MEDSEA-FIN

A DSGE model of the Maltese economy with financial frictions

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BANK ĊENTRALI TA' MALTA
EUROSISTEMA
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1. NEW MODEL TO STUDY MACROPRUDENTIAL POLICY
2. TAYLORING IT FOR THE MALTESE ECONOMY

Why Macroprudential policy?

Research objective

- GFC highlighted the need for a MacroPru framework
  1. Mitigating the risk of financial instability
  2. Reducing related macroeconomic costs
- Creating institutions tasked with MacroPru oversight
  - European Systemic Risk Board (ESRB)
  - National Competent Authority (NCA)
- Appealing toolkit adding flexibility to MSs
- Enanching research on the topic
  1. In a small-open economy
  2. Within a monetary union
- As in the case of Malta

Why a new tool?

Why not using the old good ones?

Connected theoretical and practical issues

- Practical issues
  1. Standard NK models do not include a financial sector
  2. Macroprudential policy cannot be investigated
- Theoretical issues
  1. Finacial sector frictionless
  2. Recent financial crisis suggests a re-thinking

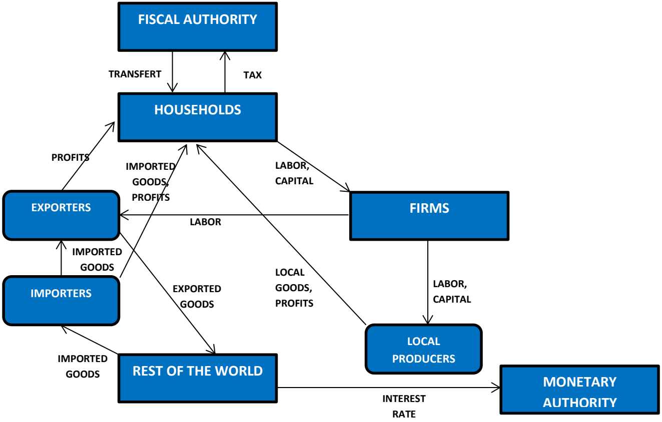
Presenting MEDSEA-FIN

A new tool to study Macroprudential policy in Malta

- DSGE models (Smets and Wouters, 2003, 2007)
  1. Price and wage rigidities (Rotemberg, 1982)
  2. Catching up with the Joneses (Abel, 1990)
- Starting with MEDSEA (Rapa, 2016)
  1. Open-economy model (Lane, 2001)
  2. Within a monetary union (Clancy and Merola, 2016)
  3. With a rich production sector
- Including a financial sector
  - Iacoviello (2005); Gerali et al. (2010)
  - Rubio and Carrasco-Gallego (2014, 2016)
- Constraining borrowing by collateral
  - Kiyotaki and Moore (1997); Bernanke et al. (1999)
- Studying Loan-to-Value (LTV) ratio in Malta

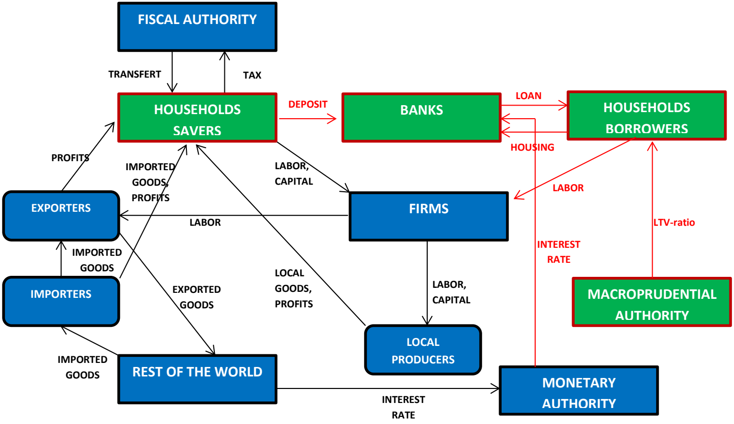
MEDSEA Model structure

Graphical representation



MEDSEA-FIN Model structure

Graphical representation



Model structure

MEDSEA-FIN—new features

1. Two agent types:
   - Savers ▸ Go equations
     1.1 Invest in Housing, Bonds, Banks Deposits, Capital
     1.2 Own production plants
     1.3 Consume
     1.4 Work
   - Borrowers ▸ Go equations
     - Invest in Housing
     - Borrow against housing
     - Consume
     - Work
2. A banking sector ▸ Go equations
   - Matching deposits and lendings
3. A Macroprudential policy autority
   - Set the Loan-to-Value ratio

