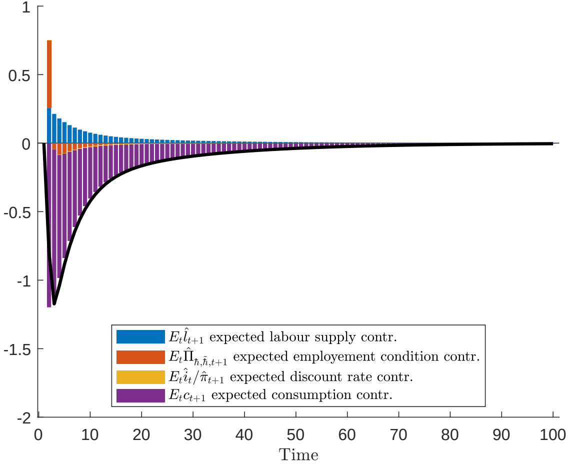


Figure 9: Household expectations of household $\hbar(e,e)$ under RE back

Expectations and supply shock 3/3

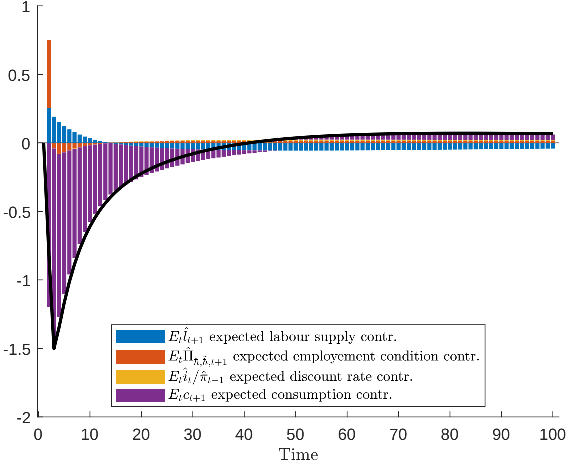


Figure 10: Household expectations of household $\hbar(e,e)$ under AL back

Responses to an negative MP shock 1/2

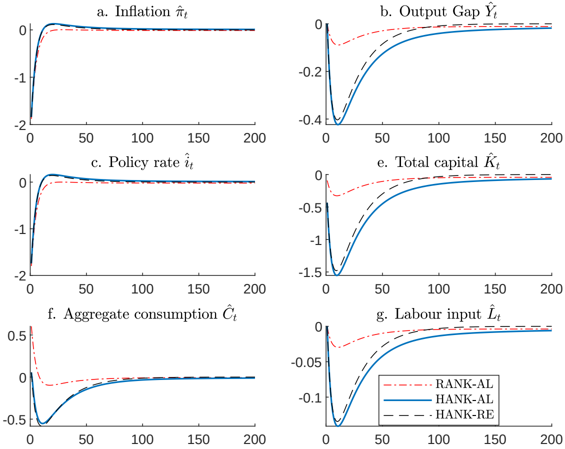


Figure 11: Response to a +1% MP shock Back

Responses to an negative MP shock 2/2

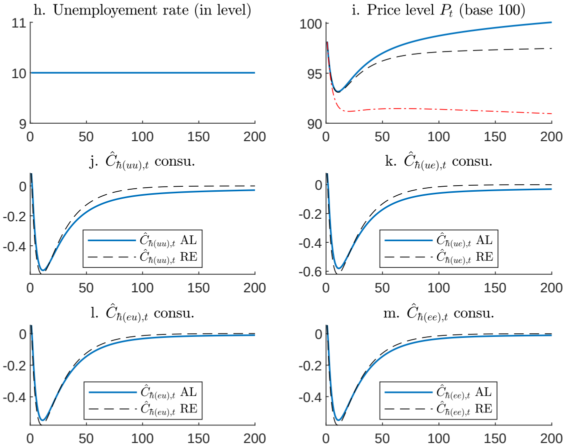
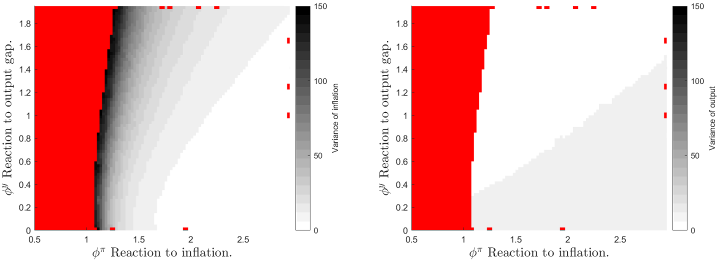


