Incorporating Financial Frictions in the New Area Wide Model

Preliminary and Incomplete

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Financial Markets in Dynamic General Equilibrium

$14 - 16^{th}$ May, Bank of Finland.

Outline

1. The New Area Wide Model (NAWM): Some Background

2. Introducing Financial Frictions in NAWM, NAWM(FIN):

   - Added - one version of the "Financial Accelerator" of Bernanke, Gertler and Gilchrist (BGG); similar to CMR.

   - Added - a housing sector with a collateral constraint on the impatient households à la Iocoviello-Neri (I-N)

       a) Allow for adj. costs in residential investment

       b) Allow for wage stickiness in *all* sectors

       c) Housing sector labour some fraction of impatient consumers' labour input.

3. Model Comparisons by Impulse Responses

4. Conclusions & Next Steps

Existing New Area Wide Model

Calibrated Version

"Tax Reform and Labour-Market Performance in the Euro Area: A Simulation-Based Analysis Using the New Area-Wide Model", by Günter Coenen, Peter McAdam and Roland Straub, *Journal of Economic Dynamics and Control*, forthcoming.

"How Do VAT Changes Affect the Economy? An Illustration Using the New Area-Wide Model", by Günter Coenen and Peter McAdam, *Research Bulletin*, 4, January 2006.

"Fiscal Consolidation in the Euro Area: Long-Run Benefits and Short-Run Costs", by Günter Coenen, Matthias Mohr and Roland Straub, *Economic Modelling*, forthcoming.

Estimated Version

"The New Area-Wide Model of the Euro Area: Specification, Estimation and Properties", by Kai Christoffel, Günter Coenen and Anders Warne, April 2008. (CCW)

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- 4 Agents: Households; Firms; Fiscal & Monetary Authority.

- Firms: domestic intermediate good firms; final good firms; foreign intermediate good firms.

- No Banking, Housing Sector.

- External habit formation in consumption;

- Generalized adjustment costs in investment;

- Variable capacity utilization;

- Fixed cost in intermediate goods production;

- Monopolistic competition in intermediate goods and labour markets;

- Sticky prices and wages à la Calvo allowing for dynamic indexation;

- Generalized adjustment costs in the import content of the final good production;

- Intermediation cost for trading foreign bonds.

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Introducing Financial Frictions in NAWM:

Households. There are two types of househods as in Iacoviello and Neri (2008)(New):

1. Patient:

   (a) Have preferences for consumption (with external habits), leisure and housing (New);

   (b) Accumulate foreign assets;

   (c) Hold nominal deposits in a bank who lends to firms (New);

   (d) Hold nominal deposits in a bank who lends to impatient households (New,see below);

   (e) Accumulate physical capital;

   (f) Pay a small transfer of wealth to the entrepreneurs start-ups (New);

   (g) Supply labour to intermediate-goods firms only;

   (h) Set wages à la Calvo (1983) (with indexation);[2]

2. Impatient:

   (a) Have same preferences as patient household except that have a higher discount factor (lower β);

   (b) Borrow from banks against housing collateral (New);

   (c) Purchase houseing services (New);

   (d) Supply labour to housing sector and intermediate-goods firms;

   (e) Set wages à la Calvo (1983) in both sectors (with indexation);

Firms. There are six types of firms. All staggered price setting is augmented by indexation.

1. Intermediate-goods (wholesale) producers:

   (a) They combine capital services (purchased from entrepreneurs) and labour (purchased from trade unions) in a Cobb-Douglas cum fixed-cost production function

   (b) Set prices in their currency for both home and foreign markets à la Calvo (1983) (with indexation)

2. Non-tradable final-goods producers:

   (a) Combine domestic intermediate goods with imported intermediate goods with a CES function displaying adjustment costs in changing the import bundle.

   (b) Operate in competitive markets with flexible prices

3. Non-tradable productive-captial investment-goods producers:

   (a) Combine domestic intermediate goods with imported intermediate goods with a CES function displaying adjustment costs in changing the import bundle;

   (b) Operate in competitive markets with flexible prices: i.e. are similar to previous type.

4. Non-tradable public-consumpiton-goods producers:

   (a) Use only domestic goods.

