

# Empirical Macro And Finance

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## Outline

1. Should macro care about finance? The theoretical argument
2. Macro-Finance Example:  
The empirical challenges
  - (i) Identification
  - (ii) Aggregate quantification
  - (iii) General Equilibrium

## Simplest NK DSGE Model

$$\mathbb{E}_t[d \ln C(t)] = \gamma [i(t) - \pi(t) - \rho] dt.$$

Euler

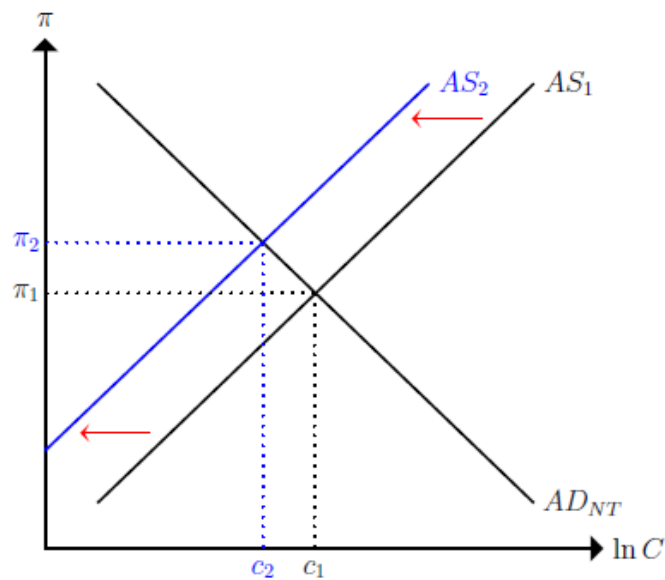
$$\ln C(t) = -\gamma \mathbb{E}_t \int_0^\infty \underbrace{[i(t+s) - \pi(t+s) - \rho] ds}_{\text{Expected Real Rates}} + \underbrace{\mathbb{E}_t \lim_{T \rightarrow \infty} \ln C(T)}_{\text{"Long-Run" Consumption}}.$$

$$\pi(t) = f(\ln C(t), u(t), \bullet), \quad \infty > f_1 > 0, \quad \infty > f_2 > 0,$$

Phillips

$$i(t) = \max\{\bar{i} + \phi_\pi(\pi(t) - \bar{\pi}) + \phi_y(\ln C(t) - \bar{\ln C}), 0\},$$

Taylor



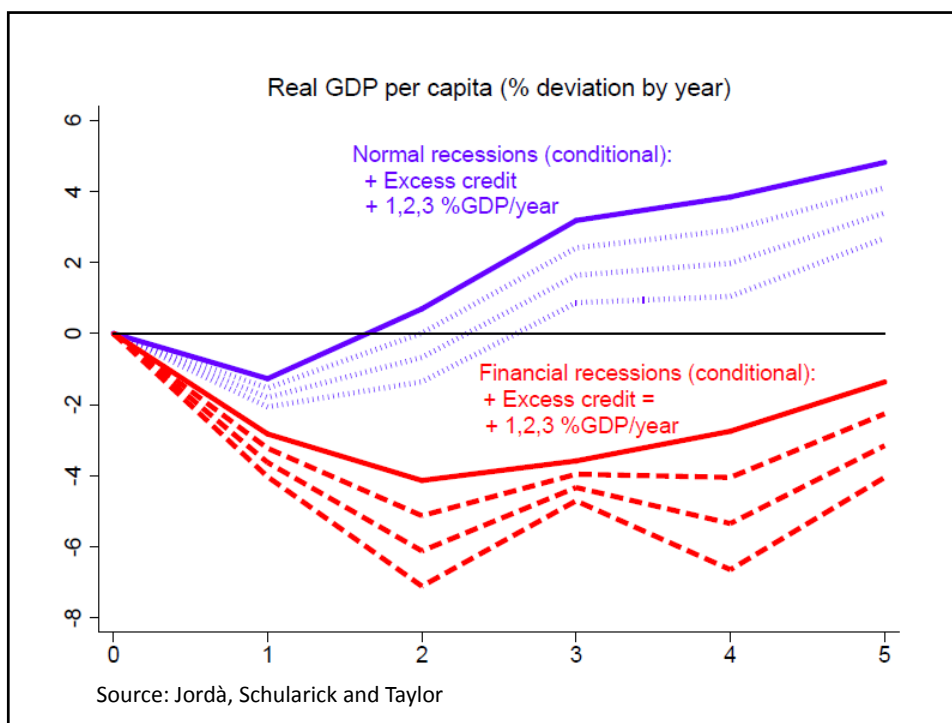
(a) Normal Times

## Finance in Macro?

- Introduction
  - Standard “New-Keyensian” DSGE models used by central banks have no role for debt
  - Focus on price rigidities, and real interest rate expectations.
- However, the real world looks quite different!
  - Debt acts like a state variable
  - Debt, especially household debt, amplifies shocks, including asset price shocks.
  - Bank lending channel is not necessarily the best way to “incorporate finance into macro”

## Private debt as a state variable

- “When credit bites back: leverage, business cycles, and crises”, by Òscar Jordà, Moritz HP. Schularick and Alan M. Taylor
- 14 advanced countries, 1870-2008, 200 recessions
- Debt a state variable ...