Model dynamics

We are introducing an crucial mechanism

1. Borrowers in the model are constrained in their decisions
2. The constraint is related to housing wealth
3. Housing wealth equals price times quantity ($P_t^H H_t^b$)

- Setting allows studying standard shocks
- But also shocks on asset prices have implications

Shock on Housing Demand

Model dynamics

Assuming a shock increasing the demand for housing

- House price goes up ($P_t^H \uparrow$)
- Net wealth of Borrowers increases ($P_t^H H_t^b \uparrow$)
- They can borrow more ($L_t \uparrow$)
- They can consume more ($C_t^b \uparrow$)

However they also get more indebted IRFs

Framework we are studying

- Framework produces a financial accelerator
  1. Housing price is procyclical
  2. Good times $\Rightarrow$ Amplified booms
  3. Bad times $\Rightarrow$ Deeper recessions
- Room for a Macroprudential autority
  1. Setting the LTV ratio
  2. Reduces the amount of loans
  3. Dampens the credit/business-cycle

What's next

Way forward

- Properly calibrate the model
- Running different simulations

Way *forward*^{2}

1. Deposit/lending interest rate spread
2. Imperfect interest rate pass-trough
3. Countercyclical Capital Buffer (CCyB)
4. Capital Adequacy Ratio (CAR)
5. Non-Performing Loans (NPL)

Conclusion

- Developing a new model
- To study Macroprudential policy
- In particular the effects of LTV ratio
- In a small open economy
- Within a monetary union
- As in the case of Malta

THANKS FOR LISTENING!

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Savers maximizes their life-time utility

$$\max \ \mathbb{E}_t \left\{ \sum_{t=0}^{\infty} (\beta^s)^t \varepsilon_t^C \left((1-\chi) \log \left(C_{j,t}^s - \Gamma_{j,t-1}^s \right) + \varepsilon_t^H \log \left(H_{j,t}^s \right) - \frac{(N_{j,t}^s)^{1+\varphi}}{1+\varphi} \right) \right\}$$

Subjet to their budget constraint

$$\begin{aligned} & P_t^C C_{j,t}^s + P_t^H (H_{j,t}^s - H_{j,t-1}^s) + P_t^C D_{j,t} + P_t^C B_{j,t}^* + P_t^I I_{j,t} \\ & \quad = W_t N_{j,t}^s + R_t^K K_{j,t-1} + R_{t-1} P_{t-1}^C D_{j,t-1} + R_{t-1}^* \xi(\phi_{t-1}, \varepsilon_{t-1}^R) P_{t-1}^C B_{j,t-1}^* \\ & \qquad + P_t^C \mathrm{DIV}_{j,t} - P_t^C AC_{j,t}^{s,P} - P_t^C AC_{j,t}^{s,W} \end{aligned}$$

and a law of motion for capital

$$K_{j,t} = (1-\delta) K_{j,t-1} + I_{j,t} \left[1 - \frac{\xi^I}{2} \left(\frac{I_{j,t}}{I_{j,t-1}} - 1 \right)^2 \right]$$

Borrowers maximize their life-time utility

$$\max \ \mathbb{E}_t \left\{ \sum_{t=0}^{\infty} \beta^{b,t} \varepsilon_t^C \left((1-\chi) \log \left(C_{j,t}^b - \Gamma_{j,t-1}^b \right) + \varepsilon_t^H \log \left(H_{j,t}^b \right) - \frac{\left(N_{j,t}^b \right)^{1+\varphi}}{1+\varphi} \right) \right\}$$

Subject to their budget constraint

$$C_{j,t}^b + q_t (H_{j,t}^b - H_{j,t-1}^b) + \frac{R_{t-1} L_{t-1}(j)}{\Pi_t^C} = w_{j,t}^b N_{j,t}^b + L_{j,t} - AC_{j,t}^{b,W}$$