Figure 12: Response to a +1% MP shock Back

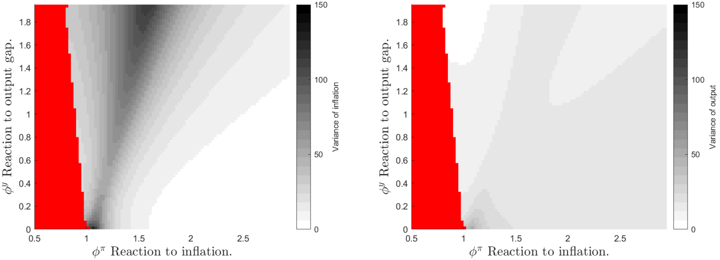
MP trade-off in the RANK AL model under IT



(a) Inflation variance in RANK AL (b) Output variance in RANK AL

FIGURE 13: Variances over the MP space Back

MP trade-off in the HANK RE model under IT



(a) Inflation variance in HANK RE (b) Output variance in HANK RE

Figure 14: Variances over the MP space Back

Responses to an negative supply shock under PLT 1/2

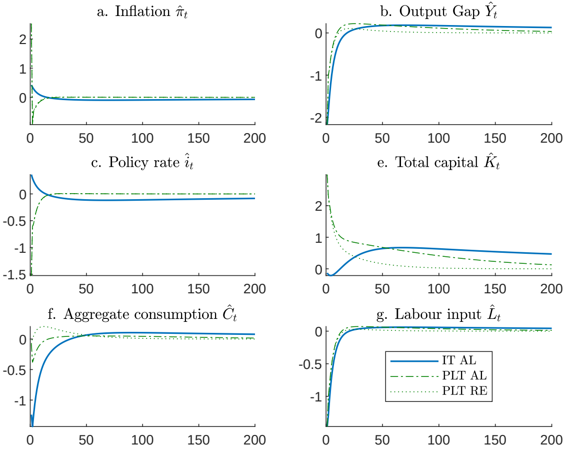


Figure 15: Response to a -1% productivity shock back

Responses to an negative supply shock under PLT 2/2

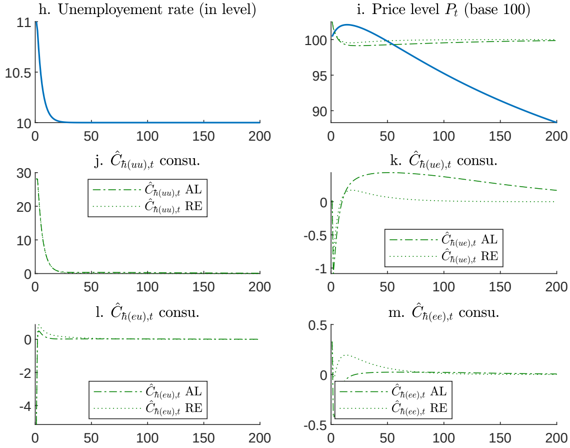


Figure 16: Response to a -1% productivity shock back

Expectations and supply shock under PLT

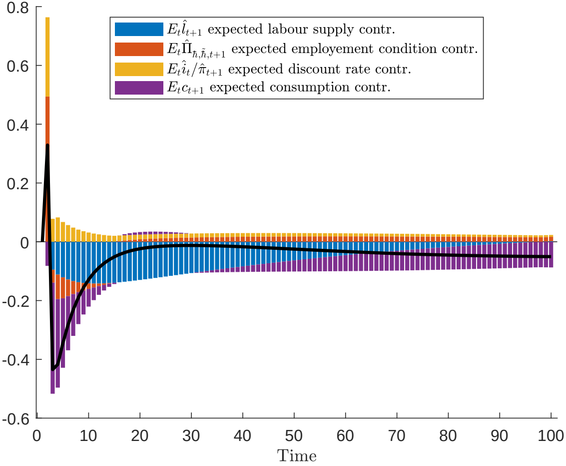
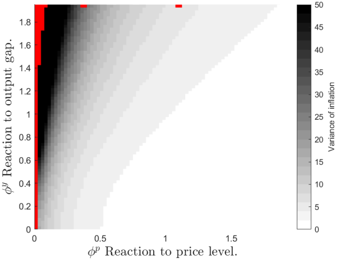
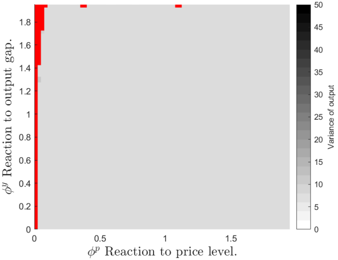


