Speculative bubbles

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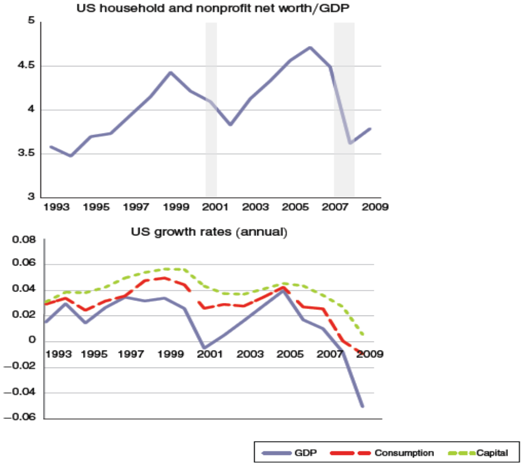
Motivation


US household and nonprofit net worth/GDP
5
4.5
4
3.5
3
1993
1995
1997
1999
2001
2003
2005
2007
2009
US growth rates (annual)
0.08
0.06
0.04
0.02
0
−0.02
−0.04
−0.06
GDP
Consumption
Capital

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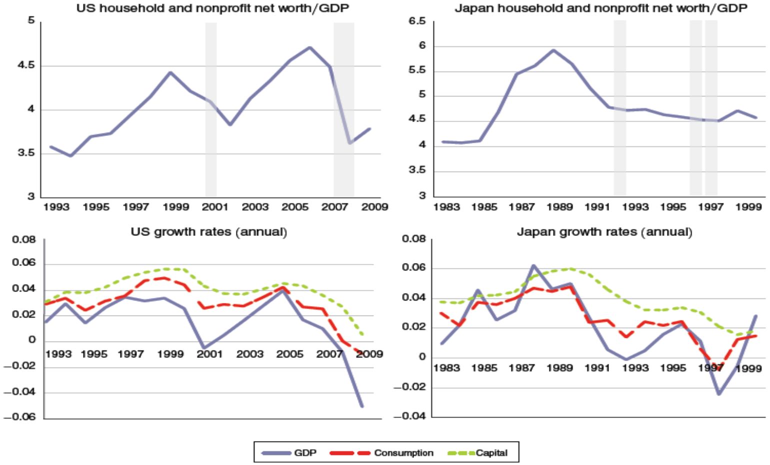

US household and nonprofit net worth/GDP
5
4.5
4
3.5
3
1993 1995 1997 1999 2001 2003 2005 2007 2009
Japan household and nonprofit net worth/GDP
6.5
6
5.5
5
4.5
4
3.5
3
1983 1985 1987 1989 1991 1993 1995 1997 1999
US growth rates (annual)
0.08
0.06
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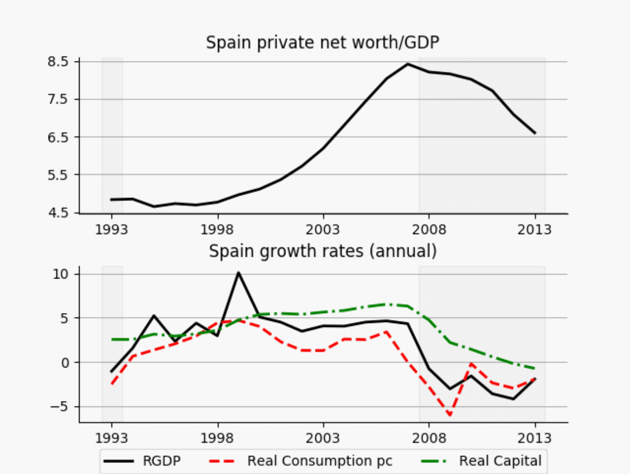
Motivation



Spain private net worth/GDP
8.5
7.5
6.5
5.5
4.5
1993
1998
2003
2008
2013
Spain growth rates (annual)
10
5
0
−5
1993
1998
2003
2008
2013
RGDP
Real Consumption pc
Real Capital