## Macro-Finance Nexus

- Financial shocks (e.g. asset price movements) in combination with leverage shift the distribution of net-worth across agents
- The redistribution of net-worth impacts the real economy either via the “investment channel”, or via the “consumption channel”.
- The two channels are very different in terms of their policy prescription: we may end up recapitalizing the wrong sector.

## Macro-Finance Nexus

- Investment Channel



- Consumption Channel



## Macro-Finance Example

- What was the effect of the extraordinary housing gains between 2002 and 2006 on consumer spending?
  - Benchmark: No / little effect
  - “Cash on hand”: wealth shock tied to cash on hand, and strong heterogeneity. (Deaton (1991), Carroll (1992), Harris and Laibson (2002), Kaplan and Violante (2014))
  - Identification
  - Quantification
  - General Equilibrium

## Identification

- Focus on the 2002 to 2006 housing boom, exploiting cross-sectional variation across U.S. cities in the extent of house price growth
- Find evidence supporting cash-on-hand theories:
  - Low income households borrow and spend aggressively out of home value shocks
  - High income households completely unresponsive
  - “Housing wealth effect” is a “housing borrowing effect”, completely driven by lower half of income distribution

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## Quantification and GE effects

- Average MPC out of housing wealth shocks during 2002 to 2006 housing boom: \$0.10 per \$1.00; almost all of *spending* driven by *borrowing*
- Aggregate effect, ignoring GE: 0.08% of GDP in 2003, 0.8% in 2004, 1.3% in 2005 and 2006
- Why didn't economy overheat? General Equilibrium analysis and possibilities toward the end

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## Data

- Main level of observation in analysis is zip code, where we have annual data on:
  - House prices, income, net worth, credit scores, education levels, mortgage refinancing, auto sales
  - Sample covers 55% of U.S. population – main restriction is zip-code level house prices
- CBSA-level: Housing supply elasticity (Saiz)
- Individual-level credit bureau data: MS (2011)

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## Summary Statistics

(Table 1)

	N	Mean	SD	10th	90th
<u>Zip level data</u>					
House price growth, 2002 to 2006	5163	0.360	0.217	0.089	0.638
Change in home value (\$000), 2002 to 2006	5163	54.9	54.0	6.6	121.8
Annual cash-out refinancing share, 2003 through 2006	5163	0.105	0.047	0.049	0.170
Annual no-cash-out refinancing share, 2003 through 2006	5163	0.093	0.032	0.055	0.133
Change in annual cash-out refinancing share	5163	0.023	0.043	-0.024	0.080
Change in annual no-cash-out refinancing share	5163	-0.017	0.020	-0.043	0.004
Change in auto purchases per household, (\$000), 02 to 06	5163	0.862	1.129	-1.056	2.635
Housing supply inelasticity	5163	0.672	0.179	0.404	0.865
Adjusted gross income per household (\$000), 2002	5163	49.9	25.1	29.5	74.5
Net worth per household (\$000) 2002	5163	322.4	303.6	108.5	597.2
Fraction with credit score below 660, 2002	5163	0.344	0.134	0.180	0.531
Less than high school education fraction, 2000	5163	0.173	0.110	0.056	0.321
Wage shock, 2002 to 2006	5162	-0.019	0.083	-0.093	0.058
Median home value (\$000), 2002	5163	176.7	109.5	83.2	305.0
Number of households, thousands	5163	14.4	6.7	6.9	22.7
<u>Individual level homeowner data</u>					
Change in debt (\$000), 2002-2006	60858	52.1	203.4	-69.2	229.2
Credit score, 1997	60858	788.4	103.4	641.0	910.0