Figure 17: Household expectations of household $\hbar(e,e)$ under AL Back

MP trade-off in the RANK AL model under PLT



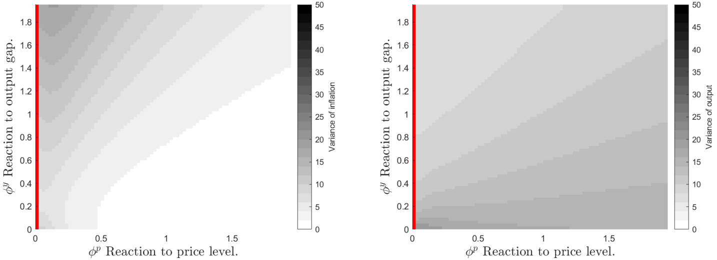
(a) Inflation variance in RANK AL



(b) Output variance in RANK AL

Figure 18: Variances over the MP space Back

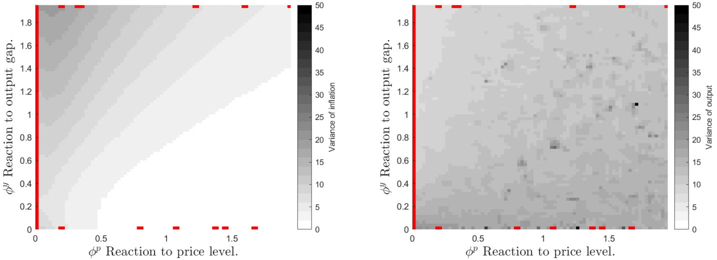
MP trade-off in the HANK RE model under PLT



(a) Inflation variance in HANK RE (b) Output variance in HANK RE

Figure 19: Variances over the MP space Back

MP trade-off in the HANK AL model under PLT



(a) Inflation variance in HANK AL (b) Output variance in HANK AL

Figure 20: Variances over the MP space Back

Models' moments

Monetary policy regime: *Calibration*	*Standard IT* $\phi^\pi = 1.5$ $\phi^y = 0.125$	*Hawkish IT* $\phi^\pi = 2.50$ $\phi^y = 0$	*Dovish IT* $\phi^\pi = 1$ $\phi^y = 1$	*PLT* $\phi^p = 0.25$ $\phi^y = 1$
Inflation Variance $var(\hat{\pi}_t)$:				
RANK-AL	9.6906 (0.0151)	1.1679 (0.0018)	356.5283 (0.3770)	15.6856 (0.0116)
HANK-RE	8.8518 (0.0127)	1.1303 (0.0017)	31.2210 (0.0386)	9.1640 (0.0070)
HANK-AL	**9.3797** (0.0141)	**1.1379** (0.0018)	**34.2460** (0.0446)	**9.3199** (0.0070)
Output Gap Variance $var\left(\hat{Y}_t\right)$:				
RANK-AL	6.4486 (0.0118)	6.5042 (0.0122)	3.9548 (0.0050)	6.8125 (0.0014)
HANK-RE	18.1107 (0.0353)	16.9978 (0.0308)	7.0714 (0.0069)	8.3490 (0.0104)
HANK-AL	**20.5742** (0.0445)	**20.5339** (0.0491)	**7.0660** (0.0069)	**9.9830** (0.0154)
Employed Consumption Variance $var\left(\hat{c}_{\hbar(eu),t}\right)$:				
HANK-RE	12.0004 (0.0370)	8.5259 (0.0224)	5.2813 (0.0088)	2.7210 (0.0099)
HANK-AL	**16.3411** (0.0477)	**14.4165** (0.0383)	**4.0961** (0.008)	**2.5191** (0.0064)
Unemployed Consumption Variance $var\left(\hat{c}_{\hbar(ue),t}\right)$:				
HANK-RE	22.8162 (0.0563)	19.1556 (0.0415)	4.2169 (0.008)	4.3296 (0.0098)
HANK-AL	**33.2964** (0.0914)	**47.2806** (0.2435)	**3.9644** (0.0076)	**17.3357** (0.0848)
Excess forecast Error HANK, AL w.r.t RE:				
Excess error $\mathbb{E}^{AL}C_{\hbar(ee),t+1}$	**+0.3151%**	**+0.6419%**	**+ 0.7129%**	**+0.4959%**
Excess error $\mathbb{E}^{AL}C_{\hbar(ue),t+1}$	**+0.8922%**	**+0.2841%**	**+0.2158%**	**+0.2914%**

Table 1: Moments under different CB's reaction function calibrations back

=> PLT reduces aggregate variance and excess forecast errors

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