A model of asset prices

- Assumptions
  - Time is a sequence of dates $t = 0, 1, 2, ...$
  - There is a market with traders willing to borrow and lend at the expected return of $1 + r$ per period
- Question
  - What is the price of an asset that pays a sequence of dividends: d_0, d_1, ...
  - Assume that the asset is traded only in date zero

A model of asset prices

- What future payments does the asset promise?

$$d_{1,} d_2, ..., d_n, ...$$

- What is the expected value of these future payments?

$$E_0 d_{1,} E_0 d_2, ..., E_0 d_n, ...$$

A model of asset prices

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- What is the expected value of these future payments?

$$E_0 d_{1,} E_0 d_2, ..., E_0 d_n, ...$$

- How much are traders willing to pay today for these future payments?

$$\frac{E_0 d_1}{1+r}, \frac{E_0 d_2}{(1+r)^2}, ..., \frac{E_0 d_n}{(1+r)^n}, ...$$

Market equilibrium

- Let x_n be today's value of payment at time n. Then,

$$x_1 \cdot (1 + r) = E_0 d_1 \Rightarrow x_1 = \frac{E_0 d_1}{1 + r}$$

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$$\vdots$$

$$x_n \cdot (1+r) \cdot (1+r) ... (1+r) = E_0 d_n \Rightarrow x_n = \frac{E_0 d_n}{(1+r)^n}$$

A model of asset prices

- How much are traders willing to pay today for these future payments?

$$\frac{E_0 d_1}{1+r}, \frac{E_0 d_2}{(1+r)^2}, ..., \frac{E_0 d_n}{(1+r)^n}, \dots$$

- How much are traders willing to pay for the asset?

$$\frac{E_0 d_1}{1+r} + \frac{E_0 d_2}{(1+r)^2} + ... + \frac{E_0 d_n}{(1+r)^n}, \dots$$

- Thus, the price of the asset is

$$p_0 = \sum_{t=1}^{\infty} \frac{E_0 d_t}{(1+r)^t}$$

- Note: asset prices are high when
  - expected payments are high
  - interest rates are low

Stocks: the Dotcom boom (late 90s)

- Assume dividends reflect corporate earnings
- Price of stocks should follow corporate earnings

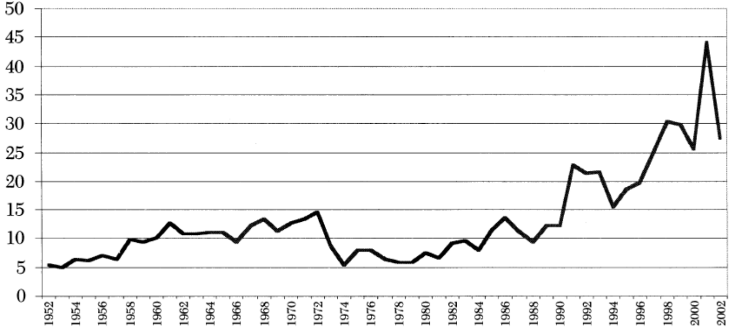
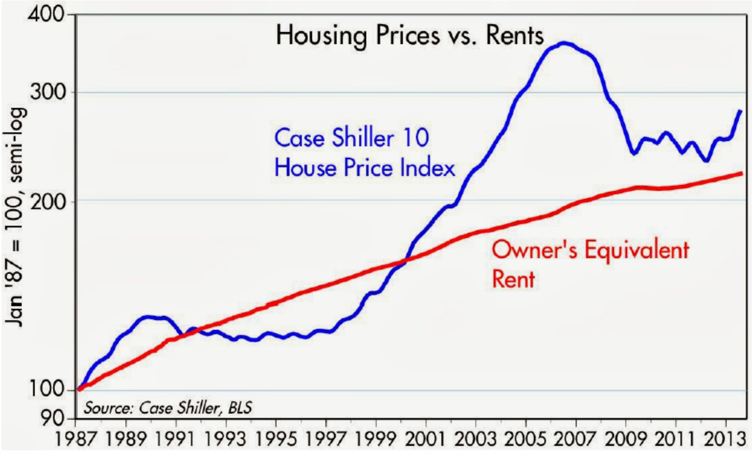


Figure 2. Equity Value/Corporate Earnings

Housing: the bubble (early 00's)



Modifying our model of asset prices

- We have assumed so far that the asset is traded only at time 0
- Assume from now on that the asset is traded in all periods
- Can the ability to resell the asset modify its value?