   (b) Operate in competitive markets with flexible prices

5. Non-tradable housing-investment-goods producers (NEW):

   (a) Combine domestic intermediate goods with capital, land and labour;

   (b) Operate in competitive markets with flexible prices.

6. Foreign intermediate-goods (wholesale) producers:

   (a) Set prices in the currency of the importer (home country) à la Calvo (1983).

Entrepreneurs.   See Bernanke et al. (1999). Our specification is similar to Christiano et al. (2007)

1. At end of period purchase capital from patient consumers

2. The value of capital in excess of the net-worth of the entrepreneur must be financed with loans from banks

3. entrepreneurs face idiosincratic shocks to the capital services that they rent to firms

4. Debt contract are nominal and are of the costly state verification type

5. The interest rate spread of the loan rate over the risk-free rate is a convex function of the leverate of the entrepreneur

6. In each period a fraction of entrepreneurs exits the market and is replaced by an equal amount of entrepreneurs endowed with a small transfer of wealth from the patient households.

7. They decide the degree of capital utilization and rent effective capital services to firms.

Banks.   (NEW) There are two types of banks. One lends to househods, the other to entrepreneurs

1. Building societies (households' finance)

    (a) Receive deposits from patient households and lend to impatient households

    (b) In order to introduce a spread in this market returns we could think of this banks as a new type of entrepreneurs combining deposits with housing to produce loans. Housing must be purchased with existing net worth and issuing bonds to the other type of banks

2. Banks (entrepreneurs' finance)

    (a) Receive deposits from patient households and lend to entrepreneurs at a premium making zero profits.

Government.   The fiscal authority runs a balanced budget each period. The monetary authority follows an interest rate rule.

Other Remarks

➢ Parameter Values taken from mode estimates of NAWM (CCW) + parameters in BGG + I-N.

➢ As in I-N Model differentiated trend growth rate in housing and intermediate goods sector.

➢ Capital used in housing investment sector same as that in intermediate-goods sector. Thus return is equalized across sectors. [We could have a separate entrepreneur for the capital used in the housing-investment sector?]

➢ Some slight core differences with NAWM:

  o Capital Utilization cost function (I-N rather than NAWM).

  o Slight recalibration of some ratios as a result.

➢ Final Object of project: to use NAWM (FIN) in Projections and for policy simulations. Increasing number of Projection-related issues in housing and banking matters. Consistency of model and existing data and projections framework essential.

Consumers' Optimization

Patient Households

$$\max_{C_{1,t},\mathcal{H}_{1,t},I_t,B^*_{t+1},B_t,W_{1,t},D^H_t,D^B_t} E_t \sum_{k=0}^{\infty} \left(\tilde{\beta}_1 G_C\right)^k U\left(C_{1,t+k} - \kappa\bar{C}_{1,t-1+k}, \mathcal{H}_{1,t+k}, N_{1,t+k}\right) \tag{1a}$$

subject to

$$(1+\tau_t^C)C_{1,t} + \frac{P_{I,t}}{P_{C,t}}I_t + (\epsilon^{RP}R_t)^{-1}\frac{B_{t+1}}{P_{C,t}} + (R_t^*(1-\Gamma_{B^*}(s_{B^*,t+1})))^{-1}\frac{S_t}{P_{C,t}}B^*_{t+1} + \frac{\Xi_t + \Phi_t}{P_{C,t}} =$$

$$\frac{B_t + S_t B_t^*}{P_{C,t}} - q_{h,t}\mathcal{H}_{1,t} + q_{h,t}(1-\delta_h)\mathcal{H}_{1,t-1} + \frac{(1+R_t^{DH})D^H_{t-1} - D^H_t + (1+R_t^{DB})D^B_{t-1} - D^B_t}{P_{C,t}} + \Omega_t$$

$$+ (1-\tau_t^N - \tau_t^W)\frac{W_{1,t}}{P_{C,t}}N_{1,t} - \frac{Q_t}{P_{C,t}}(1-\delta)K_t + \frac{Q_t}{P_{C,t}}K_{t+1} + (1-\gamma_t)(T_t^\gamma - T_t^e) \tag{1b}$$

and to

$$K_{t+1} = (1-\delta)K_t + \epsilon_t^I\left(1 - \Gamma_I\left(\frac{I_t}{I_{t-1}}\right)\right)I_t \tag{1c}$$

