THE HOUSEHOLD SECTOR IN DSGE MODELS

Ivan Frankovic, May 25th 2018

1

SIGNIFICANCE OF THE HOUSEHOLD SECTOR

Mechanisms

- Determines the response of consumption in DSGE models (50% Consumption-to-GDP share in Norway)
- Important in the determination of wages and (un)employment
- Numerous fiscal policy mechanisms operate through households

Modeling approaches

- Failure of the standard household modeling approach (representative agent)
- Large diversity of other possible modeling approaches

2

STANDARD MODELING APPROACH: THE REPRESENTATIVE AGENT

- Agents in the model follow optimal plans:
  - Maximize lifetime expected utility subject to a budget constraint
  - Lifetime is infinite

$$U = E_o \Sigma_{t=0}^{\infty} \beta^t u(C_t, N_t)$$

$$C_t + I_t = (1 - \tau_t) Y_t + TR_t$$

Baxter and King (1993)

- Consider increase in government expenditures
  - Present value of household tax liabilities increases (irrespective of financing type)
    → Negative wealth effect: Households feel poorer
    → Consumption and leisure decline

- Three problems
  1. Consumption declines after fiscal stimulus
  2. Financing type does not matter (Ricardian equivalence)
  3. Consumption follows Euler equation

3

1. FISCAL EFFECTS – EMPIRICAL EVIDENCE

- Regardless of identification approach, VAR studies report an **increase in output** as a result of a positive government shock → in line with rep. agent framework
- Evidence on the response of consumption are mixed. However the literature seems to assign more credibility to studies finding a **positive response of consumption.**
  → in conflict with the rep. agent framework
  → **Consumption Puzzle** (see e.g. Hebous 2011)

4

2. RICARDIAN EQUIVALENCE

- In rep. agent models: **Ricardian Equivalence** holds
- Definition by Barro (1974) : "fiscal effects involving changes in the relative amounts of tax and debt finance for a given amount of public expenditure would have no effect on aggregate demand, interest rates, and capital formation"
- However timing of tax and debt finance matters in real world
- Solving consumption puzzle ≠ breaking Ricardian Equivalence

5

3. EULER EQUATION

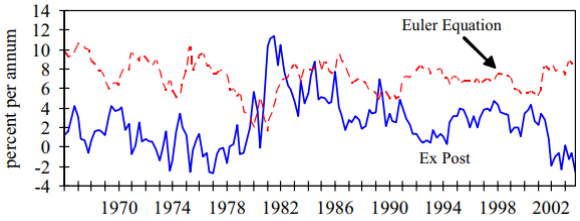
Euler Equation for the rep. agent problem

$$\frac{C_{t+1}}{C_t} = \beta R_t$$

Consumption change over time is governed by real interest rate:

- Higher interest rate → Consumption is postponed to the future

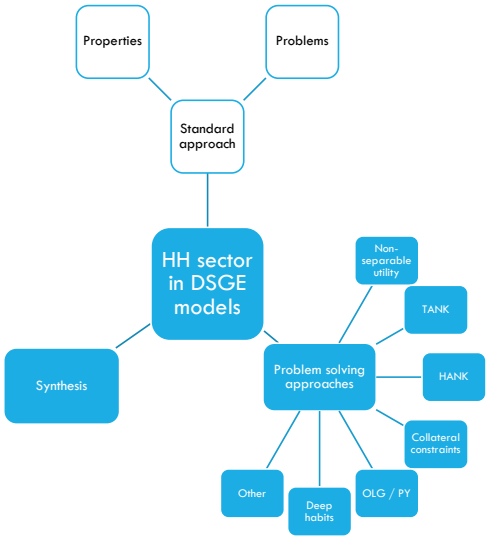
However, Euler equation does not hold empirically (Canzoneri et al. 2007)



Graph: Federal Funds Rate, Interest Rate implied by Euler equation
-> Correlation is negative

6

STRUCTURE OF THE PRESENTATION



7

NON-SEPARABLE UTILITY FUNCTIONS

8

NON-SEPARABLE UTILITY FUNCTION

- Utility function: additive-separable vs. non-separable:

$$u(C_t, N_t) = f_1(C_t) + f_2(N_t) = \frac{C_t^{1-\sigma}}{1-\sigma} - \frac{N_t^{1+\psi}}{1+\psi}$$

$$u(C_t, N_t) = f(C_t, N_t) = \frac{1}{1-\sigma}\left(C_t - \frac{N_t^{1+\psi}}{1+\psi}\right)^{1-\sigma}$$