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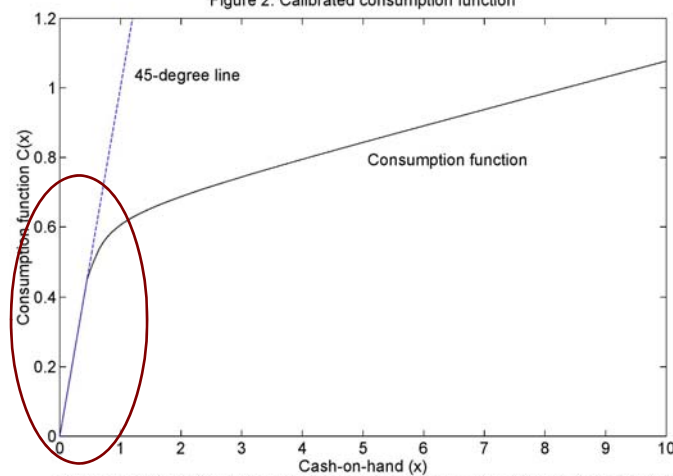
# Theory and Estimation Strategy

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## Concavity Illustration

(Harris and Laibson (2002))

Figure 2: Calibrated consumption function



The consumption function is based on simulations in which  $\beta = .7$ ,  $\delta = .9571$ ,  $\rho = 2$ ,  $R = 1.0375$ ,  $a = 5$ .

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## Application to Housing

- Is rise in home values a “cash-on-hand” shock?
- Two questions:
  - How easy is it to borrow out of housing wealth?
  - Does more borrowing lead to spending?

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## OLS Estimation

- Testing consumption concavity in zip-code level data using 2002 to 2006 first differences

$$\Delta y_{zc} = \alpha + \beta * \Delta HomeValue_{zc} + \varepsilon_{zc}$$

$$\Delta y_{zc} = \alpha + \beta * \Delta HomeValue_{zc} + \delta * \Delta HomeValue_{zc} * CashonHand_{z,2002} + \gamma CashonHand_{z,2002} + \varepsilon_{zc}$$

- Dollar on dollar specification to match theory, where  $\Delta y_{zc}$  will be either borrowing or spending

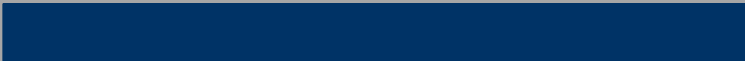
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## Estimation Challenges

1. Fixing permanent income – cash-on-hand shocks must be orthogonal to omitted permanent income shocks



2. How to measure cash on hand?



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## Estimation Challenges

1. Fixing permanent income – cash-on-hand shocks must be orthogonal to omitted permanent income shocks

- CBSA-level housing supply elasticity instrument

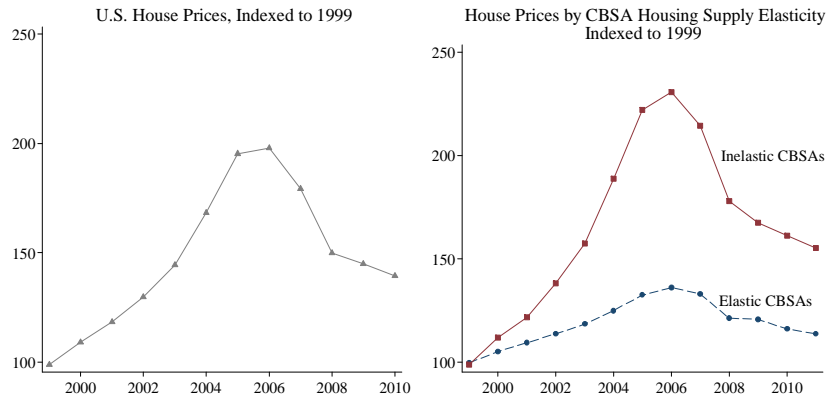
2. How to measure cash on hand?

- Adjusted gross income, net worth, credit scores

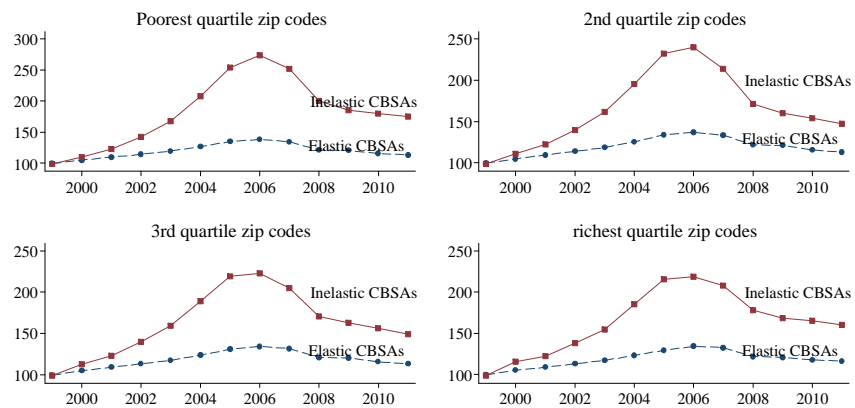
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# House Prices, First Stage