New market equilibrium

- Let p_n be the price of the asset in date n. Then:

$$p_0 \cdot (1+r) = E_0 d_1 + E_0 p_1 \Rightarrow p_0 = \frac{E_0 d_1}{1+r} + \frac{E_0 p_1}{1+r}$$

$$E_0 p_1 \cdot (1+r) = E_0 d_2 + E_0 p_2 \Rightarrow p_0 = \frac{E_0 d_1}{1+r} + \frac{E_0 d_2}{(1+r)^2} + \frac{E_0 p_2}{(1+r)^2}$$

$$\vdots$$

$$\begin{aligned} E_0 p_n \cdot (1+r) &= E_0 d_{n+1} + E_0 p_{n+1} \Rightarrow \\ p_0 &= \frac{E_0 d_1}{1+r} + \frac{E_0 d_2}{(1+r)^2} + \ldots + \frac{E_0 d_n}{(1+r)^n} + \frac{E_0 p_n}{(1+r)^n} \end{aligned}$$

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- Iterating forever....

$$p_0 = \sum_{t=1}^{\infty} \frac{E_0 d_t}{(1+r)^t} + \lim_{t \to \infty} \frac{E_0 p_n}{(1+r)^n}$$

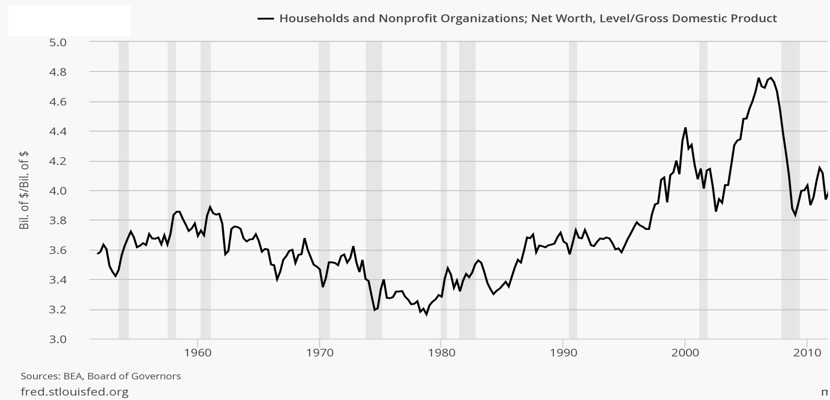
New market equilibrium

- Iterating forward:

$$p_0 = \underbrace{\sum_{t=1}^{\infty} \frac{E_0 d_t}{(1+r)^t}}_{\text{fundamental}} + \underbrace{\lim_{t\to\infty} \frac{E_0 p_n}{(1+r)^n}}_{\text{bubble}}$$

- Asset prices have a fundamental and a bubble component.
- The bubble component is a pyramid scheme.
- Perhaps market psychology (self-fulfilling expectations) plays a crucial role in asset price fluctuations.

Calculating fundamental and bubble components



Calculating fundamental and bubble components

1. Estimate the cash-flows that US productive assets generate as capital income, net of taxes and investment

2. Compute the expected present discounted value of these cash-flows by assuming:

    1. The interest rate is constant for all time horizons (equal to the 1950-2010 period average);
    2. Out-of-sample cash-flows grow at a constant rate (equal to the 1950–2010 period average), and resort to perfect foresight for within-sample cash-flows.

Calculating fundamental and bubbly components

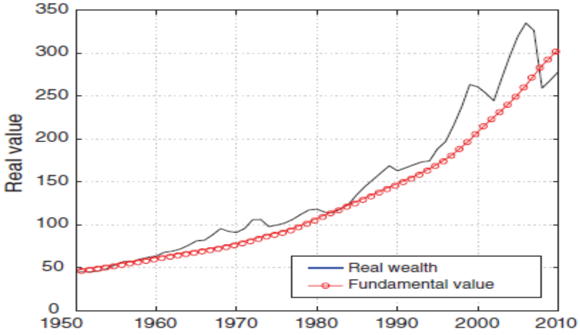


FIGURE 1. REAL VALUE OF US WEALTH AND ITS FUNDAMENTAL VALUE, 1950–2010

- Results:
  1. Up until the early 1990s wealth remained remarkably close to its fundamental
  2. The boom-and-bust episodes of the 1990s and 2000s are driven by bubbles

A simple macroeconomic model of bubbles

- **Warning:** no useful models without simplification!