- Consumption puzzle can be resolved within representative agent framework when non-separable utility function is used
  (Linnemann 2006, Bilbiie 2008/10, Monacelli and Perotti 2008/10)

- Basic intuition for non-separable util. fn.:
  - Fiscal spending induces a negative wealth effect, hours supplied increase
  - If $U_{c,h} = 0$ (add-separable), marginal utility of consumption remains unchanged if hours increase
  - If $U_{c,h} > 0$ (non-separable) , marginal utility of consumption increases if hours increase

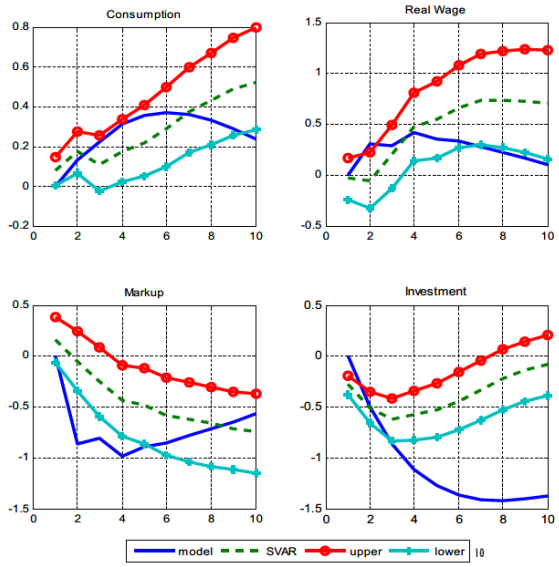
- In NK DSGE models labor supply increases due to increase in real wages
  → Marg. Utility of consumption increases
  → Consumption increases

9

NON-SEPARABLE UTILITY FUNCTION – FISCAL POLICY

- Monacelli and Perotti 2008 overcome consumption puzzle using non-separable utility function (where wealth effect on labor supply is very weak)

- Drawbacks
  - Ricardian Equivalence still holds
  - Technical "story" to why consumption increases after fiscal expansion



10

TWO AGENT NEW KEYNSIAN MODELS (TANK)

TWO AGENT NK MODEL

- Include two types of households
  1. Rep. agent households as in the standard approach
  2. Rule-of-thumb (RoT, aka Hand-to-Mouth) households consuming all their current income:

$$\underbrace{P_t C_t^r}_{\text{Consumption}} = \underbrace{W_t P_t N_t^r - P_t T_t^r}_{\text{Income net of taxation}}$$

Gali et al. (2007) interpretation of RoT: myopia, lack of access to capital markets, ignorance of intertemporal trading opportunities

(Log-lin.) aggregate consumption equation then becomes

$$c_t = \underbrace{\Theta_n \; n_t - \Theta_\tau \; t_t^r}_{\text{Component stemming from RoT households}} \underbrace{- \sigma \sum_{k=0}^{\infty} E_t\{r_{t+k} - \pi_{t+k+1}\}}_{\text{Component stemming from rep. agent}}$$

Component stemming from RoT households:
- Term's importance increases with the share of RoT
- depends positively on labor supply and negatively on taxes

Component stemming from rep. agent
- Term's importance decreases with the share of RoT
- Permanent income theory

TANK II

TANK DSGE Model

- overcomes Ricardian equivalence; solves the consumption puzzle for high enough share of RoT households; improves fit of Euler consumption equation

Drawback: Empirical conflicts

1. Empirical studies usually find a share of 30 % behaving in RoT fashion (Kaplan and Violante 2005)
2. Estimating the RoT share within DSGE – Models also yields around 30% (Coenen and Straub 2005)

Potential improvement by Lopez-Salido and Rabani (2007):

- RoT households and non-separable utility function reinforce each other with respect to overcoming the consumption puzzle
- Non-separable utility function decreases the estimated share of RoT households and model fit improves

13

HETEROGENEOUS AGENT NEW KEYNESIAN MODELS (HANK)

14

TWO ASSET MODEL

Kaplan and Violante (2014)