(Figure 1)



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## First Stage/Exclusion Restriction

(Table 2)

	(1)	(2)	(3)	(4)	(5)
	House price growth, 2002-2006	Home value change (\$000), 2002-2006	Wage growth shock 2002-2006	Wage growth shock, 2002-2006	Wage growth shock, 2002-2006
Housing supply inelasticity	0.673** (0.089)	86.720** (13.824)	0.001 (0.017)		0.009 (0.037)
Median home value, 2002 (\$000)		0.256** (0.048)			
AGI per household (\$000), 2002				0.647** (0.101)	0.925 (0.717)
Inelasticity*AGI per household					-0.370 (0.908)
Constant	-0.092 (0.048)	-48.574** (10.049)	-0.020 (0.012)	-0.052** (0.005)	-0.059* (0.027)
Observations	5,163	5,163	5,162	5,162	5,162
R-squared	0.310	0.484	0.000	0.038	0.039

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## IV Estimation

$$\Delta y_{zc} = \alpha^{IV} + \beta^{IV} * \Delta \widehat{HomeValue}_{zc} + \delta^{IV} * \Delta HomeValue_{zc} * \widehat{CashonHand}_{z,2002} + \gamma^{IV} CashonHand_{z,2002} + \epsilon_{zc}$$

$$\begin{aligned} \Delta HomeValue_{zc} &= \omega + \eta * Inelasticity_c + \theta * Inelasticity_c * CashonHand_{z,2002} + \vartheta * CashonHand_{z,2002} + \epsilon_{zc} \end{aligned}$$

$$\begin{aligned} \Delta HomeValue_{zc} * CashonHand_{z,2002} &= \psi + \iota * Inelasticity_c + \kappa * Inelasticity_c * CashonHand_{z,2002} + \lambda * CashonHand_{z,2002} + \zeta_{zc} \end{aligned}$$

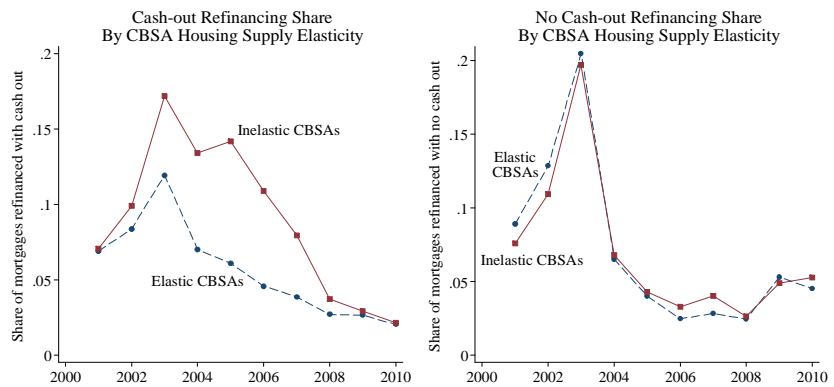
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# Results: Marginal Propensity to Borrow

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## Cash-out Refinancing

(Figure 2)



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### House Price Growth and Cash-Out Refi Share

(Table 4)

	(1)	(2)	(3)	(4)	(5)	(6)
	Change in cash-out refinancing share, 2002 to 2006					
	OLS	OLS	OLS	IV	IV	IV
House price growth, 2002-2006	0.142** (0.010)	0.178** (0.017)	0.152** (0.012)	0.128** (0.012)	0.192** (0.026)	0.177** (0.014)
(HP growth, 02-06)*(AGI, 2002)		-0.854** (0.268)			-1.281* (0.529)	
AGI per household (\$ millions), 2002		-0.041 (0.105)			0.116 (0.151)	
(HP growth, 02-06)*(\$35K < AGI < \$50K)			-0.009 (0.010)			-0.035** (0.013)
(HP growth, 02-06)*(\$50K < AGI < \$100K)			-0.038* (0.015)			-0.102** (0.021)
(HP growth, 02-06)*(AGI > \$100K)			-0.092** (0.019)			-0.164** (0.043)
\$35K < AGI < \$50K			-0.006* (0.003)			0.004 (0.004)
\$50K < AGI < \$100K			-0.009 (0.005)			0.014* (0.006)
AGI > \$100K			-0.004 (0.008)			0.023 (0.013)
Constant	-0.028** (0.003)	-0.024** (0.006)	-0.020** (0.004)	-0.023** (0.004)	-0.029** (0.007)	-0.030** (0.004)
Observations	5,163	5,163	5,163	5,163	5,163	5,163
R-squared	0.526	0.579	0.587	0.520	0.577	0.571

