Aggregate shocks and the volatility of house prices

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Extremely Preliminary

Sveriges Riksbank
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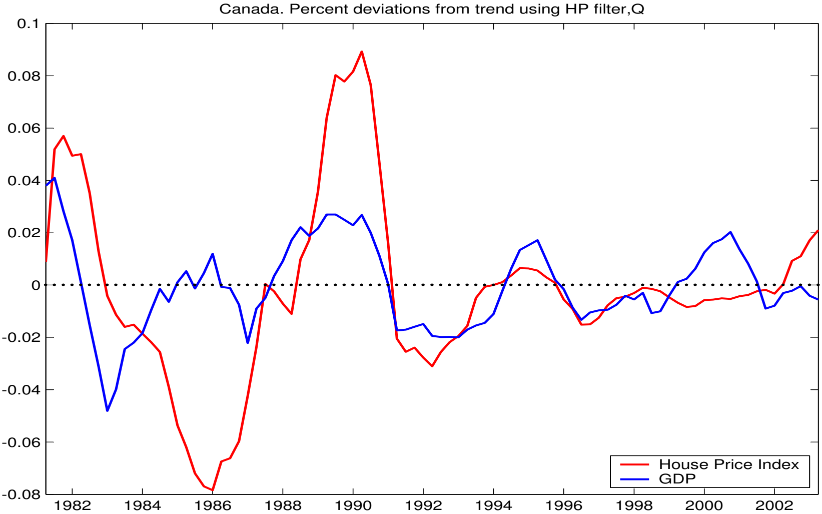
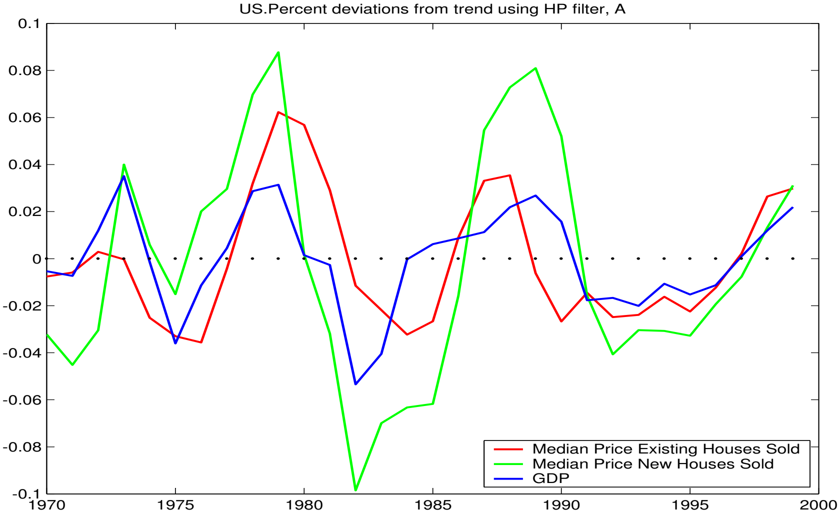
Housing market

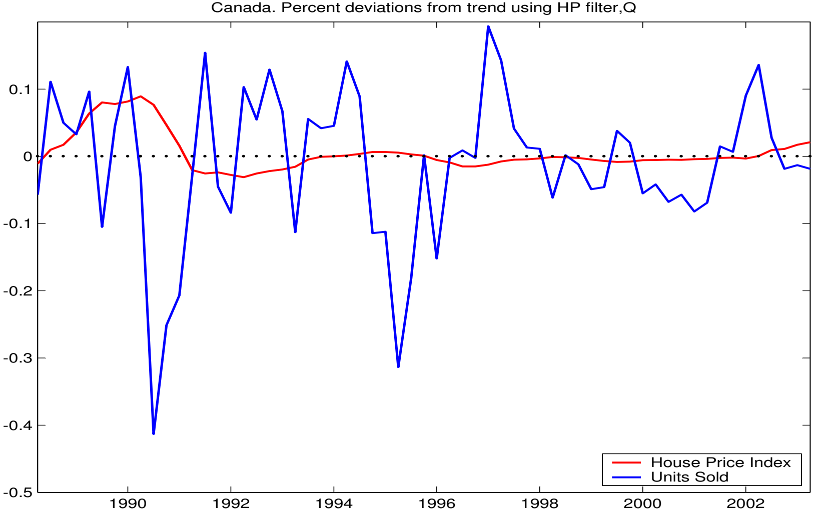
Two properties of houses

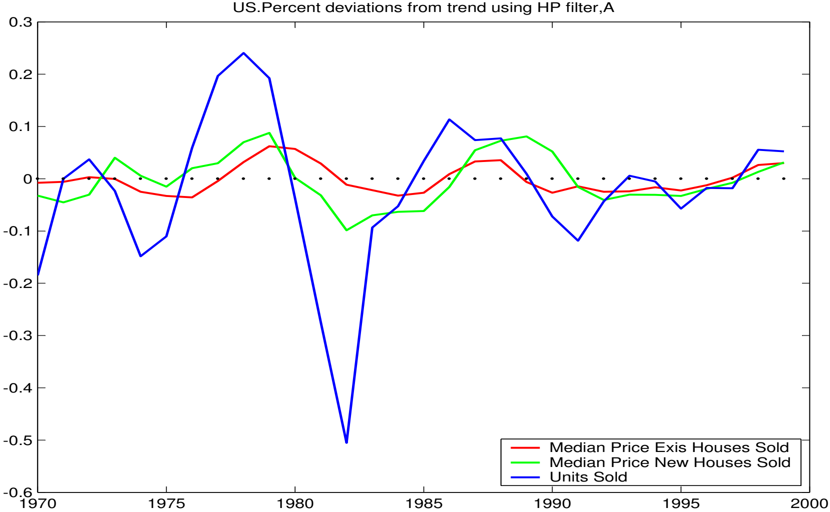
1 Houses prices are more volatile than GDP (Canada, U.S.). They are positively correlated (.56 for existing houses and .78 for new ones).