where

$$U\left(C_{1,t} - \kappa C_{t-1}, \mathcal{H}_t, N_{1,t}\right) = \epsilon^{C,1}\left(1 - \frac{\kappa}{G_C}\right)\ln\left(C_{1,t} - \kappa\bar{C}_{1,t-1}\right) + j_{1,t}\ln\mathcal{H}_{1,t} - \frac{\epsilon_t^{N,1}}{1+\zeta}N_{1,t}^{1+\zeta}, \tag{2}$$

$$T_t^\gamma \equiv (1-\gamma_t)\left\{R_t^K Q_{t-1}K_t - \left[1 + \chi_{t-1}(\cdot)\frac{(1+R_{t-1}^{DB})}{\pi_t}\right]\frac{D_{t-1}}{P_{t-1}}\right\} \text{ is the transfer from exiting en-}$$

trepreneurs to patient households, i.e. their net worth net of the gross bank loan. Ω_t is a tranfer to household cosisting of the monitoring costs of the net worth of defaulting firms.[3]

G_C is the growth rate of consumption, $\bar{C}_{1,t}$ is the aggregate consumption of patient households, [4] Q_t is the price of capital. Ξ_t measures profits and income from renting the land to residential investment sector.

First order conditions

$$B_{t+1} : \qquad \lambda_t^{\mathrm{P}} = \beta_1 E_t \left[\lambda_{t+1}^{\mathrm{P}} \frac{R_t}{\pi_{t+1}} \right]$$

$$D_t^H : \qquad \lambda_t^{\mathrm{P}} = \beta_1 E_t \left[\lambda_{t+1}^{\mathrm{P}} \frac{(1 + R_t^{DH})}{\pi_{t+1}} \right]$$

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$$B_{t+1}^* : \qquad \lambda_t^{\mathrm{P}} \left((1 - \Gamma_{B*} (s_{B*,t+1})) \right)^{-1} S_t = \beta_1 E_t \left[\lambda_{t+1} \frac{S_{t+1} R_t^*}{\pi_{t+1}} \right]$$

$$C_{1,t} : \qquad \lambda_t^{\mathrm{P}} = \epsilon_t^{C,1} \left(1 - \frac{\kappa}{G_C} \right) (C_{1,t} - \kappa C_{t-1})^{-1}$$

$$\mathcal{H}_t : \qquad j_{1,t}^H \mathcal{H}_{1,t}^{-1} + \beta_1 E_t \left[\lambda_{t+1}^{\mathrm{P}} (1 - \delta_h) q_{h,t+1} \right] = \lambda_t^{\mathrm{P}} q_{h,t}$$

$$I_t : \quad \lambda_t^{\mathrm{P}} \frac{P_{I,t}}{P_{C,t}} = \frac{Q_t}{P_{C,t}} \lambda_t^{\mathrm{P}} \epsilon_t^I \left(\left(1 - \Gamma_I \left(\frac{I_t}{I_{t-1}} \right) \right) - \Gamma_I'(\cdot) \frac{I_t}{I_{t-1}} \right) +$$

$$E_t \left[\frac{Q_{t+1}}{P_{C,t+1}} \beta_1 \lambda_{t+1}^{\mathrm{P}} \epsilon_{t+1}^I \left(\Gamma_I' \left(\frac{I_{t+1}}{I_t} \right) \left(\frac{I_{t+1}}{I_t} \right)^2 \right) \right]$$

Impatient Households

$$\max_{C_{2,t},\mathcal{H}_{2,t},W_{2,t},N_{H,t},B_t^H} E_t \sum_{k=0}^{\infty} \left(\tilde{\beta}_2 G_C\right)^k U\left(C_{2,t+k} - \kappa\bar{C}_{2,t-1+k}, \mathcal{H}_{2,t+k}, N_{2,t+k}, N_{H,t+k}\right)$$

subject to

$$0 = -(1 + \tau_t^C)P_{C,t}C_{2,t} + B_t^H - q_{h,t}\mathcal{H}_{2,t} + q_{h,t}(1 - \delta_h)\mathcal{H}_{2,t-1} +$$
$$- \left(1 + R_t^{DH}\right)B_{t-1}^H + \left(1 - \tau_t^N - \tau_t^W\right)W_{2,t}N_{2,t} + \left(1 - \tau_t^N - \tau_t^W\right)W_{H,t}N_{H,t}$$