- Develop model with idiosyncratic earnings and two assets

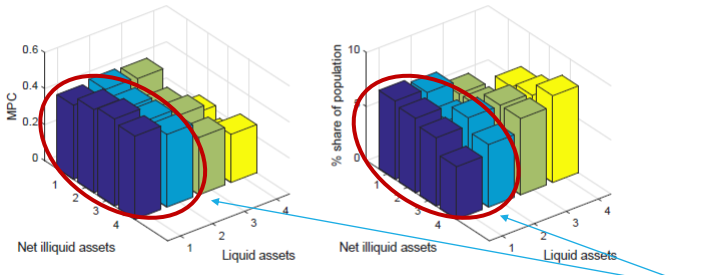
Liquid assets	Illiquid assets
Cash, checking account	Housing, Retirement account
Low return	High return
No transaction cost	Transaction cost

Individual income history generates wealth distribution in the model

- Individual with low level of liquid assets have high marginal propensity to consume out of transitory income (current consumption tracks current income)
- Holds also for those with high level of illiquid assets (Wealthy Hand-to-Mouth)
- Those wealthy Hand-to-mouth agents do not use illiquid assets due to transaction cost ⟶ no consumption smoothing, permanent income hypothesis breaks down

FAGERENG, HOLM AND NATVIK (2016)

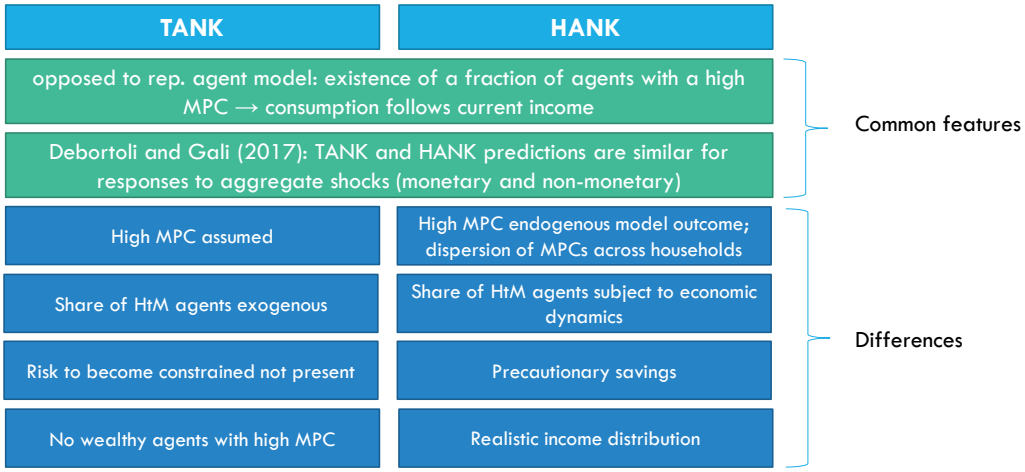
Figure 4: Heterogeneous consumption responses. Quartiles of liquid and net illiquid assets



Notes: Controls include time-fixed effects, income$_{t-1}$, age, age^2, family size, family size^2 and no. of children under 18. Estimation method: OLS. Total N: 266,263.

Those with low level of liquid assets exhibit high MPC **irrespective of the level of illiquid assets**!

COMPARING TANK WITH HANK



17

CHALLENGES OF THE HANK FRAMEWORK

- HANK framework is mathematically and technically much more involved
- HANK framework potentially in conflict with other important model components (wage-setting)
- Operation on frontier of economic science → fewer resources to rely on, higher operational risk for the modeling project
- Higher analytical burden on model maintainers and users
- Higher computational burden affects feasibility of estimation

18

COLLATERAL CONSTRAINTS

COLLATERAL-CONSTRAINED HOUSEHOLDS

- Model economy populated by patient and impatient households
  (Kiyotaki and Moore 1997, Iacoviello 2005)
- Utility derived from consumption, leisure and housing stock
- Housing stock also serves as store of wealth against which can be borrowed
- Patient households save ⟶ they lend to borrowers and own production capital
- Impatient households borrow, using housing as collateral
  - Collateral constraint can be always binding -> Individuals spend whole current income (partly on housing to store wealth)
  - OR Collateral constraint can be occasionally binding

COLLATERAL-CONSTRAINED HOUSEHOLDS AND FISCAL POLICY

Articles by Iacoviello and co-authors do not look at fiscal policy, however:

- Plattimur (2016) / Andres et al. (2015, 2017) show fiscal expansion is particularly effective when collateral constraints are met
  - When collateral constraints are met, invididuals consume less than they would if they could borrow more; Higher disposable income will result in higher consumption (similar to RoT households)
  - When collateral constraints are slack, higher disposable income will not affect the optimal level of consumption strongly