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### Home Value Changes and Cash-Out Refi Share

(Table 5)

	(1)	(2)	(3)	(4)	(5)	(6)
	Change in cash-out refinancing share, 2002 to 2006					
	OLS	OLS	OLS	IV	IV	IV
Home value change (\$000), 2002-2006	0.0006** (0.0001)	0.0007** (0.0001)	0.0011** (0.0001)	0.0014** (0.0002)	0.0014** (0.0001)	0.0017** (0.0002)
(HV change, 02-06)*(AGI, 2002)		-0.0024** (0.0006)			-0.0064** (0.0023)	
AGI per household (\$ millions), 2002		-0.2944** (0.1026)			0.2048 (0.2038)	
(HV change, 02-06)*(\$35K < AGI < \$50K)			0.0001** (0.0001)			0.0006** (0.0001)
(HV change, 02-06)*(\$50K < AGI < \$100K)			0.0007** (0.0001)			0.0017** (0.0001)
(HV change, 02-06)*(AGI > \$100K)			0.0010** (0.0001)			0.0012** (0.0001)
\$35K < AGI < \$50K			-0.0104** (0.0030)			0.0027 (0.0028)
\$50K < AGI < \$100K			-0.0068 (0.0045)			0.0120** (0.0042)
AGI > \$100K			0.0192* (0.0077)			0.0207 (0.0194)
Median home value, 2002	-0.0002** (0.0000)	-0.0001** (0.0000)	-0.0001** (0.0000)	-0.0005** (0.0001)	-0.0003** (0.0000)	-0.0002** (0.0000)
Constant	0.0306** (0.0051)	0.0292** (0.0067)	0.0168** (0.0039)	0.0317** (0.0088)	0.0057 (0.0080)	0.0065 (0.0036)
Observations	5,163	5,163	5,163	5,163	5,163	5,163
R-squared	0.301	0.387	0.517		0.163	0.405

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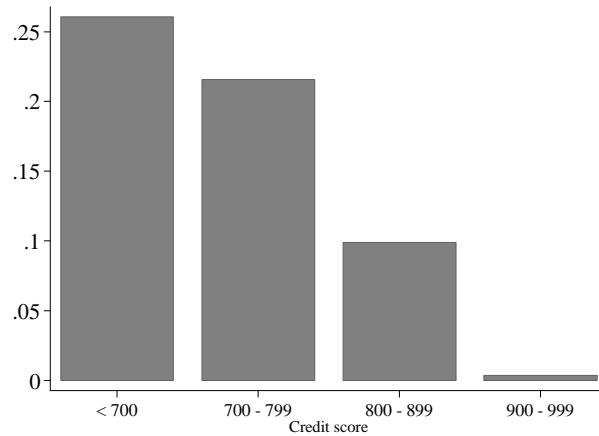
## Individual Level Data

- Sample of 60,000 homeowners for which we have debt outstanding and credit scores
- We match to zip-code level house prices to get right hand side variable – allows us to estimate marginal propensity to borrow for homeowners
- Cash-on-hand sorting variable: individual-level credit scores because zip-code level income is not as accurate for individuals

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## Marginal Propensity to Borrow out of \$1 Increase in Home Equity

(Figure 3)



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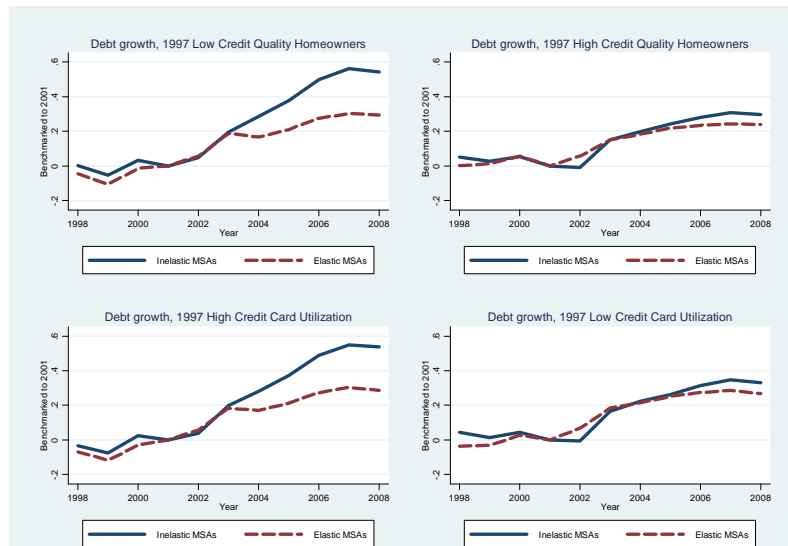
# Marginal Propensity to Borrow