$$0 \le m^B E_t \left(\frac{q_{h,t+1}\pi_{t+1}\mathcal{H}_{2,t}}{(1 + R_t^{DH})}\right) - \frac{B_t^H}{P_{C,t}}$$

$$U\left(C_{2,t} - \kappa\bar{C}_{2,t-1}, \mathcal{H}_{2,t}, N_{2,t}, N_{H,t}\right) = \epsilon^{C,2}\left(1 - \frac{\kappa}{G_C}\right)\ln\left(C_{2,t} - \kappa\bar{C}_{2,t-1}\right) + j_{2,t}\ln\mathcal{H}_{2,t} - \frac{\epsilon_t^{N,2}}{1+\zeta_2}N_{2,t}^{1+\zeta_2} - \frac{\epsilon_t^{N,H}}{1+\zeta_H}N_{H,t}^{1+\zeta_H}$$

First order conditions

$$B_t^H: \qquad \lambda_t - \beta_2 E_t\left[\lambda_{t+1}\frac{\left(1 + R_t^{DH}\right)}{\pi_{t+1}}\right] - \lambda_t^B = 0$$

$$C_{2,t}: \qquad -\lambda_t(1 + \tau^C) + \epsilon^{C,2}\left(1 - \frac{\kappa}{G_C}\right)\left(C_{2,t} - \kappa\bar{C}_{2,t-1}\right)^{-1} = 0$$

$$\mathcal{H}_t: \quad -\lambda_t q_{h,t} + j_{2,t}^H \mathcal{H}_{2,t}^{-1} + \beta_2 E_t\left[\lambda_{t+1}(1 - \delta_h)q_{h,t+1}\right] + m_t^B\lambda_t^B E_t\left(\frac{q_{h,t+1}\pi_{t+1}}{(1+R_t^{DH})}\right) = 0$$

Notice that since the collateral constraint is assumed to be always binding the Lagrange multiplier associated with the borrowing constraint λ_t^B will be positive.

Entrepreneurs

$$q_{K,t}K_{t+1} = N_{t+1} + \frac{D_t^B}{P_t}$$

Net Worth:

Effective capital brought to market: $\quad K_t^e \equiv u_t \varpi_t K_t,$

Capacity utilization Costs $\qquad\qquad$ **Efficient Utilization rate**
$\qquad\qquad\qquad\qquad\qquad\qquad\qquad$ **(Real marg. return to utiliz.= marg. cost of utilization)**

$$P_t^a a(u_t)\varpi_t K_t \qquad\qquad r_t^K = a'(u_t) P_t^a$$

Entrepreneurs' expected real gross return on capital = expected cost of borrowing

$$E_t\left[R_{t+1}^K\right] \equiv E_t\left[\frac{\left((1-\tau_{t+1}^k)\left(r_{t+1}^k u_{t+1} - a(u_{t+1})\right) + (1-\delta)q_{k,t+1} + \tau_{t+1}^k \delta q_{k,t}\right)}{q_{k,t}}\right] = (\chi_t(\cdot))E_t\left[\frac{\left(1+R_t^{DB}\right)}{\pi_{t+1}}\right]$$

External Finance Premium

$$\chi_t \equiv \chi\left(\frac{\dfrac{D_t^B}{P_t}}{N_{t+1}}; \epsilon_t^\chi\right) \qquad \text{where } \chi' > 0, \ \chi(0) = 1 \text{ and } \chi(\infty) = \infty$$

$$N_{t+1} = \gamma_t\left\{R_t^K q_{K,t-1}K_t - \left[\chi_{t-1}(\cdot)\frac{\left(1+R_{t-1}^{DB}\right)}{\pi_t}\right]\frac{D_{t-1}}{P_{t-1}}\right\} + T_t^e$$