- En aquel imperio, el arte de la cartografía logró tal perfección que el mapa de una sola provincia ocupaba toda una ciudad, y el mapa del imperio, toda una provincia. Con el tiempo, estos mapas desmesurados no satisficieron y los colegios de cartógrafos levantaron un mapa del imperio, que tenía el tamaño del imperio y coincidía puntualmente con él. Menos adictas al estudio de la cartografía, las generaciones siguientes entendieron que ese dilatado mapa era inútil y no sin impiedad lo entregaron a las inclemencias del sol y los inviernos. En los Desiertos del Oeste perduran despedazadas ruinas del mapa, habitadas por animales y por mendigos; en todo el país no hay otra reliquia de las disciplinas geográficas.

Del Rigor en la Ciencia, J.L. Borges

A simple macroeconomic model of bubbles

- Overlapping-generation economy:
  - Time is discrete: $t = 0, 1, 2, 3, ...,$
  - In each period, a new generation is born: constant size
  - Agents live for two periods: youth and old age
- Preferences: agents care only about old-age consumption, i.e.,

$$U_t = c_{t,t+1}$$

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$$\pi_{t+1}^L = (1 + \gamma) \cdot \pi_t^L$$

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- Investment technology: constant return per unit of investment

$$\pi_{t+1}^K = \pi^K$$

A simple macroeconomic model of bubbles

- We know that

$$U_t = c_{t,t+1} = \pi_t^L \cdot (1 + r_t)$$

  - But what is r_t?

A simple macroeconomic model of bubbles

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  - But what is r_t?

- **First answer:** since trade between generations is impossible, agents trade only with "mother nature"
  - Invest all labor income in investment technology ($r_t = \pi^K$ for all t)

$$U_t = c_{t,t+1} = \pi_t^L \cdot (1 + \pi^K)$$

Surprise, surprise

- **Surprise #1:** competitive equilibrium is not Pareto optimal (PO)!
  - Social contract: work for your parents, and your children work for you

$$U_t = c_{t,t+1} = \pi^L_{t+1} = \pi^L_t \cdot (1+\gamma)$$

  - If $\gamma > \pi^K$, everyone is better off!
  - Economy is dynamically inefficient

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  - If $\gamma > \pi^K$, everyone is better off!
  - Economy is dynamically inefficient
- **Surprise #2:** there are competitive equilibria in which agents value a useless piece of paper
  - Such equilibria can restore Pareto optimality!

Sketch of the argument

- Suppose there is a useless asset Q_t. In equilibrium, its price must follow:

$$B_{t+1} = (1 + r_t) \cdot B_t$$

- Define $b_t = \frac{B_t}{\pi_t^L}$. Then,

$$b_{t+1} = \frac{1 + r_t}{1 + \gamma} \cdot b_t$$

- But what is r_t?

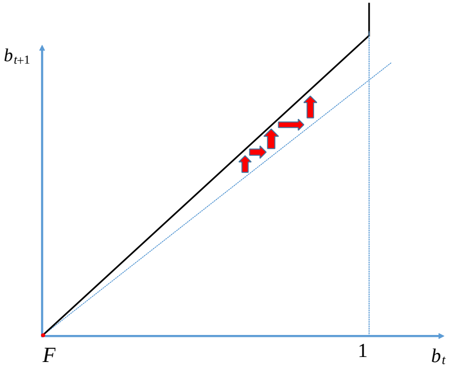
$$r_t \begin{cases} = \pi^K & \text{if } b_t < 1 \\ \in \left[\pi^K, \infty\right) & \text{if } b_t = 1 \end{cases}$$

Are bubbly equilibria possible?