- Possible to combine Ricardian, RoT households and collateral-constrained household in one model (QUEST III, Andres et al. 2017)
- However, Rule-of-Thumb households response to fiscal expansion much higher than for collateral constrained
- Drawbacks:
  - Cannot overcome the consumption puzzle
  - Effect of fiscal policy is sensitive to form of utility function (Bermpeoglou 2015)

21

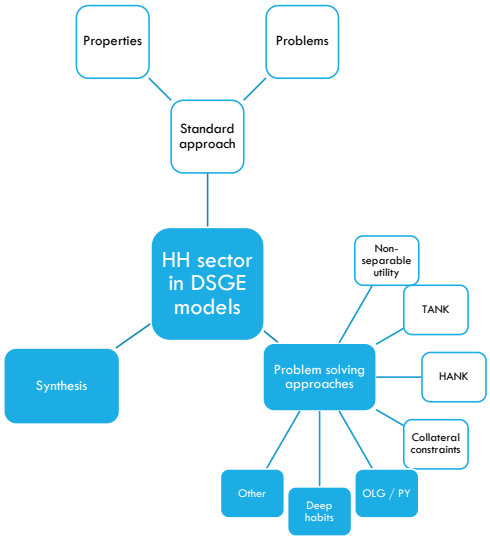
"HANK – LITE APPROACH"

- Andres et al. (2017) present a model with 6 types of households
  - Ricardian households
  - poor and wealthy HtM agents
  - highly and weakly leveraged borrowers
  - indebted households
- Shares are identified using US micro data

- captures heterogeneity across households with respect to balance sheets and MPCs
- successfully breaks Ricardian Equivalence and solves consumption puzzle
- No aggregate consumption equation – However, consumption tracks income for some household types
- Allows for distributional analysis (wealth inequality)
- Technically less involved than HANK

22

STRUCTURE OF THE PRESENTATION



23

PERPETUAL YOUTH AND OLG

24

PERPETUAL YOUTH

- Individuals have a constant probability to die
  - Financial wealth is discounted at the market interest rate; Human wealth is discounted at the market interest rate + mortality rate
  - **Agents thus discount future tax liabilities at a higher rate than the market interest rate because they attach a significant probability to not becoming responsible for them**
  - successfully overcomes the consumption puzzle and Ricardian equivalence, improves Euler equation

Drawbacks

- Results of PY framework very similar to simpler TANK framework (Kumhof and Laxton 2007, 2009)
- Constant probability to die needs to be large (around 15 years of Life expectancy); reinterpretation as planning horizon problematic due to assumption of annuity markets

25

REALISTIC OVERLAPPING GENERATIONS

- Difference to Perpetual Youth: Mortality rate is not constant
- Not much literature on DSGE models and overlapping generations
- If so, studies have a very long-term focus (and are deterministic)
  - Analysis of long-run budget sustainability, demographic change, pension systems
- Danish project DREAM attempts combining OLG with DSGE components

26

SUPERFICIAL AND DEEP HABITS

27

SUPERFICIAL HABITS

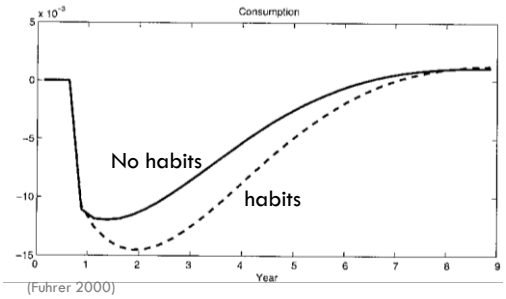
- Utility from consumption in period t depends on consumption in period t-1

$$u(C_t, N_t) = \frac{(C_t - hC_{t-1})^{1-\sigma}}{1-\sigma} - \frac{N_t^{1+\psi}}{1+\psi}$$

- Individuals now smooth
  - not only the **level of consumption** across periods
  - but also the **change of consumption** across periods

- Superficial habits do not break Ricardian equivalence, nor solve the consumption puzzle, nor improve fit of Euler equation

Response of consumption to shocks is then hump-shaped with peak response several quarters after the innovation → more in line with empirical responses



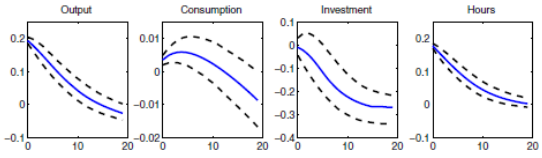
(Fuhrer 2000)