And the borrowing constraint

$$R_t L_{j,t} \leq \mathrm{m}_t \mathbb{E}_t \left\{ q_{t+1} H_{j,t}^b \Pi_{t+1}^C \right\}$$

The unions choose labour hours from each household j, $N^i_{j,t}$, taking the wage rate $w^i_{j,t}$ as given, to maximise

$$\max_{N^s_{j,t}} \quad w^s_t N^s_t - \int_0^{\omega} w^s_{j,t} N^s_{j,t} \, dj$$

$$\max_{N^b_{j,t}} \quad w^b_t N^b_t - \int_{\omega}^{1} w^b_{j,t} N^b_{j,t} \, dj$$

This yields optimal demand schedules for saver and borrower households:

$$N^s_{j,t} = \left(\frac{w^s_{j,t}}{w^s_t} \right)^{-\mu^W_t} N^s_t$$

$$N^b_{j,t} = \left(\frac{w^b_{j,t}}{w^b_t} \right)^{-\mu^W_t} N^b_t$$

Labor market–Aggregation

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A labour agency combines labour hours from each household type into a homogeneous service and maximises income

$$\max_{N_t^s, N_t^b} \; w_t N_t - w_t^s N_t^s - w_t^b N_t^b$$

subject to the aggregation technology

$$N_t = \left(\omega^{\frac{1}{\mu_t^W}} (N_t^s)^{\frac{\mu_t^W - 1}{\mu_t^W}} + (1-\omega)^{\frac{1}{\mu_t^W}} (N_t^b)^{\frac{\mu_t^W - 1}{\mu_t^W}} \right)^{\frac{\mu_t^W}{\mu_t^W - 1}}$$

Optimal demand for labour hours from each household type is:

$$N_t^s = \omega \left(\frac{w_t^s}{w_t} \right)^{-\mu_t^W} N_t$$

$$N_t^b = (1-\omega) \left(\frac{w_t^b}{w_t} \right)^{-\mu_t^W} N_t$$

Banks are neutral in the model matching deposits and lendings

$$L_t = D_t$$

The macroprudential authority sets the LTV ratio as a fixed constant

$$m_t = 0.9$$

Or in a counter-cyclical way

$$\mathrm{m}_t = \mathrm{m}_{t-1}^{\rho_{\mathrm{m}}} \left(\overline{\mathrm{m}} \left(\frac{L_t}{Y_t} \Big/ \overline{\frac{L}{Y}} \right)^{-\tau} \right)^{(1-\rho_{\mathrm{m}})}$$

Firms–Local producers

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Firms maximize their expected profits

$$\max_{N_{j,t}^N, K_{j,t-1}^N, P_{j,t}^N} \quad \mathbb{E}_0 \sum_{t=0}^{\infty} \beta^{s,t} \lambda_t^s \left(P_{j,t} Y_{j,t}^N \left(1 - \frac{\xi^N}{2} (\Omega_t^N)^2 \right) - W_t N_{j,t}^N - R_t^K K_{j,t-1}^N \right)$$

Subject to a production function

$$Y_{j,t}^N = A_t^N (N_{j,t}^N)^{\gamma_N} (K_{j,t-1}^N)^{1-\gamma_N}$$

And a downward slooping demand

$$Y_{j,t}^N = \left(\frac{P_{j,t}^N}{P_t^N} \right)^{-\mu_t^N}$$

Firms maximize their expected profits

$$\max_{P^M_{j,t}} \quad E_0 \sum_{t=0}^{\infty} \beta^{s,t} \lambda_t^s \left(P^M_{j,t} Y^M_{j,t} \left(1 - \frac{\xi^M}{2} (\Omega_t^M)^2 \right) - MC_t^M Y^M_{j,t} \right)$$

Subject to a downward slooping demand

$$Y^M_{j,t} = \left(\frac{P^M_{j,t}}{P^M_t} \right)^{-\mu_t^M} Y_t^M$$

Taking foreign price as given

$$MC_t^M = P_t^* S_t$$

Exporters combine a good they produce locally with an imported good to produce the exported good

$$Y_t^X = \min\left\{\frac{Y_t^{XD}}{1-\alpha_X}, \frac{Y_t^{MX}}{\alpha_X}\right\}$$