2 Units sold co-move with house prices (both existing and new units sold) but with larger volatility (Canada, U.S.). The correlation is .78.


Canada. Percent deviations from trend using HP filter,Q
0.1
0.08
0.06
0.04
0.02
0
-0.02
-0.04
-0.06
-0.08
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
House Price Index
GDP


US.Percent deviations from trend using HP filter, A
0.1
0.08
0.06
0.04
0.02
0
-0.02
-0.04
-0.06
-0.08
-0.1
1970
1975
1980
1985
1990
1995
2000
Median Price Existing Houses Sold
Median Price New Houses Sold
GDP


Canada. Percent deviations from trend using HP filter,Q
0.1
0
-0.1
-0.2
-0.3
-0.4
-0.5
1990
1992
1994
1996
1998
2000
2002
House Price Index
Units Sold


US.Percent deviations from trend using HP filter,A
0.3
0.2
0.1
0
-0.1
-0.2
-0.3
-0.4
-0.5
-0.6
1970
1975
1980
1985
1990
1995
2000
Median Price Exis Houses Sold
Median Price New Houses Sold
Units Sold

Our Target

1. To have a model economy with suitable chosen frictions that resembles the data in certain dimensions: home-ownership distribution, wealth distribution and some macroeconomic aggregates, including features of the mortgage issuing sector.

2. To ask whether the model delivers some of the features we observe in the housing market in relation to volatility of prices and sales.

Related Literature

- Ortalo-Magne and Rady (2005): capital gain of owning partial equity on the house and bearing the price risk accounts for price volatility.
- Nakajima (2004) asks whether the stock market and housing prices rise due to increase volatility in individual earnings.
- Davis and Heathcote (2004) look at BC properties of housing construction, quantities.
- Garriga and Schlagenhauf (2008) that relates housing default with house price dynamics.
- Eerola and Määttänen (2008) that explores de importance of borrowing constrains for house price dynamics.
- Kiyotaki, Michaelides and Nikolov (2007) on the distribution effects of house prices.

What are Houses?

- Big items that people like.

1. They are costly to buy and sell.
2. There is more than one size (costly to change size).
3. There is a large advantage to own the house you live in.
4. Households can borrow some to buy the house.

Our model

We pose a model of the Bewley-Imrohoroglu-Huggett-Aiyagari variety with houses and aggregate fluctuations to study housing prices.

- Exponential population, so that there is a rationale for some buying and selling of houses.
- Uninsurable shocks to earnings.
- Borrowing constraints but houses serve as collateral, although borrowing commands a premium.
- Adjustments costs when buying or selling a house.
- Two types of property that we call dwellings : flats and houses.

Model economy 1: A stationary version

- Exponential population with turnover rate π.
- Shocks to earnings ϵ drawn from $F(\epsilon, e)$ with $e \sim \Gamma_{ee'}$.
- Assets: a tree and dwellings $d = \{0, f, h\}$.
  1. A Lucas tree in fixed supply of 1, with dividends r and price p_ℓ.
  2. A flat, if held affects utility. $\exists \mu_f$ flats, with p_f.
  3. A house. Like a flat but better $0 < \mu_f + \mu_h < 1$, with p_h.
- There are borrowing constrains and need of collateral (can borrow a fraction $1 - \alpha$ of dwellings value).
- Dwellings are traded with costs (on the buyer):

$$\phi(d, d') = p'_d(1 + \delta) \qquad \text{if } d = 0,$$

$$\phi(d, d') = p'_d(1 + \delta) - p_d \qquad \text{if } d \neq d'.$$

Borrowing Limits and Bankruptcy

- Dwellings serve as collateral, otherwise borrowing is not allowed

- Households can borrow a fraction $1 - \alpha$ of the dwelling value at the moment of the purchase

- After purchase, households may owe up to a (higher) limit $\underline{\ell}$.

- Bankruptcy takes place when the household cash in hand is not enough to keep the debt below this limit. Furthermore,bankruptcy may be chosen by the household as an optimal choice in the stochastic economy if her cash in hand is lower than the value of her dwelling

- If bankruptcy takes place the household consume 10% of the minimum earnings of her earnings group and goes to next period with zero assets

- The mortgage premium finance the debt of those who go bankrupt

Maximization problem: $W_{e,d}(a) \;=\; \max_{d'} \; \left\{ W_{e,d}^{d'}(a) \right\}$

$$W_{e,d}^{d}(a) = \max_{y} \;\; u_d(c) + \pi \beta E \left\{ V_{e',d}(y) | e \right\} \qquad \text{if not trading dwelling}$$

$$c + p_\ell \; y \;=\; a, \qquad V_{e,d}(y) = \int_\varepsilon \;\; W_{e,d}(y+\varepsilon) \; F(d\varepsilon, e)$$

$$W_{e,d}^{d'}(a) = \max_{y} \;\; u_{d'}(c) + \pi \beta E \left\{ V_{e',d'}(y) | e \right\} \qquad \text{if trading dwelling}$$

$$c + p_\ell \; y \; - \; \phi(d, d') = \; a, \qquad V_{e,d}(y) = \int_\varepsilon \;\; W_{e,d}(y+\varepsilon) \; F(d\varepsilon, e)$$

- Where $y \geq 0$ if $d = 0$ $y \geq \underline{\ell}$ if not trading and owning, and $\geq (1-\alpha) p_d$ if buying.

Steady State Equilibrium

It is a stationary distribution of agents x over dwellings, assets, and earnings shocks, and a set of prices $\{q, p\}$ such that agents maximize, markets clear,

$$\int_{e,d,y} y \, dx = 1 \qquad \int_{e,f,y} dx = \mu_f, \qquad \int_{e,h,y} dx = \mu_h.$$

and the distribution is stationary which is the typical condition that updating the distribution just repeats itself.