28

DEEP HABITS

- Continuum of differentiated goods in the economy
- Habits are formed for each differentiated good separately
- Firms take into account that today's price decisions will affect future demand
- Firms reduce markups to build customer base when incomes are high / aggregate demand is high

- Model can overcome consumption puzzle
(Ravn et al. 2006, Zubairy 2010 / 2014)



- However, Jacob (2015): consumption multiplier becomes very small for realistic values of price stickiness (stickiness prevents firms to exploit habits)

29

OTHER APPROACHES

30

PUBLIC – PRIVATE COMPLEMENTARITY

Consumer preferences depend on government spending (Bouakez and Rebei 2007)

$$\tilde{C}_t = \left[\phi C_t^{(\nu-1)/\nu} + (1-\phi) G_t^{(\nu-1)/\nu}\right]^{\nu/(\nu-1)}$$

- if private and public consumption are complements, government spending increases the marginal utility of consumption → consumption possibly rises
- used by Swedish policy analysis model (KI)
- Problem: Difficult to estimate complementarity

31

IMPROVING THE FIT OF EULER EQUATION – 1

In Benes et al. (2014) agents face an ad-hoc penalty cost for deviations of consumption from current income

$$D_t + P_{K,t}\sum K_t^i - \sum L_t^i - R_{t-1}D_{t-1} - R_{K,t}P_{K,t-1}\sum K_{t-1}^i + \sum R_{L,t-1}^i L_{t-1}^i$$
$$-W_t N_t\left(1-\tfrac{1}{2}\xi_W {\Omega_{W,t}}^2\right) + \underbrace{P_{C.t}\,C_t\left(1+\tfrac{1}{2}\xi_C {\Omega_{C,t}}^2\right)}_{\text{Consumption with current income effect}} + P_t I_t\left(1+\tfrac{1}{2}\xi_I {\Omega_{I,t}}^2\right) - P_{K,t}I_t - \bar{\Gamma}_t = 0,$$

Penalty cost enters aggregate consumption equation -> by varying penalty term, consumption and current income can be linked to each other to an arbitrarily high degree

32

IMPROVING THE FIT OF EULER EQUATION – 2

Following the Danish DREAM Project: Introduce banking sector

Household

- earn a rate of return lower than the interbank rate for positive assets (deposits)
- for negative assets (loans), the bank charges interest higher than the interbank rate

- The larger this interest spread → The less attractive is consumption smoothing → Consumption tracks current income more closely relative to what Euler equation implies

33

SYNTHESIS – WHICH APPROACH TO CHOSE?

34

	Ricardian Equivalence	Improved Euler Equation	Consumption puzzle solved	Analytical burden	Comments
Representative Agent	**Yes**	**No**	**No**	Low	- at odds with empirical findings - Only useful as starting point
Non-separable utility	**Yes**	**Yes**	**Yes**	Low - Medium	- Counter-intuitive, technical story - However, could be productively combined with other modeling approaches
TANK	**No**	**Yes**	**Yes**	Low-Medium	- Attractive due to simplicity - Solves all three issues - In conflict with Data / Story partly flawed
HANK	**No**	**Yes**	**Yes**	High	- Allows analysis of inequality - More realistic "story" - High mathematical and technical challenges
HANK lite	**No**	**Yes**	**Yes**	Medium	- Helps overcome calibration issues regarding TANK - Introduces rich heterogeneity while technical requirements are much lower relative to HANK - Fiscal shock effects depend on utility form
Perpetual Youth	**No**	**Yes**	**Yes**	Medium	- Analytical burden higher than with TANK - Story flawed (time horizon vs. death)
Deep Habits	**Yes**	**No**	**Yes**	Medium	- Story is quite involved, but empirically supported - Problematic with sticky prices

35

REFERENCES

36

REFERENCES

Ascari, G., & Rankin, N. (2007). Perpetual youth and endogenous labor supply: A problem and a possible solution. Journal of Macroeconomics, 29(4), 708–723. https://doi.org/10.1016/j.jmacro.2006.03.001

Barro, R. J. (1974). Are Government Bonds Net Wealth? Journal of Political Economy, 82(6), 1095–1117. Retrieved from http://www.jstor.org/stable/1830663

Baxter, M., & King, R. G. (1993). Fiscal Policy in General Equilibrium. The American Economic Review, 83(3), 315–334. Retrieved from http://www.jstor.org/stable/2117521