And maximize their expected profits

$$\max_{N_{j,t}^{XD}, Y_t^X} E_0 \sum_{t=0}^{\infty} \beta^{s,t}\lambda_t^s \left(P_{j,t}^{XW} Y_t^X \left(1 - \frac{\xi^{XW}}{2}(\Omega_t^{XW})^2\right) - W_t N_{j,t}^{XD} - R_t^K K_{t-1}^{XD} - P_t^M Y_t^{MX}\right)$$

s.t.

$$Y_t^{XD} = A_t^{XD}(N_t^{XD})^{\gamma_{XD}}(\bar{K}_{t-1}^X)^{1-\gamma_{XD}}$$
$$Y_t^{XD} = (1-\alpha_X)Y_t^X$$
$$Y_t^{MX} = \alpha_X Y_t^X$$

Firms–Final sellers on the local market

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Final sellers combine local produced and imported goods to create a final good sold on the local market

$$\max_{Y_t^N, Y_t^M} \quad \mathcal{P}_t^i \equiv P_t Y_t^i - P_t^N Y_t^N - P_t^M Y_t^M, \quad i = (C, I)$$

s.t

$$Y_t^i = \left((1-\alpha_i)^{\frac{1}{\eta_i}} \left(Y_t^N \right)^{\frac{\eta_i - 1}{\eta_i}} + \alpha_i^{\frac{1}{\eta_i}} \left(Y_t^M \right)^{\frac{\eta_i - 1}{\eta_i}} \right)^{\frac{\eta_i}{\eta_i - 1}}, \quad i = (C, I)$$

Firms–Final sellers on the foreign market

A distribution service intensive in local non-tradables delivers the final products to the final consumers

$$P_t^X = P_t^{XW} + \theta P_t^N$$

Government spending Y_t^G is financed by a lump-sum tax T_t, in a way that the budget is balanced

$$T_t = P_t^N Y_t^G$$

Also, government spending is assumed to be a fixed fraction of the steady-state level of output Y

$$Y_t^G = YG_t$$

The monetary authority sets the local interest rate equal to the foreign rate through the *Uncovered Interest rate Parity* (UIP) condition

$$R_t = R_t^* \frac{\mathbb{E}_t S_{t+1}}{S_t} \exp\left[\rho_\phi \left(\log\left(\frac{B_t^*}{Y_t}\right) - \log\left(\frac{B*}{Y}\right)\right) + \epsilon_t^R\right]$$

where the risk premium is contingent to the gap between the foreign debt-to-GDP ratio B_t^*/Y_t and the steady-state level B^*/Y, and the parameter ρ_ϕ determines the rule sensitivity.

Foreign debt evolves according to

$$B_t^* = B_{t-1}^* R_t^* - TB_t$$

where the trade balance TB_t is equal to the difference between exports and imports in the country $TB_t \equiv P_t^X Y_t^X - P_t^M Y_t^M$.

R_t^* denotes the world interest rate

$$R_t^* = \frac{1}{\beta_s}$$

Rest of the worlds

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The rest of the world is stylized as a downward-sloping demand function

$$Y_t^X = \left(\frac{P_t^X}{S_t P_t^*} \right)^{-\eta_X} Y_t^*$$

Market clearing

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$$Y_t = P_t^C C_t + P_t^I I_t + P_t^N Y_t^G + P_t^X Y_t^X - P_t^M Y_t^M$$

$$Y_t^N = C_t^N + I_t^N + Y_t^G$$

$$Y_t^M = C_t^M + I_t^M + Y_t^{MX}$$

$$N_t = N_t^N + N_t^{XD}$$

$$K_t = K_t^N + K_t^{XD}$$

$$N_t = N_{s,t} + N_{b,t}$$

$$1 = \int_0^\omega H_{j,t}^s \, dj + \int_\omega^1 H_{j,t}^b \, dj = \omega H_{s,t} + (1-\omega) H_{b,t}$$

$$C_t = \int_0^\omega C_{j,t}^s \, dj + \int_\omega^1 C_{j,t}^b \, dj = \omega C_{s,t} + (1-\omega) C_{b,t}$$