Mapping Steady State to Data

- Some parameters can be set independently: Population turnover, 1.5%, (adult life expectancy of 67). Risk aversion set to 2.
- Some features of the financial system: a 1.% mortgage premium, a 10.% minimum down payment and a 10.% cost of buying a dwelling.
- Other are estimated

1. Preferences (3): $u_d(c) = \frac{c^{1-\sigma}}{1-\sigma}\, \gamma^d,$
2. Asset parameters (3): Dividend r, number of dwellings μ^f, μ^h. The size of the Lucas tree is normalize to 1.
3. Earnings Shocks (11):
$$F(\epsilon, e) = \left[\frac{\epsilon - \underline{\epsilon}}{\overline{\epsilon} - \underline{\epsilon}}\right]^{\chi}, \qquad \Gamma_{e,e'}, \;\; e \in \{e^1, e^2, e^3\}.$$

Calibration Targets I

1. Labor share out of income (not gdp) of 0.84. The rest is capital income.
2. Financial asset wealth relative to income: 2.18.
3. Owner occupied housing wealth relative to income: 2.61.
4. Fraction of households that own a house: 0.35.
5. Fraction of people with flat: 0.30
6. House prices relative to flat prices $\frac{p_h}{p_f}$: 2.0.

Calibration Targets II

- Cross sectional earnings and wealth distribution.
  1. Average earnings of those aged 31-60 relative to those of the group aged 20-30: 1.4.
  2. General Properties of the Lorenz Curve of earnings.
  3. General Properties of the Lorenz Curve of assets.

Other Statistics associated to the purchases of houses

1. Down payment the first time a household buys a dwelling: 16.3%.
2. Down payment of repeated buyers 26.5%.
3. Ratio of mortgage debt to income of 34%.
4. Fraction of people with debt of 45.9%
5. Average ratio of financial debt to housing value is 55.1%.

Main Statistics in Model Economies and Data

	Economy	
	Model	Target
1. Labor Share	84%	84%
2. Interest Rate	7.3%	5%
3. Financial asset wealth relative to income	2.18	2.18
4. Owner occupied housing wealth relative to income	2.61	2.61
5. Households that own a house	35%	35%
6. Households what own a flat	30%	30%
7. House prices relative to flat prices $\frac{p_h}{p_f}$	2.0	2.0.
8. Downpayment first-time buyers	17.9%	16.3%
9. Downpayment repeat buyers	28.0%	26.5%
10. Fraction of People with Debt	45.8%	45.9%
11. Ratio Debt to Housing Value	67.5%	55.1%
12. Earnings of ages 31-60 relative to ages 20-30	1.8	1.4
Other Statistics		
Households that buy a flat each year	2.70%	
Households that buy a house	0.53%	
Households that buy a dwelling	3.23%	5.0%

Cross-Sectional Distributions

Wealth Distribution in Model and Data (1998 SCF)

		Quintiles					
		1st	**2nd**	**3rd**	**4th**	**5th**	**Gini**
Total	Model	0.24	1.30	2.27	9.92	86.27	0.819
Assets	U.S.	-0.29	1.35	5.14	12.38	81.42	0.796
Financial	Model	-22.34	-17.43	-1.39	2.33	138.83	1.568
Assets	U.S.	-7.27	-0.25	1.14	6.92	99.45	0.953
Housing	Model	0.00	5.69	20.92	31.56	41.84	0.457
Wealth	U.S.	0.00	1.40	12.31	22.08	64.21	0.656

Earnings Distribution in Model and Data (1998 SCF)

	Quintiles					
	1st	**2nd**	**3rd**	**4th**	**5th**	**Gini**
Model	3.5	5.0	7.8	11.1	72.7	0.654
U.S.	-.2	4.0	13.0	22.9	60.2	0.611

Model economy 2: Stochastic version

- Let the aggregate exogenous state of the economy be z with transition $\Gamma_{z,z'}$. We consider aggregate shocks to

  1 Dividends, $d(z)$.

  2 Earnings, $[\underline{\epsilon}^j(z), \overline{\epsilon}^j(z)]$.

  3 Mortgage premium $m(z)$.

  4 All of the above together.

Choices and problem of the Stochastic version

- We have three markets.

- The minimal is a storage or small open economy where the financial asset always has price of one and the interest rates are exogenous. Still 2 endogenous markets.

- But we also want to pose prices for stocks to see interactions. If so, there are many possibilities. In this paper, we have the simplest closed economy we can think of: all the financial assets, including mortgages are shares. This makes the set of markets to be 3.

- The problem is that now the state vector is $\{z, x\}$.

Solving the Stochastic version

- We also have to calculate the pricing functions

$$\{p^\ell(x,z), p^f(x,z), p^h(x,z)\}.$$

- A daunting task, so we use Krusell and Smith (1997).

- The key question is what moments of the distribution to use to both COMPUTE and FORECAST prices.

- The simplest is to use the asset price themselves.

- We need to pose a forecasting pricing function. Let $p' = \Psi_{z,z'}(p)$ be such a forecasting function. Moreover, let Ψ be an afine function. There are various possibilities depending on whether we index those parameters by z or by z and z'. We finally set on indexing the constant but not the slope by z and z'.