Bilbiie, F. (2017). The New Keynesian Cross: Understanding Monetary Policy with Hand-to-Mouth Households (CEPR Discussion Paper No. 11989). Retrieved from https://econpapers.repec.org/paper/cprceprdp/11989.htm

Bilbiie, F. O. (2009). Nonseparable Preferences, Fiscal Policy Puzzles, and Inferior Goods. Journal of Money, Credit and Banking, 41(2–3), 443–450. https://doi.org/10.1111/j.1538-4616.2009.00213.x

Bilbiie, F. O. (2011). Nonseparable Preferences, Frisch Labor Supply, and the Consumption Multiplier of Government Spending: One Solution to a Fiscal Policy Puzzle. Journal of Money, Credit and Banking, 43(1), 221–251. https://doi.org/10.1111/j.1538-4616.2010.00372.x

Bilbiie, F. O., Monacelli, T., & Perotti, R. (2014). Is Government Spending at the Zero Lower Bound Desirable? (No. 20687). https://doi.org/10.3386/w20687

Bouakez, H., & Rebei, N. (2007). Why Does Private Consumption Rise after a Government Spending Shock? (Pourquoi est-ce que la consommation privée augmente après un choc de dépenses gouvernementales?). The Canadian Journal of Economics / Revue Canadienne d'Economique, 40(3), 954–979. Retrieved from http://www.jstor.org/stable/4620639

Canzoneri, M. B., Cumby, R. E., & Diba, B. T. (2007). Euler equations and money market interest rates: A challenge for monetary policy models. Journal of Monetary Economics, 54(7), 1863–1881. https://doi.org/10.1016/j.jmoneco.2006.09.001

Cardia, E. (1991). The dynamics of a small open economy in response to monetary, fiscal, and productivity shocks. Journal of Monetary Economics, 28(3), 411–434. https://doi.org/10.1016/0304-3932(91)90033-K

Coenen, G., & Straub, R. (2005). Non-Ricardian Households and Fiscal Policy in an Estimated DSGE Model of the Euro Area (Computing in Economics and Finance 2005). Retrieved from https://ideas.repec.org/p/sce/scecf5/102.html

Corsetti, G., Meier, A., & Müller, G. J. (2011). Fiscal Stimulus with Spending Reversals. The Review of Economics and Statistics, 94(4), 878–895. https://doi.org/10.1162/REST_a_00233

Debortoli, D., & Galí, J. (2017). Monetary Policy with Heterogeneous Agents: Insights from TANK models.

Galí, J., López-Salido, J. D., & Vallés, J. (2007). Understanding the Effects of Government Spending on Consumption. Journal of the European Economic Association, 5(1), 227–270. https://doi.org/10.1162/JEEA.2007.5.1.227

Giorgio, G. D., Nisticò, S., & Traficante, G. (2015). Government spending and the exchange rate (Working Papers). Retrieved from https://ideas.repec.org/p/saq/wpaper/04-15.html

Gourinchas, P.-O., & Parker, J. A. (2002). Consumption over the Life Cycle. Econometrica, 70(1), 47–89. Retrieved from http://www.jstor.org/stable/2692163

Guerrieri, L., & Iacoviello, M. (2017). Collateral constraints and macroeconomic asymmetries. Journal of Monetary Economics, 90(Supplement C), 28–49. https://doi.org/10.1016/j.jmoneco.2017.06.004

Hebous, S. (2011). The Effects of Discretionary Fiscal Policy on Macroeconomic Aggregates: A Reappraisal. Journal of Economic Surveys, 25(4), 674–707. https://doi.org/10.1111/j.1467-6419.2010.00659.x

Heijdra, B. J., & Romp, W. E. (2008). A Life-Cycle Overlapping-Generations Model of the Small Open Economy. Oxford Economic Papers, 60(1), 88–121. Retrieved from http://www.jstor.org/stable/25167678

Iacoviello, M., & Neri, S. (2010). Housing Market Spillovers: Evidence from an Estimated DSGE Model. American Economic Journal: Macroeconomics, 2(2), 125–164. https://doi.org/10.1257/mac.2.2.125

Kiyotaki, N., & Moore, J. (1997). Credit Cycles. Journal of Political Economy, 105(2), 211–248. https://doi.org/10.1086/262072