- Remember:

$$b_{t+1} = \frac{1 + r_t}{1 + \gamma} \cdot b_t$$

  - If $\pi^K > \gamma$, the only possible equilibrium is $b_t = 0$ for all t
  - If $b_t > 0$ for any t, then it must grow explosively!

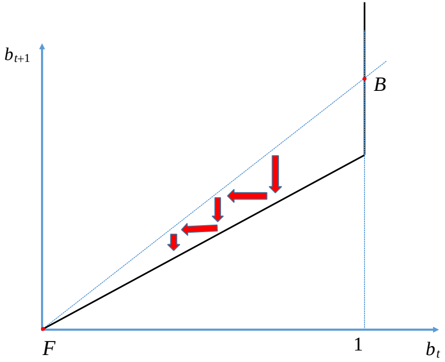


Are bubbly equilibria possible?

- Remember:

$$b_{t+1} = \frac{1 + r_t}{1 + \gamma} \cdot b_t$$

  - If $\pi^K < \gamma$, there are now two stationary equilibria, F $(b = 0)$ and B $(b > 0)$
  - There is also a sequence of non-stationary bubbly equilibria



Insights

- Simple, elegant, theory:
  - Bubbles possible in low interest rate environments
  - Bubbles eliminate inefficient investments (crowding-out effect)
  - Bubbles driven by market psychology
- What is the bubbly asset?
  - Money
  - Stocks
  - Real estate
  - Government debt
- Basic idea easily generalizable
  - Richer environments
  - Bubble creation (wealth effect)
  - Bubble attached to certain investments (subsidy effect)

Problems

- Bubbles absorb savings and reduce investment (CROWDING-OUT EFFECT)
  - Are bubbles contractionary?
- Is the economy dynamically inefficient?

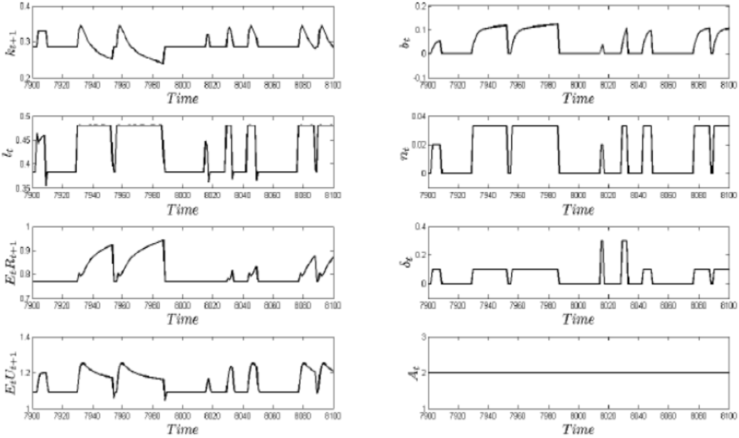
A simple twist

- In baseline model, everyone can invest: $r_t = \pi^K$
  - Suppose only subset of agents know how to invest
- Add financial frictions
  - Limited borrowing ($r_t < \pi^K$)
- Implications:
  - Bubbles can arise even if economy dynamically efficient
  - Bubbles can be expansionary: help intermediate resources
    - Provide liquidity (Caballero-Krishnamurthy 2007, Farhi-Tirole 2012)
    - Provide collateral (Martin-Ventura 2011, 2012)
    - Reduce the cost of capital (Ventura 2011)