The Stochastic Problem

$$W_{z,e,d}(a,p) \quad = \quad \max_{d'} \quad \left\{ W^{d'}_{z,e,d}(a,p) \right\}$$

$$W^{d}_{z,e,d}(a,p) = \max_{y} \quad u_d(a - p_\ell y) + \pi \beta E \left\{ V_{z,e',d}(y,p) | e \right\} \qquad d = d'$$

$$V_{z,e,d}(y,p) = \sum_{z'} \Gamma_{z,z'} \int_{\varepsilon} W_{z,e,d}[(\Psi^{\ell}_{z,z'}(p) + r')y + \varepsilon, \Psi_{z,z'}(p)] \; F(d\varepsilon, e)$$

$$W^{d'}_{z,e,d}(a,p) = \max_{y} \; u_{d'}[a - p_\ell y - \phi] + \pi \beta E \{ V_{z,e',d'}(y,p) | e \} \quad d \neq d'$$

$$V_{z,e,d}(y,p) = \sum_{z'} \Gamma_{z,z'} \int_{\varepsilon} W_{z,e,d}[(\Psi^{\ell}_{z,z'}(p) + r')y + \varepsilon, \Psi_{z,z'}(p)] \; F(d\varepsilon, e)$$

Equilibrium with Limited Rationality

- A set of decision rules that depend on the aggregate exogenous state, on prices and on individual states. A true pricing function $p = \zeta(z, x)$, and a forecasting function Ψ such that
  - Decision rules solve the hhold problem given forecasting function Ψ.
  - Pricing function ζ clears the market.
  - Forecasting function Ψ is a good one, i.e. is the best linear predictor of prices given the aggregate shock and current prices and, moreover, lagged prices and aggregate statistics of the distribution (correlation of financial and housing wealth for instance) do not really help to forecast prices.
- Note that function ζ does not really have to be computed. Along the simulations we solve each period for the market clearing prices.

Forecasting Function, We use

$$p^{j\prime} = \Psi_{z,z'}(p) = \alpha_0^j + \alpha_1^j 1_{\{z=1,z'=2\}} + \alpha_2^j 1_{\{z=1,z'=2\}} + \alpha_3^j 1_{\{z=1,z'=2\}} + \alpha_4^j p^j$$

OLS Estimates for Price Forecasting Functions

	α_0	α_1	α_2	α_3	α_4	R^2
Dependent variable						
p^ℓ	5.230	1.398	-0.439	0.955	0.312	0.989
p^h	9.447	4.067	-1.926	2.225	0.499	0.989
p^f	2.856	1.758	-1.097	0.639	0.688	0.990

R^2 with various sets of regressors

Regressors	p^ℓ	p^h	p^f
Forecast depends only on z and z'	0.987	0.987	0.976
What we use	0.989	0.989	0.990
What we use + All Lagged Prices	0.989	0.990	0.990

What is an experiment?

- There is an aggregate shock that takes two values.
- The persistence of the shock is 95%
- We populate the economy with 200,000 households and let it run
  - 16 periods with the first state (sometimes more if shows trend).
  - 10 periods with the second state.
  - 25 more periods in the first state.
- We show the outcome

Quantitative effects of aggregate shocks

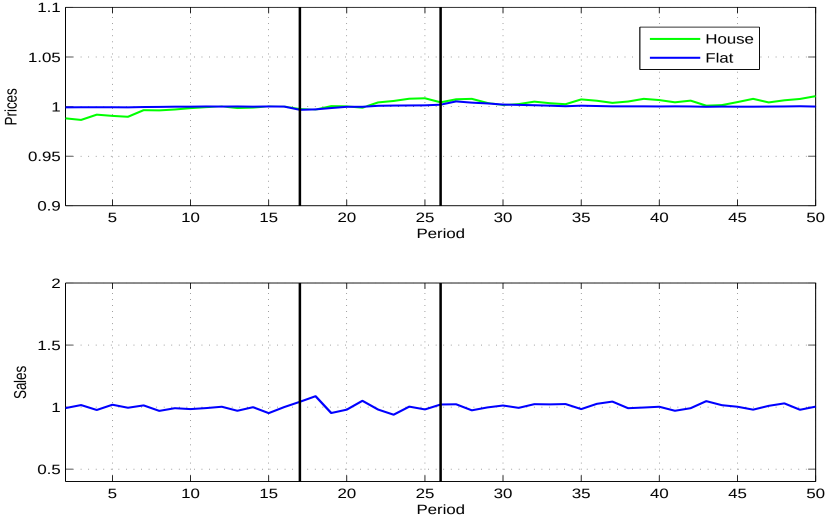
- We consider two alternative economies
  1. Exogenous interest rate (small open economy)
  2. Endogenous interest rate

- The exogenous interest rate economy isolates the effects on prices without the general equilibrium adjustments that occur when financial assets and interest rates adjust.

- These two economies are very different.

Which Experiments we run?

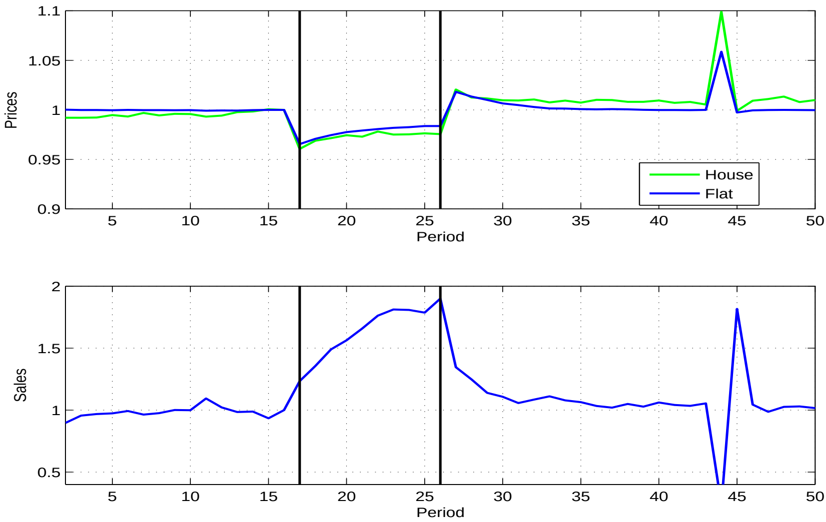
- We undertake the following experiments
  1. Shock to dividends -15% to 15%: Open economy with constant mortgage rate.
  2. Shock to dividends -15% to 15%: Open Economy with variable mortgage rates.
  3. Shock to Labor earnings -5% to 5%. Open Economy.
  4. Shocks to Mortgage Premium 0% to 2%. Open Economy.
  5. All of the above perfectly correlated. Open Economy.
  6. Dividend Shocks. Closed Economy.
  7. Mortgage Mark-up Shocks. Closed Economy.
  8. Earnings Shocks. Closed Economy.
  9. All Shocks. Closed Economy.