Kormilitsina, A., & Zubairy, S. (2015). Propagation Mechanisms for Government Spending Shocks: A Bayesian Comparison (EcoMod2015 No. 8646). Retrieved from https://econpapers.repec.org/paper/ekd008007/8646.htm

Monacelli, T. (2009). New Keynesian models, durable goods, and collateral constraints. Journal of Monetary Economics, 56(2), 242–254. https://doi.org/10.1016/j.jmoneco.2008.09.013

Monacelli, T., & Perotti, R. (2008). Fiscal Policy, Wealth Effects, and Markups (No. 14584). https://doi.org/10.3386/w14584

Monacelli, T., & Perotti, R. (2010). Fiscal Policy, the Real Exchange Rate and Traded Goods*. The Economic Journal, 120(544), 437–461. https://doi.org/10.1111/j.1468-0297.2010.02362.x

MULTIMOD Mark III--The Core Dynamic and Steady-State Models, OP 164 - Table of Contents. (n.d.). Retrieved December 12, 2017, from https://www.imf.org/external/pubs/ft/op/op164/index.htm

Nisticò, S. (2012). Monetary policy and stock-price dynamics in a DSGE framework. Journal of Macroeconomics, 34(1), 126–146. https://doi.org/10.1016/j.jmacro.2011.09.008

Nisticò, S. (2016). Optimal Monetary Policy and Financial Stability in a Non-Ricardian Economy. Journal of the European Economic Association, 14(5), 1225–1252. https://doi.org/10.1111/jeea.12182

Piergallini, A. (2006). Real Balance Effects and Monetary Policy. Economic Inquiry, 44(3), 497–511. https://doi.org/10.1093/ei/cbj029

Rabanal, P., & Lopez-Salido, D. (2006). Government Spending and Consumption-Hours Preferences (No. ID 1011703). Rochester, NY: Social Science Research Network. Retrieved from https://papers.ssrn.com/abstract=1011703

Ratto, M., Roeger, W., & Veld, J. in 't. (2009). QUEST III: An estimated open-economy DSGE model of the euro area with fiscal and monetary policy. Economic Modelling, 26(1), 222–233. https://doi.org/10.1016/j.econmod.2008.06.014

Ravn, M. O., Schmitt-Grohé, S., & Uribe, M. (2012). Consumption, government spending, and the real exchange rate. Journal of Monetary Economics, 59(3), 215–234. https://doi.org/10.1016/j.jmoneco.2012.02.001

Ravn, M. O., Schmitt-Grohé, S., Uribe, M., & Uuskula, L. (2010). Deep habits and the dynamic effects of monetary policy shocks. Journal of the Japanese and International Economies, 24(2), 236–258. https://doi.org/10.1016/j.jjie.2009.12.002

Ravn, M., Schmitt-Grohé, S., & Uribe, M. (2006). Deep Habits. The Review of Economic Studies, 73(1), 195–218. Retrieved from http://www.jstor.org/stable/3700622

Wegmueller, P. (2014). Utility functions, fiscal shocks and the open economy - In the search of a positive consumption multiplier (Diskussionsschriften). Retrieved from https://econpapers.repec.org/paper/ubedpvwib/dp1407.htm

Zubairy, S. (2010). Explaining the Effects of Government Spending Shocks (MPRA Paper). Retrieved from https://ideas.repec.org/p/pra/mprapa/26051.html

Zubairy, S. (2014). On Fiscal Multipliers: Estimates from a Medium Scale Dsge Model. International Economic Review, 55(1), 169–195. https://doi.org/10.1111/iere.12045

37

APPENDIX

38

QUEST III – EXTENSION WITH CREDIT CONSTRAINED HOUSEHOLDS

Consider three types of Households

1. Ricardian Households
2. Liquidity-constrained households (aka rule-of-thumb, hand to mouth)
3. Credit-constrained households (aka collateral constraint)

Fiscal multiplier of Model with 1 2 3 >
Fiscal multiplier of Model with 1 2 >
Fiscal multiplier of Model with 1

Assumption of Shares

1) 0.3 – 2) 0.4 – 3) 0.3

2 is based on estimates of RoT HH in Europe

The remaining allocation between 1 and 3 is arbitrary and influences results directly

Credit-constrained HH increase consumption on impact of fiscal policy shock (but less so than RoT).