(Table 6)

	(1)	(2)	(3)	(4)	(5)	(6)
	Change in total debt (\$000), 2002 to 2006					
	OLS	OLS	OLS	IV	IV	IV
Home value change (\$000), 2002-2006	0.088** (0.023)	0.143** (0.042)	0.575** (0.156)	0.188** (0.049)	0.206** (0.053)	0.797** (0.168)
(HV change, 02-06)*(AGI, 2002)		-0.971* (0.417)			-1.014 (0.664)	
AGI per household (\$ millions), 2002		2.827 (94.207)			96.155 (113.301)	
(HV change, 02-06)*(Credit score, 1997)			-0.063** (0.018)			-0.082** (0.018)
Credit score (divided by 100), 1997			-3.513 (2.079)			-0.490 (1.906)
Median home value, 2002	0.120** (0.012)	0.159** (0.025)	0.161** (0.013)	0.063* (0.026)	0.112* (0.053)	0.122** (0.024)
Constant	13.338** (3.168)	4.976 (4.710)	33.765 (18.617)	12.209** (3.981)	1.947 (6.337)	8.700 (17.012)
Observations	60,856	60,856	60,856	60,856	60,856	60,856
R-squared	0.012	0.012	0.016	0.010	0.012	0.016

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## Home Equity-Based Borrowing Channel By Credit Score, Credit Card Utilization





# MPC on New Autos

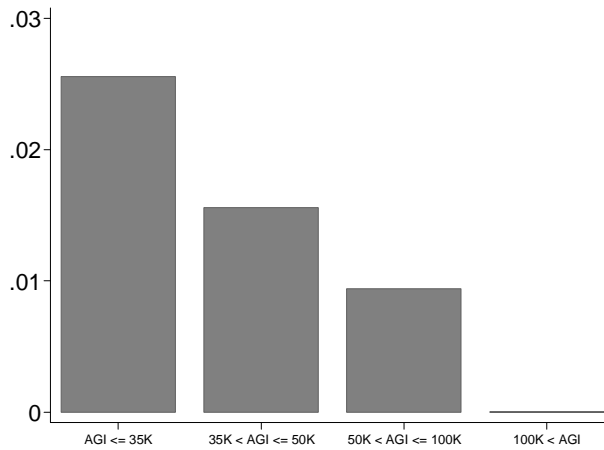
(Table 7)

	(1)	(2)	(3)	(4)	(5)	(6)
	Change in New Auto Purchases (\$000), 2002 - 2006					
	OLS	OLS	OLS	IV	IV	IV
Home value change (\$000), 2002-2006	0.016** (0.003)	0.022** (0.003)	0.025** (0.005)	0.017** (0.005)	0.027** (0.007)	0.026** (0.008)
(HV change, 02-06)*(AGI, 2002)		-0.082** (0.016)			-0.177** (0.051)	
AGI per household (\$ millions), 2002		13.219** (3.366)			23.890** (6.693)	
(HV change, 02-06)*(\$35K < AGI < \$50K)			-0.005 (0.004)			-0.010 (0.006)
(HV change, 02-06)*(\$50K < AGI < \$100K)			-0.010* (0.004)			-0.016* (0.007)
(HV change, 02-06)*(AGI > \$100K)			-0.017** (0.005)			-0.026** (0.009)
\$35K < AGI < \$50K			0.093 (0.191)			0.264 (0.239)
\$50K < AGI < \$100K			0.442 (0.254)			0.685* (0.305)
AGI > \$100K			1.893** (0.413)			2.417** (0.746)
Median home value, 2002	-0.004** (0.001)	-0.005** (0.001)	-0.005** (0.001)	-0.005** (0.002)	-0.005* (0.002)	-0.003 (0.002)
Constant	0.762** (0.143)	0.204 (0.180)	0.507* (0.195)	0.764** (0.135)	-0.345 (0.278)	0.291 (0.205)
Observations	5,163	5,163	5,163	5,163	5,163	5,163
R-squared	0.043	0.049	0.051	0.043	0.041	0.046

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## Marginal Propensity to Spend out of \$1 Increase in Home Equity