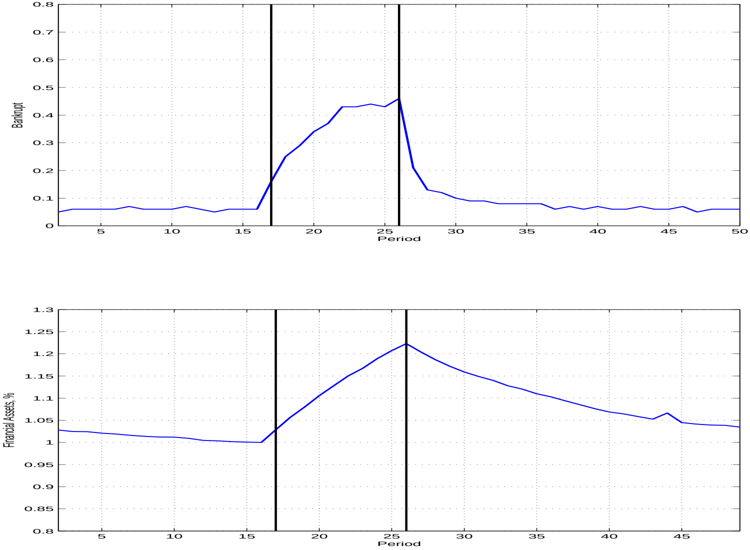
Dividends -15% to 15%, Fixed rate mortgage

Findings of Dividends Shocks in Open Ec, Fixed rates

- The rate of return to savings is stochastic, but the interest rate of the mortgage is fixed.
- NOTHING HAPPENS TO PRICES (except for a slight increase in house prices at the end of the expansion as households have been accumulating more quickly to build the downpayment)
- Households accumulate more financial assets during the expansion as is standard in these Aiyagari-et-al worlds.

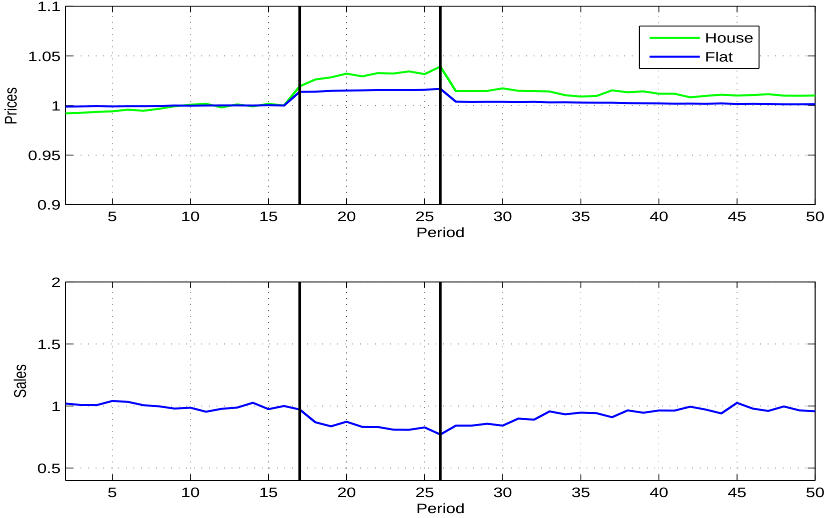


Dividends -15% to 15%, Flexible rate mortgage


Bankrupt
Period
Financial Assets, %
Period

Findings of Dividends Shocks in Open Ec, Flexible rates

- User cost of housing for mortgage holders to go up. Prices go down by 4% or so.
- Bankruptcies also go up: higher turnover.
- Precautionary Savings are like always accumulated.
- Note turnover and housing prices move opposite ways.



Labor Earnings -5% to 5%

Findings of Earnings Shocks in Open Ec I

- There is an increase in the present value of earnings

- A decrease in bankruptcy rate and an increase in financial asset accumulation as a consequence

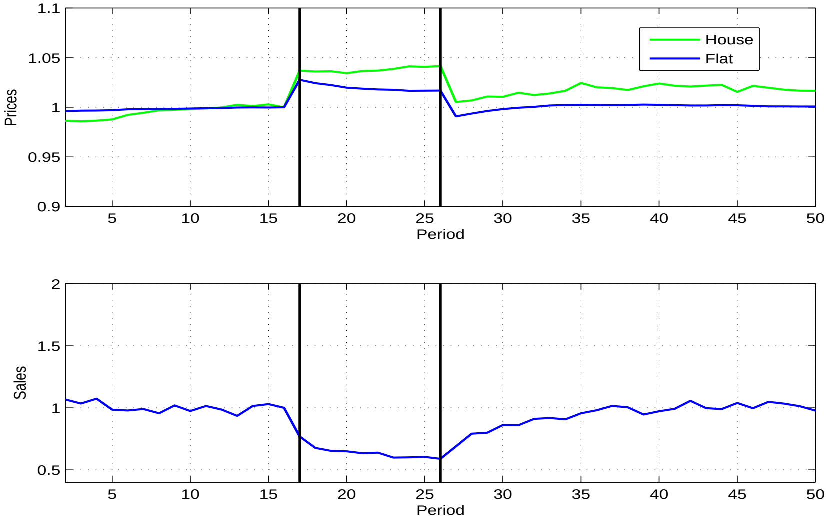
- Flat owners have a capital gain: flat price go up, however the value of debt remains constant

- In spite of this, very small effect of dwelling prices, 2% for flats and 4% for houses. The higher increase in house prices could be due to the capital gain of flat owners that as a result are willing to go up in the property ladder. The fact that the flat price only goes up in the first period of the expansion, whereas the house price continue to go up after the first period support this argument.