39

HETEROGENEOUS AGENT NEW KEYNESIAN MODELS

Monetary Policy in HANK Models – Kaplan Moll Violante (2017)

- Introduce into a traditional NK DSGE models (infinitely lived) households that have access to liquid and illiquid assets a la Kaplan & Violante (2014)
- Important differences to RANK models arise when analyzing monetary policy effects

I. Intertemporal substitution effect: Matters strongly in RANK as the Euler equation directly links interest rate with aggregate consumption
In HANK, HtM households are barely affected by interest rate change

II. General equilibrium effects: Rather small in RANK but most important in HANK

III. Fiscal policy response to monetary policy shock matters strongly in HANK

40

PERPETUAL YOUTH – UTILITY FUNCTION

Carton (2012) Aggregation among cohorts is intractable without restrictions on the utility function -> 2 Types

$$U(C,L) = (1-\kappa)\log(C) + \kappa\log(\bar{L} - L)$$

As used in Blanchard (1985), Kumhof & Laxton (2007/09), di Girgio et al. (2015)

Allows for a decreasing labor endowment with age

$$U(C,L) = \log(C - V[L])$$

Ascari & Rankin (2007)

- Avoids negative labor supply for very old
- Could potentially solve real exchange rate problem

41

SUPERFICIAL HABITS

Superficial Habits: Habits are formed at the composite good level

$$E_o \sum_{t=0}^{\infty} \beta^t U(x_t^{c,j} - b^C s_{t-1}^C, h_t^j)$$

Period utility function of composite consumption minus habit stock and hours

$$x_t^{c,j} = \left[\int_0^1 (c_{it}^j)^{1-\frac{1}{\eta}} di\right]^{1/(1-\frac{1}{\eta})}$$

Continuum of consumption goods i ∈ [0,1]

$$s_t^C = x_t^c$$
$$s_t^C = \rho^c s_{t-1}^C + (1-\rho^C) x_t^c$$

Composite consumption is CES aggregate across all differentiated consumption goods i ∈ [0,1]

42

DEEP HABITS

Habits are formed at the single good type level

$$E_0 \sum_{t=0}^{\infty} \beta^t U(x_t^{c,j}, h_t^j)$$

Period utility function of composite consumption good and hours

$$x_t^{c,j} = \left[\int_0^1 (c_{it}^j - b^c s_{it-1}^C)^{1-\frac{1}{\eta}} di \right]^{1/(1-\frac{1}{\eta})}$$

Continuum of consumption goods i ∈ [0,1]

Effective consumption of good i = actual consumption – habit stock for good i

$$s_{it}^C = c_{it}$$
$$s_{it}^C = \rho^c s_{it-1}^C + (1-\rho^C) c_{it}$$

Composite consumption is CES aggregate across all differentiated consumption goods i ∈ [0,1]

43

COMPARING DEEP AND SUPERFICIAL HABITS

Deep Habits: Habits are formed at the single good level

$$E_0 \sum_{t=0}^{\infty} \beta^t U(x_t^{c,j}, h_t^j)$$

$$x_t^{c,j} = \left[\int_0^1 (c_{it}^j - b^c s_{it-1}^C)^{1-\frac{1}{\eta}} di \right]^{1/(1-\frac{1}{\eta})}$$

$$s_{it}^C = c_{it}$$
$$s_{it}^C = \rho^c s_{it-1}^C + (1-\rho^C) c_{it}$$

Superficial Habits: Habits are formed at the composite good level

$$E_o \sum_{t=0}^{\infty} \beta^t U(x_t^{c,j} - b^C s_{t-1}^C, h_t^j)$$

$$x_t^{c,j} = \left[\int_0^1 (c_{it}^j)^{1-\frac{1}{\eta}} di \right]^{1/(1-\frac{1}{\eta})}$$

$$s_t^C = x_t^c$$
$$s_t^C = \rho^c s_{t-1}^C + (1-\rho^C) x_t^c$$

44

DEEP HABITS

- Continuum of differentiated goods in the economy
- Habits are formed for each differentiated good separately
- Gives rise to the following consumption demand function

$$c_{it}^{j} = \left(\frac{P_{it}}{P_t}\right)^{-\eta} x_t^{c,j} + b^c s_{it-1}^{C}$$

Price-elastic component, depends on aggregate demand

Price-inelastic component, depends on habit stock

Mechanism for fiscal expansion

- Increase in aggregate demand increases the share of price-elastic component
- Firms take into account that today's price decisions will affect future demand
- Firms reduce markups to build customer base when aggregate demand is high
- counter-cyclical markups

45