Total Final Net Worth:

$$[1-F(\bar\varpi)]D_t^B Z_t + (1-\mu_B)\int_0^{\bar\varpi} \varpi E_t R_{t+1}^K Q_t K_{t+1} \mathrm{d}F(\varpi) = \left(1+R_t^{DB}\right)\mathbf{p}D_t^B$$
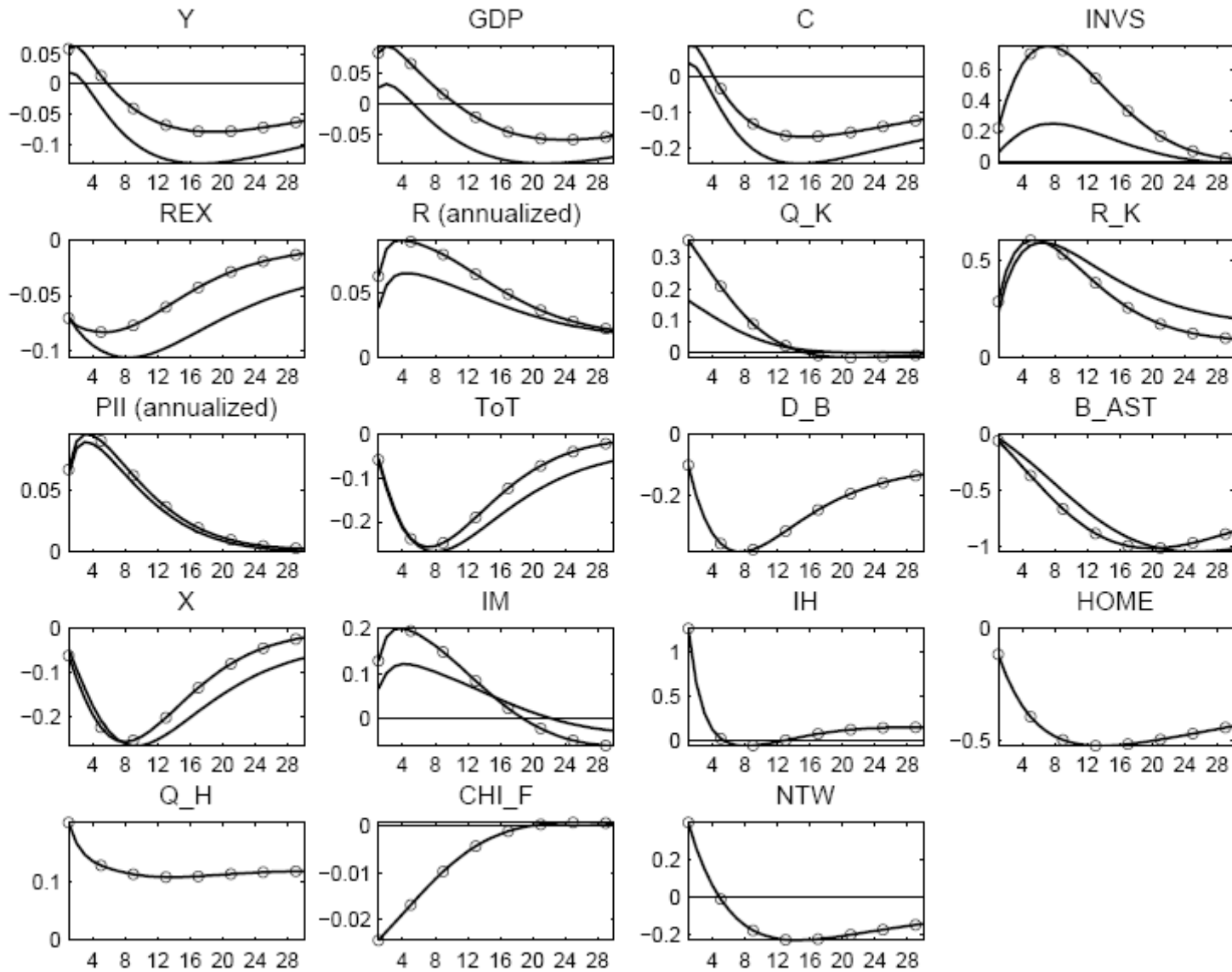
Banks' zero-profit condition:

IRFs

1. Permanent Productivity Shock in Intermediate Goods Market

2. Temporary Productivity Shock in Intermediate Goods Market

3. Transitory Monetary Policy Shock

4. Transitory "Risk Premia" Shock (domestic, external finance)

NAWM, 2 financial-market frictions shocks: external risk premium   (net foreign assets)
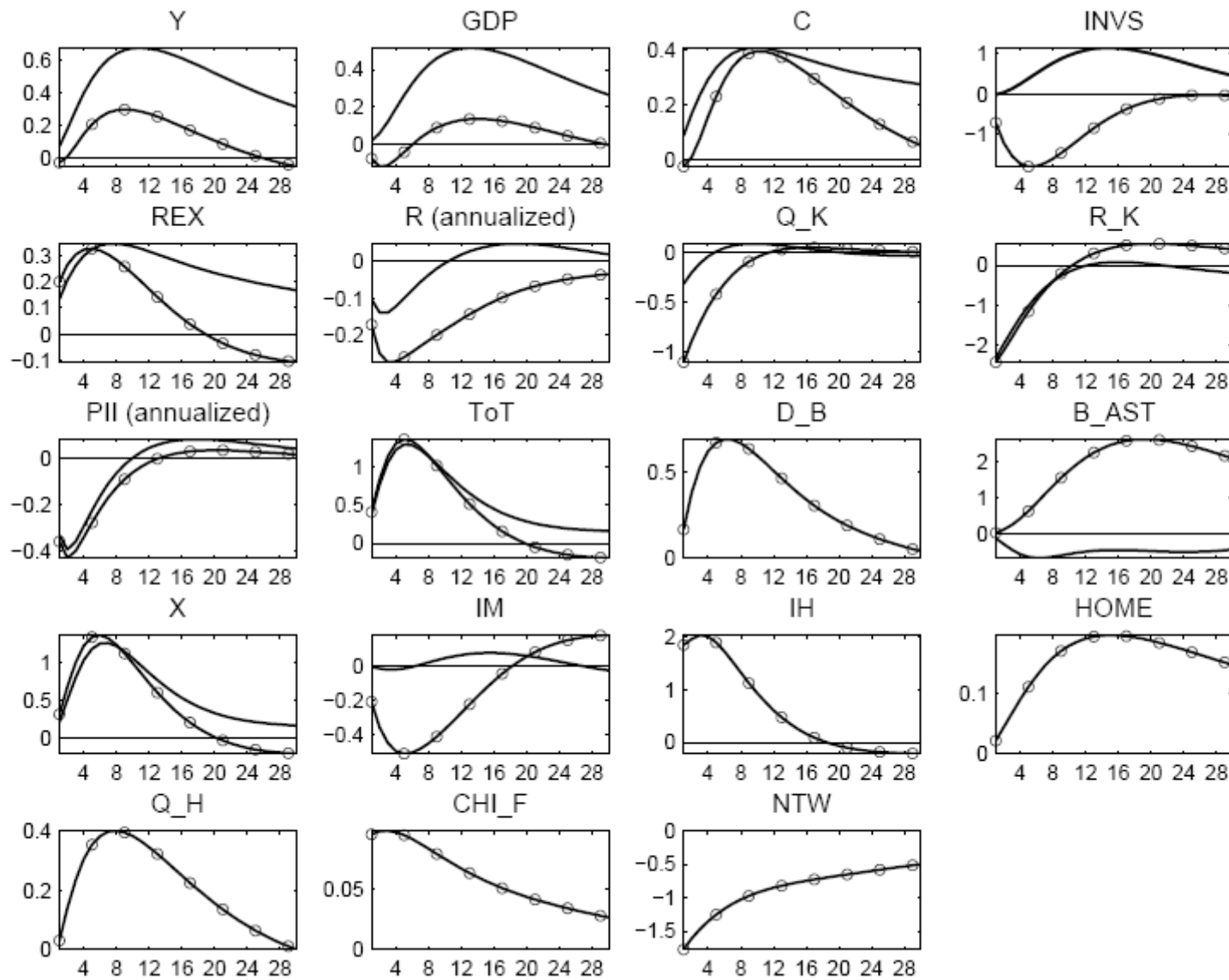   domestic risk premium (domestic assets)

NAWM(FIN), 2 financial-market frictions shocks: external risk premium   (net foreign assets)
     external finance premium

NAW: $\lambda_t = \beta E_t \left[\lambda_{t+1} \dfrac{R_t}{\pi_{t+1}} \right] \cdot \varepsilon_t^{RP}$ NAW(FIN): $\chi(\cdot)_t = \chi\left(\dfrac{D_t^B / P_t}{N_{t+1}}, \varepsilon_t^{\chi} \right)$