Findings of Earnings Shocks in Open Ec II

- The expected capital loss at the end of the expansion associated to dwelling, in contrast to financial assets, prevents a higher demand for dwellings during the expansion

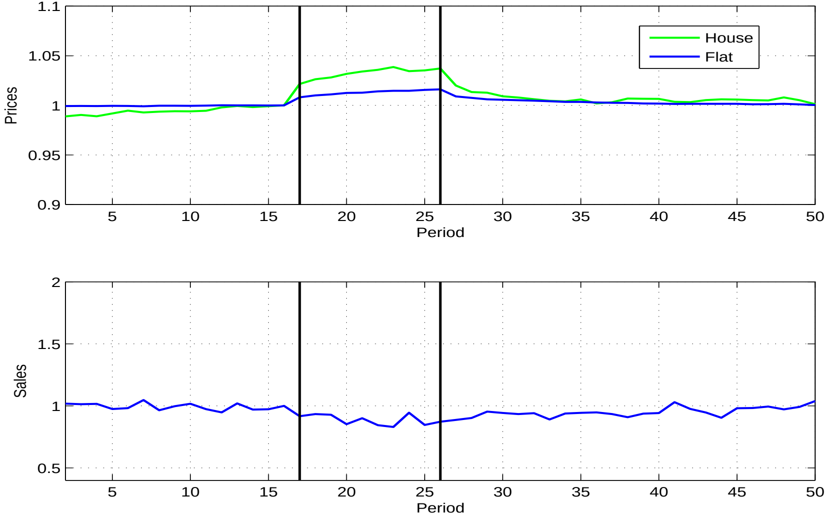
- During the expansion there is accumulation of financial asset for precautionary reasons, including the expected decrease of the dwelling value in relation to household debt when the recession hits the economy



Mortgage mark-up 2% to 0%

Findings of Mark-up Shocks in Open Ec

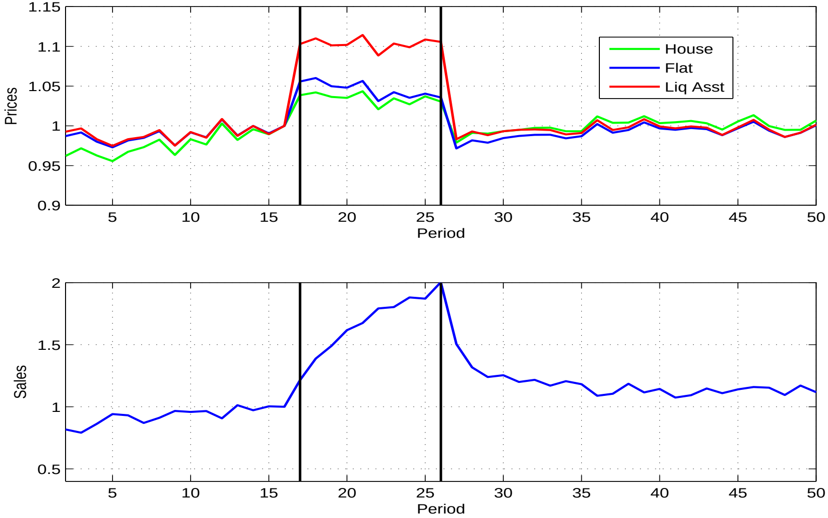
- House prices go up by 4% slowly during the expansion, whereas flat prices go up by 2.5% at the beginning of the expansion and adjust down afterwards
- So the substitution effect is small here
- Again the capital gain of flat owners at the beginning of the expansion may be behind the subsequent increase in house prices as flat owners are willing to go up in the property ladder.
- A reduction in the bankruptcy rate is observed as a result of the improvement in the financial situation of households with debt



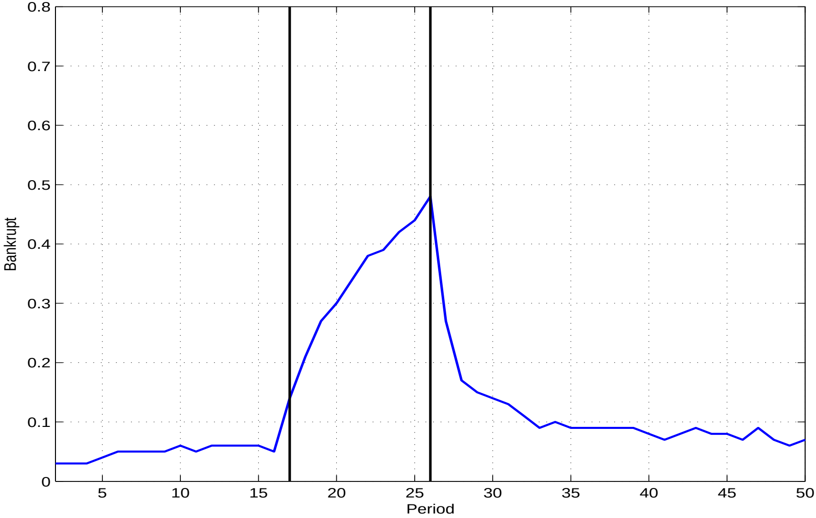
All shocks, flexible rates

Findings with All Shocks in Open Ec, Flexible rates

- The expected interest rate in the recession is 6.35%, in the expansion 8.33%. This is also the interest rate for borrowers
- Given that the cost of mortgage increases during the expansion, prices go up much less. Still house prices increase by more than flat prices
- Sales only decrease slightly for the same reasons. The improvement in the financial situation due to higher earnings is partially overcome by the increase in the cost of debt.