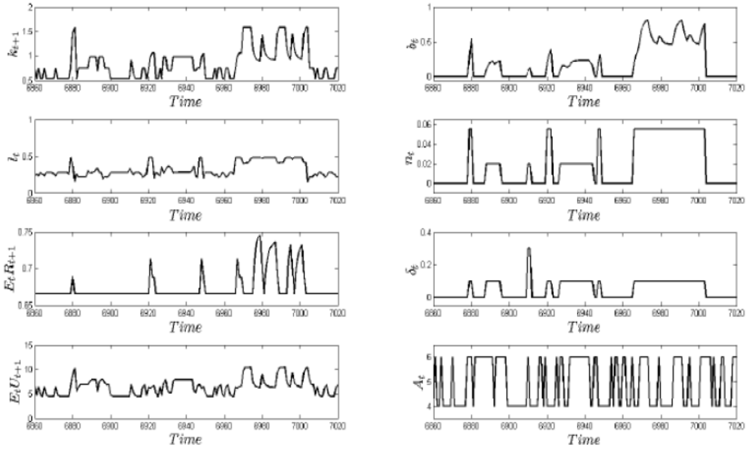
The Martin-Ventura model

- Effects of bubbles on investment
  - Sufficient collateral: CROWDING-OUT EFFECT
  - Insufficient collateral: CROWDING-IN EFFECT
- Which effect dominates:
  - If bubble is not too large: expansionary effect
  - Once bubble is too large: contractionary effect

Simulated economy: no productivity shocks



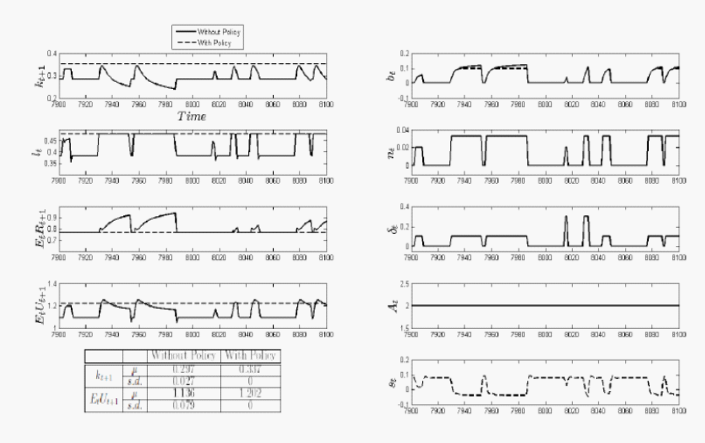
Simulated economy: productivity shocks



Implications for policy

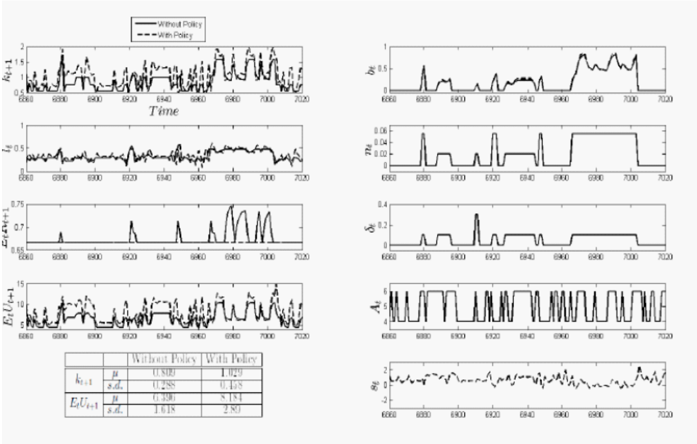
- Bubble is sometimes too large and sometimes too small
- There is no market mechanism that guarantees the optimal bubble
  - Market psychology capricious
- Governments should tax/subsidize credit when bubble is too large/small
- This policy raises welfare and has no fiscal cost

Simulated economy: no productivity shocks and policy



		Without Policy	With Policy
k_{t+1}	μ	0.297	0.337
	$s.d.$	0.027	0
$E_t U_{t+1}$	μ	1.136	1.202
	$s.d.$	0.079	0

Simulated economy: productivity shocks and policy



		Without Policy	With Policy
k_{t+1}	μ	0.809	1.029
	$s.d.$	0.288	0.458
E_tU_{t+1}	μ	6.396	8.184
	$s.d.$	1.618	2.89

The macroeconomic theory of bubbles: implications

- Origin and effects of business cycles
- Political economy of reforms
- Effects of financial globalization
- Effects of government debt

The macroeconomic theory of bubbles: key questions

- Identifying bubbles in data
- Measuring / selecting market psychology

What have we learned?

- Asset prices have fundamental and bubbly components
- Rationality restricts the behavior of the bubble, but does not pin it down
- Market psychology and multiple equilibria play a key role
- Theory-based measure bubbles
- Bubbles have important macroeconomic effects

United States: Household Net Worth / GDP