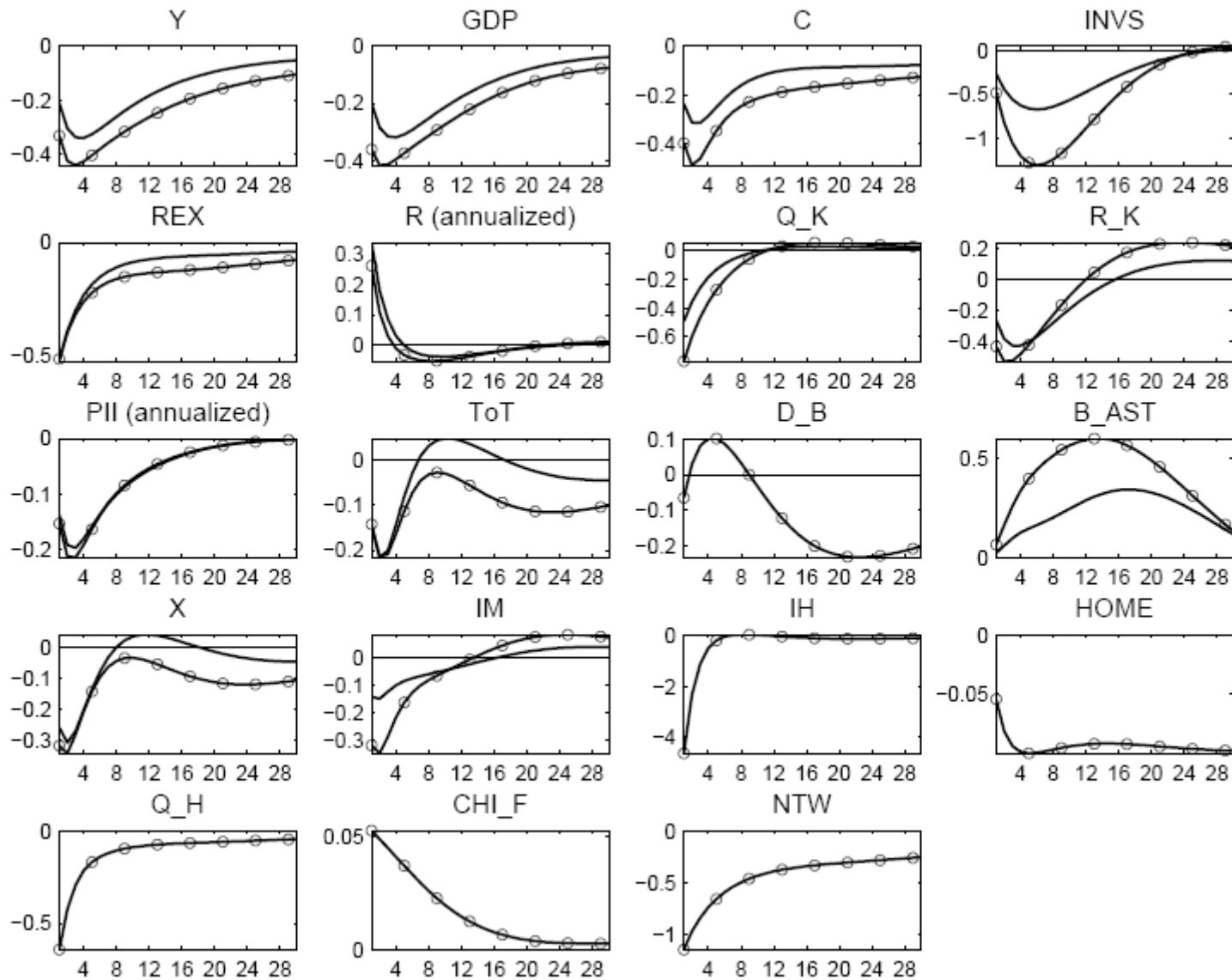# 3. Monetary Policy Shock
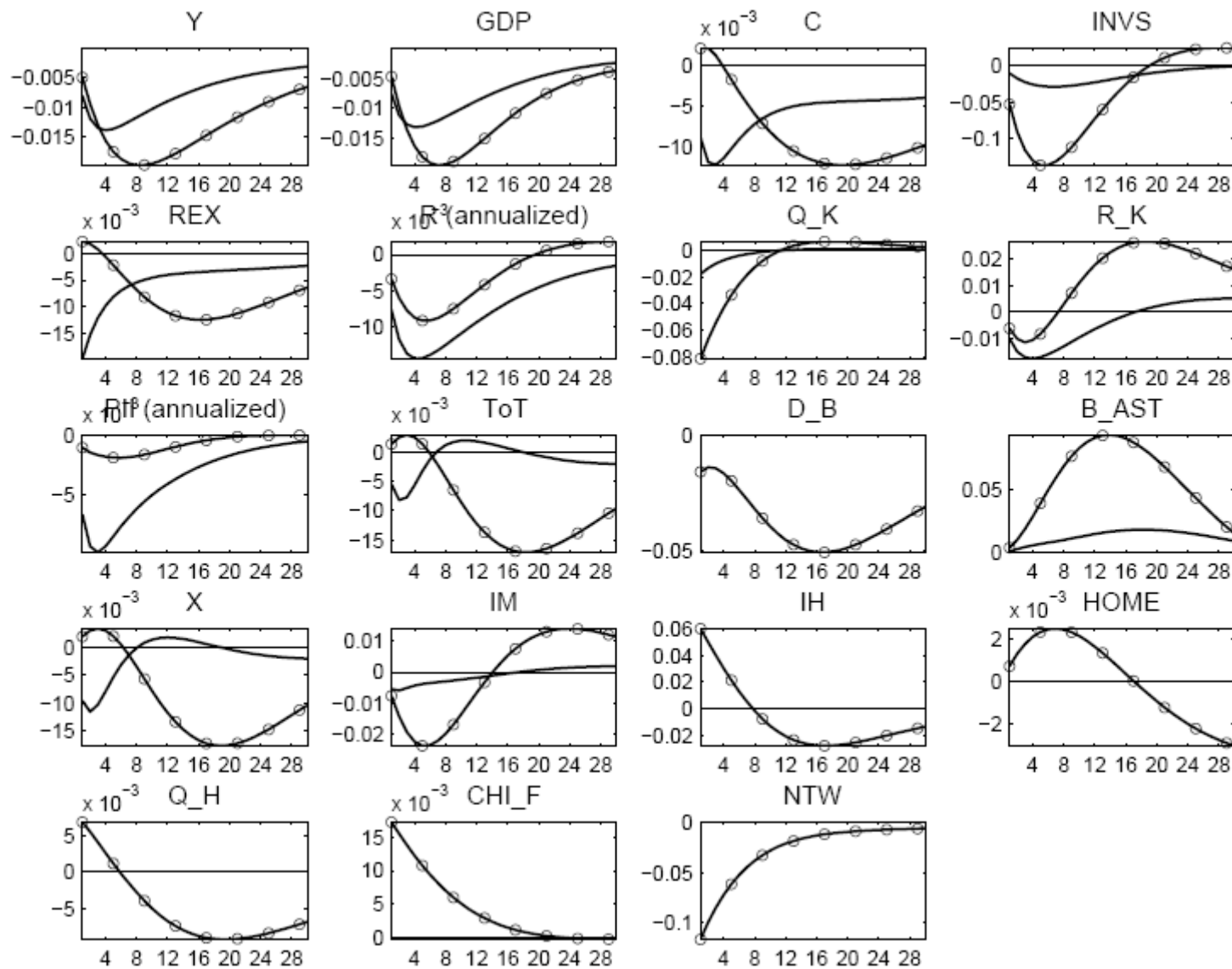
Conclusions & Next Steps

- Initial results of incorporating Housing & Banking features into existing NAWM appear encouraging in terms of plausible IRFs.

- Initial results intuitive: NAWM(FIN) additional channels (Net Worth, Finance Premia) makes investment response more volatile.

- Next Steps:

  - Bayesian Estimation of Full Model

    - Data Availability for euro area housing volumes and prices, interest rates for businesses and mortgage lending. Issues of data availability, and appropriate data concept (net worth?), data quality, real-time data revisions.

    - How does Bayesian estimation of augmented model affect the existing NAWM model parameters? (Pre-fix them?). Fewer stochastic shocks needed?

  - Enrichment of Financial Sector: e.g., multi-period contracts, BGG in credit sector. Hybrid specification? Spreads over risk-less rate in housing decisions too?