$+-15\%$ of Dividends



$+-15\%$ of Dividends

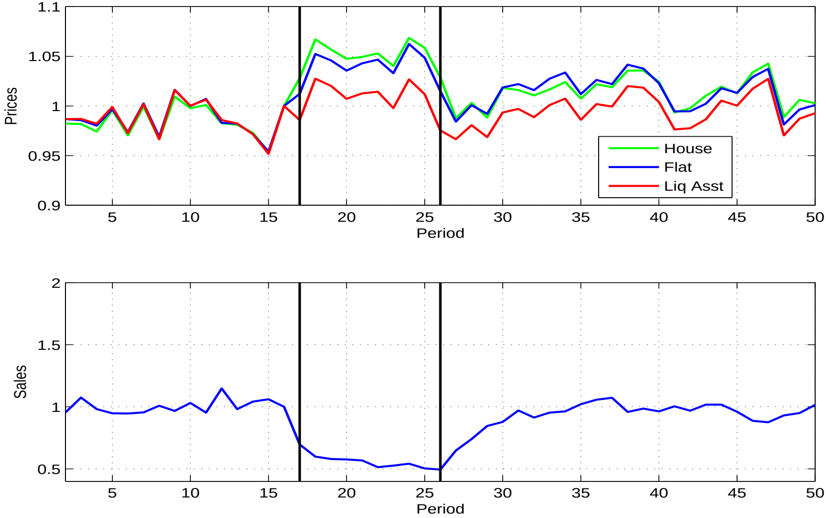
Findings with Dividend Shocks in Closed Ec I

- Capital income of National Income moves from 13.5% to 18.4%. National income increase of about 5%

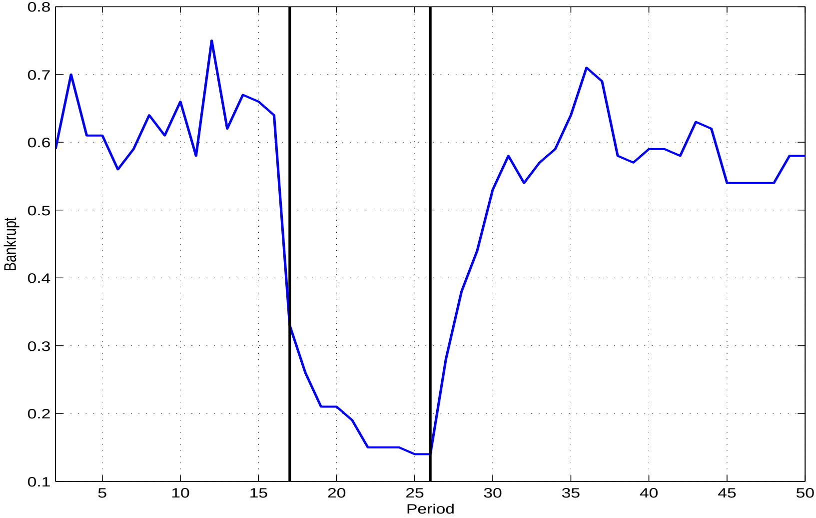
- In spite of the increase in dividends during the expansion, the expected rate of return of the financial asset is very similar to the one during the recession (7.23% versus 7.36%). This is related to the expected capital gains and losses implied by the aggregate shocks

Findings with Dividend Shocks in Closed Ec II

- Consequently there is no substitution effect that reinforce the wealth effect (households getting with positive asset having higher income) on dwelling prices
- Financial asset prices goes up by 10%, whereas dwelling prices go up only 5%
- Asymmetric effect of changes in prices: redistribution in favor of those who own financial asset, those who own debts are worse off
- Then bankruptcy rate increases from 0.04% to 0.45%. This is behind the dramatic increase in sales during the expansion



Mortgage premium 2-0%



Mortgage premium 2-0%

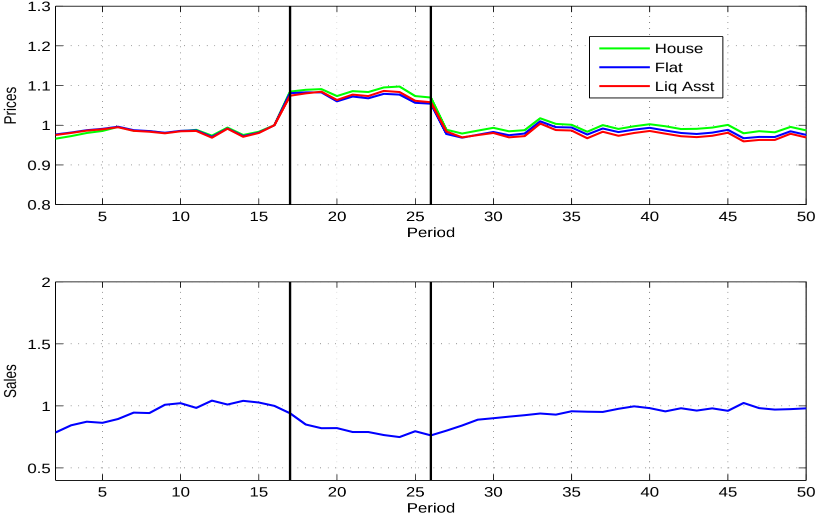
Findings with Mortgage mark-up Shocks in Closed Ec I

- The reduction in the mark-up implies a 2% increase in National Income
- The expected interest rate during the recession is 7.56%, whereas during the expansion it is 6.83%. This implies an additional decrease in the financial cost to the one provided by the decrease in the mark-up during the expansion
- This accounts for the higher increase in the dwelling prices with respect to the exogenous interest rate economy, an additional 2%