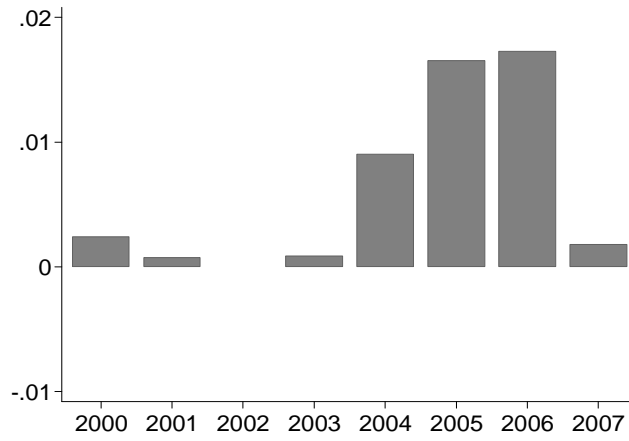
(Figure 4)



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## Marginal Propensity to Spend on New Autos, by Year

(Figure 5)



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## Quantification

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## Total MPC Using New Autos MPC

- MRS (2013): Total MPC 2006 to 2009 out of housing: \$0.054; on autos: \$0.024
- Apply this ratio to 2003 to 2006 cumulative effect

$$\$0.044 * \left( \frac{0.054}{0.024} \right) = \$0.099$$

- Homeownership is 63%, implies MPC of \$0.16 for homeowners – if MPC negative for renters, get close to \$0.19 for homeowners

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## Aggregate Effect

- Use four income categories in tables, calculate total spending effect for each income category

$$\sum_z (\beta_I^{IV} * \Delta HV_{z,I} * Pop_{z,I})$$

- Add across income categories, divide by 55.4%, (fraction of total spending in sample zips)
- Cumulative 02-06 effect: \$461B; 0.08% of GDP in 2003, 0.8% in 2004, 1.3% in 2005 and 2006

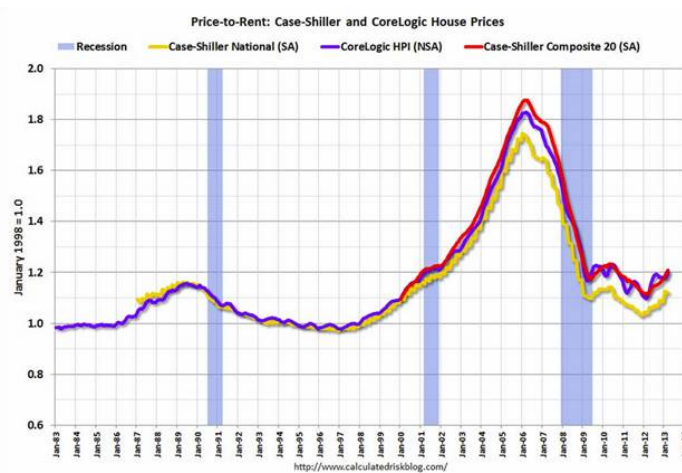
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## More on Aggregate Calculation

- Our estimation used variation in house prices that was *orthogonal* to permanent income shocks
- Our aggregate calculation implicitly assumes entire 2002 – 2006 house price boom was also *orthogonal* to fundamentals
- Was house price growth from 2002 to 2006 a “bubble” that was unrelated to fundamentals?

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## House Prices and Fundamentals?