New model new issues

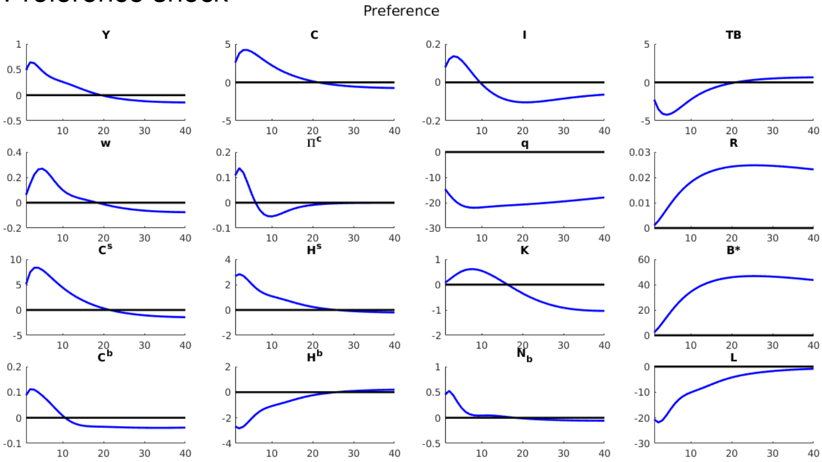
MEDSEA-FIN vs. MEDSEA

1. Aggregating labor sector to keep production as MEDSEA
2. Computational problem
   - From 57 to 73 equations (!)
   - Static model "by hand"
3. Calibration
   - More shocks
   - More parameters
   - More long-term averages to match ("great ratios")

IRFs—Very Preliminary results

Calibration not yet precise!

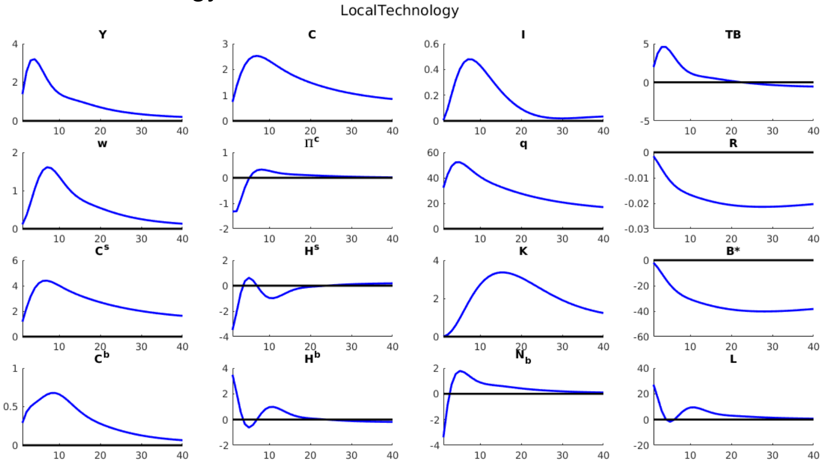
Preference shock



IRFs—Very Preliminary results

Calibration not yet precise!

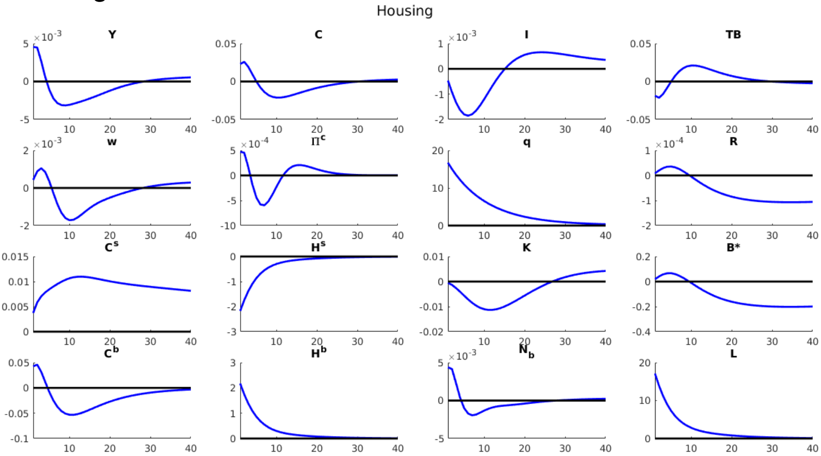
Local technology shock



IRFs—Very Preliminary results

Calibration not yet precise!