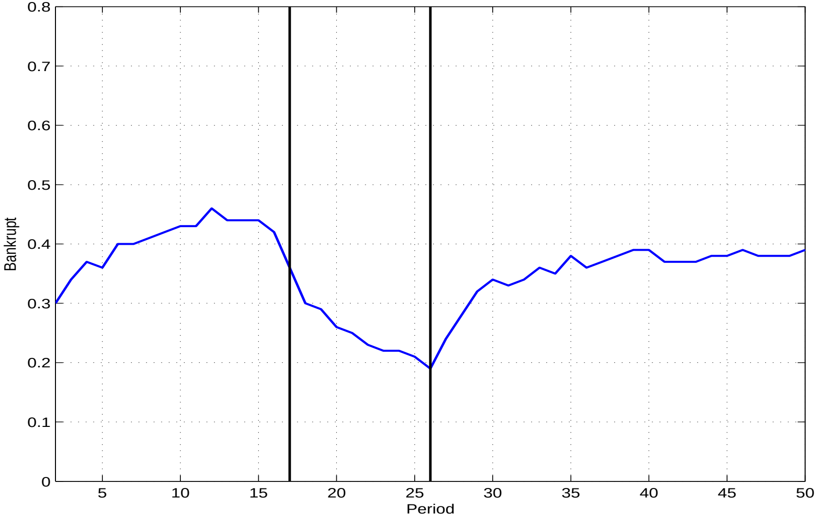
Findings with Mortgage mark-up Shocks in Closed Ec II

- The improvement in the financial situation of those who own debt reduces bankruptcy and sales, again more than in the exogenous interest rate economy

- Financial asset prices do not change as much as dwelling prices. Maybe some propagation of the shock through the capital gain of flat owners (house prices go up a bit more than flat prices).



Labor Earnings -5% to 5%



Labor Earnings -5% to 5%

Findings with Earnings Shocks in Closed Ec

- National income increase of about 8%

- All asset prices go up by 10%. No redistribution effects due to changes in asset prices

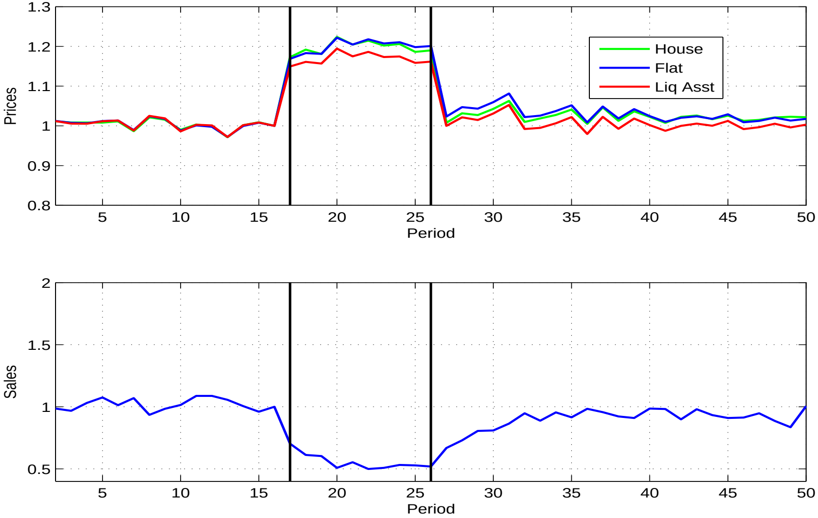
- The expected rate of return of the financial asset during expansion, 5.86%, relative to the one during the recession is 8.07% (due to precautionary savings). A substitution effect operates and reinforce the wealth effect

- As a result there is a decrease in the bankruptcy rate and sales go down

Findings with Earnings Shocks in Closed Ec

- The endogenous reduction in the financial cost of mortgage during the expansion accounts for the additional increase in dwelling prices (around an additional 7%) with respect to the exogenous interest rate economy

- In contrast to the small open economy there is no propagation mechanism of the earnings shock through the capital gain of flat owners. This is because the relative indebtedness of households do not change much as financial asset price and dwelling prices go up similarly.



Earnings, Dividend and Mortgage Shock

Findings with All Shocks in Closed Ec

- The expected interest rate during the recession is 8.19%, whereas during the expansion it is 6.56%.
- Dwelling prices reach a value 20% higher than during the recession and financial asset price increases by 18%
- Sales decrease substantially

Closed economy versus open economy

- In the small open economy prices dynamics during the expansion generate redistribution in favor of dwelling owners, whereas in the closed economy, this depends on the evolution of financial asset price relative to dwelling prices

- There is a propagation mechanism of the earnings or mortgage shocks to house prices in the small open economy as the flat price goes up relative to debt and flat owners enjoy a capital gain that make them to be willing to go up in the property ladder

Closed economy versus open economy

- In a small open economy (with exogenous interest rates) the effect of earnings and mortgage shocks on dwelling prices is smaller

- In a small open economy the effect of dividend shock on dwelling prices has opposite sign to the effect in a closed economy. The effect on sales is the same sign and similar size

- We need to understand better the joint behavior of interest rates and economic activity. Is there a negative co-movement of risky rates and mortgage interest rates?

What have we learnt?

- The combination of all shocks is able to generate a moderate increase in dwelling prices, however

- Movements in the number of sales reflect the relative performance of homeowners relative to financial asset owners. As financial situation of homeowners worsens, sales go up

- Evolution of financial costs of mortgages are crucial to understand the dynamics of house prices. So in an endogenous interest rate eco the effect of earnings shocks is amplified through the general equilibrium effect of the expansion on financial asset prices

What are the failures of the current model economy?

- Too little turnover

- Households do not repay their debts as in the data. They live with too much debt

We are working in the following extensions

- OLG economy where old household may have incentives to downsize: SCF reflects that the average housing assets of people older than 65 are substantially smaller than those owned by younger households (55-65)

- Exogenous increase in the housing demand. Moscarini and Vella (2003) find that reallocation of employment across occupation is strongly pro-cyclical. Saks and Wozniak (2006) find that internal migration is procyclical.

- Mortgage implying flow restrictions