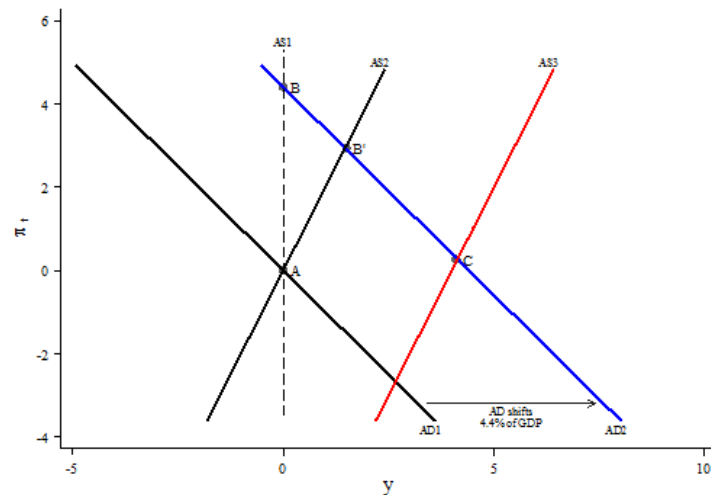


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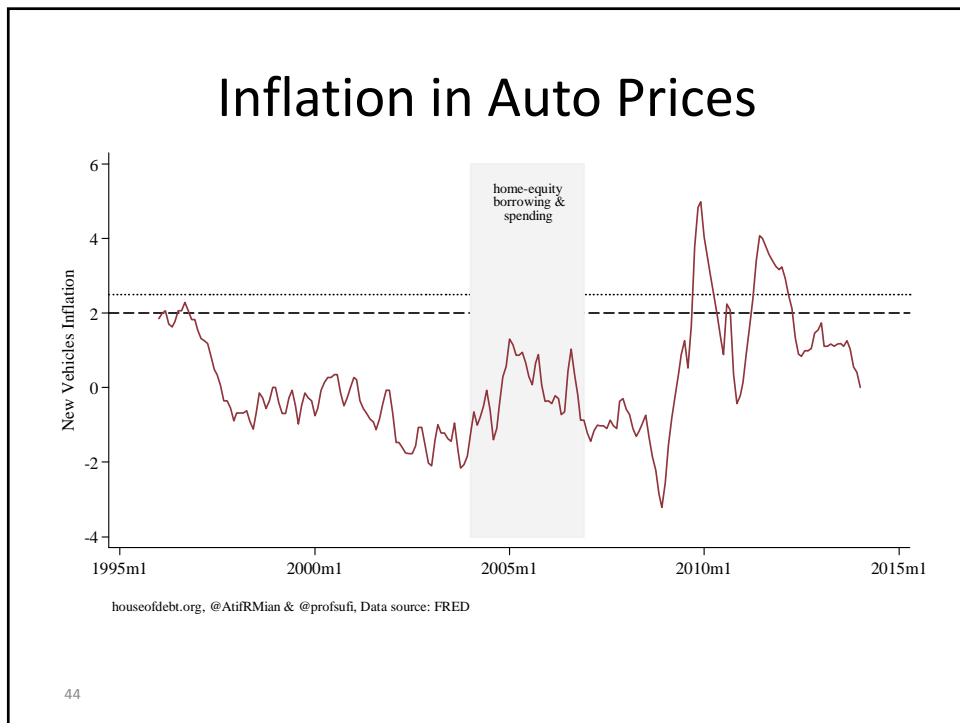
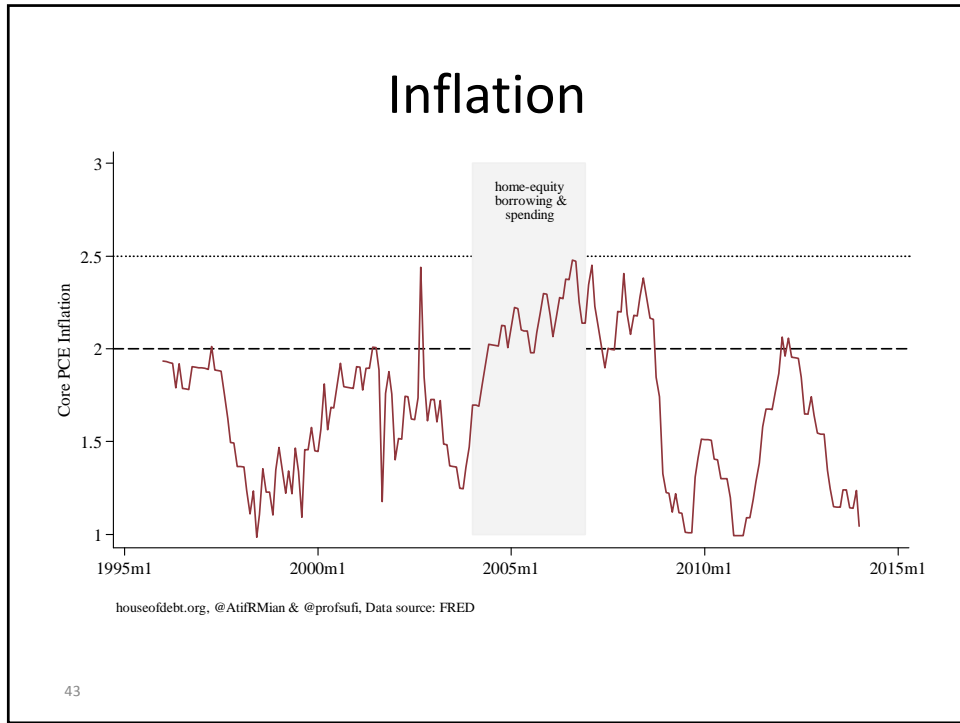
## General Equilibrium

- This completely ignores general equilibrium effects, which would likely include higher prices
- But we see very little inflation from 2002 to 2006, and in fact we see disinflation in new auto prices → house-price driven spending did not pressure capacity of economy
- We also see permanent decline in retail sales from 2007 to 2013 → **Secular stagnation?**

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# Retail Spending

U.S. Retail Sales  
We are not catching up!