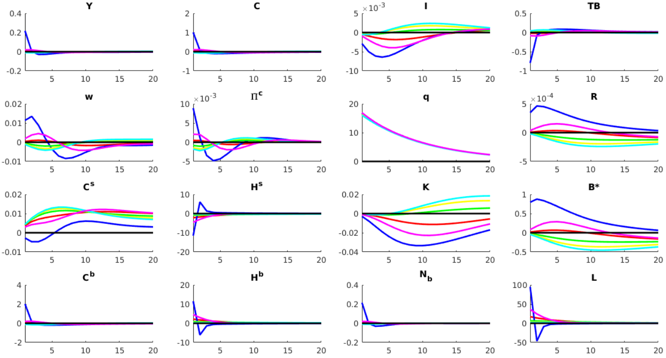
Housing demand shock



IRFs—Very Preliminary results

Calibration not yet precise!

Housing demand shock for different LTV rules



Structural parameters

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Parameter	Value	Description
β^s	0.993	discount factor savers
β^b	0.960	discount factor borrowers
χ	0.600	consumpion habit
φ	1.000	labor elasticity
δ	0.048	capital depreciation
θ	0.800	distribution cost
ρ_ϕ	0.000	EDEIR parameter
ξ^I	6.000	adjustment cost investment
ξ^M	58.300	adjustment cost imported good
ξ^N	20.400	adjustment cost local good
ξ^W	38.800	adjustment cost wage
ξ^X	58.300	adjustment cost exported good
γ^N	0.650	return-to-scale local good
γ^{XD}	0.600	return-to-scale exported intermediate good
α_C	0.500	production shares consumption good
α_I	0.640	production shares investment good
α_X	0.570	production shares exported good
ω	0.500	share of savers in population
η_C	1.100	elasticity of substitution consumption good
η_I	1.100	elasticity of substitution investment good
η_X	6.000	elasticity of substitution exported good
η_{SB}	10.000	elasticity of substitution savers and borrowers labor
ι^M	0.500	indexation parameter imported good
ι^N	0.500	indexation parameter local good
ι^W	0.800	indexation parameter wage
ι^X	0.500	indexation parameter exported good

Reduced–form parameters

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Parameter	Value	Description
$\bar{\Pi}$	1.000	inflation steady_state
ρ_K	0.900	autoregressive parameter capital in exported intermediate good shock
ρ_G	0.900	autoregressive parameter government spending shock
ρ_{P*}	0.900	autoregressive parameter foreign price shock
ρ_{Y*}	0.900	autoregressive parameter foreign demand shock
ρ_C	0.900	autoregressive parameter preference shock
ρ_R	0.900	autoregressive parameter risk-premium shock
ρ_H	0.900	autoregressive parameter housing preference shock
ρ_{MN}	0.900	autoregressive parameter mark-up local good shock
ρ_{MM}	0.900	autoregressive parameter mark-up imported good shock
ρ_{MXW}	0.900	autoregressive parameter mark-up exported intermediate good shock
ρ_{MW}	0.900	autoregressive parameter mark-up wage shock
ρ_{AN}	0.900	autoregressive parameter local good technology shock
ρ_{AXD}	0.900	autoregressive parameter exported intermediate good technology shock
$\bar{\mu}^W$	1.300	steady-state mark-up wage shock
$\bar{\mu}^N$	1.500	steady-state mark-up local good shock
$\bar{\mu}^M$	1.200	steady-state mark-up import good shock
$\bar{\mu}^{XW}$	1.200	steady-state mark-up exported intermediate good shock
$\bar{G}$	0.214	steady-state government spending shock
$\bar{e}_h$	0.150	steady-state housing preference shock