Money Illusion and Housing Frenzies

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Money illusion
U.K. evidence
Cross-country evidence

House prices in different countries

- dramatic boom-to-bust episodes, forecastable (Case-Shiller)
- Focus: Role of inflation

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Decision: Monthly rent versus monthly mortgage payments

⇒ Example of money/inflation illusion
- decline in inflation ⇒ decline in nominal interest rate $i$
- ⇒ monthly payments decline
- ⇒ larger mortgage ⇒ higher house prices

BUT

⇒ future mortgage payments are larger in real terms
  (mortgage is not inflated away.)
Mortgages, money illusion and house prices

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Outline

1 Money illusion - Related literature

2 U.K. evidence
   - Real versus nominal - A first-cut
   - Decomposing inflation effects
   - Financial frictions

3 Cross-country evidence
   - U.S. evidence

4 Conclusion
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“An economic theorist can, of course, commit no greater crime than to assume money illusion.” Tobin (1972)

- **Money Illusion:**
  Patinkin (1965), Leontief (1936), Fisher (1928)
  
  “That shirt I sold you will cost me just as much to replace as I am charging you [...] But I have made a profit on that shirt because I bought it for less.”

- Recent survey evidence:
  Shiller (1997a), (1997b)

- Related Psychological Biases:
  Shafir, Diamond, Tversky (1997), Genesove-Mayer (2001), ...

- Stock market:
Money illusion - Related literature

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Stage 1: Focus on price-rent ratio \( (P_t/L_t) \)
- abstracts from movements of fundamentals that affect prices and rents symmetrically (demographics, land cost etc.)
- not perfect substitutes: pride of ownership, ...

Stage 2: Decompose price-rent ratio in
- expected return (incl. risk premium)
- expected rent growth rate
- "mispricing"

Inflation effect on each part

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Decomposing price movements

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Money Illusion and Housing Frenzies by Brunnermeier and Julliard (2005)
A first cut

PV of permanent service flow

\[
P_t/L_t = E_t \left[ \sum_{\tau=t+1}^{\infty} \frac{1}{(1 + r_{\tau})^{\tau-t-1}} \right] \approx \frac{1}{r_t}
\]

with money illusion

\[
P_t/L_t = \tilde{E}_t \left[ \sum_{\tau=t+1}^{\infty} \frac{1}{(1 + r_{\tau})^{\tau-t-1}} \right] \approx E_t \left[ \sum_{\tau=t+1}^{\infty} \frac{1}{(1 + i_{\tau})^{\tau-t-1}} \right] \approx \frac{1}{i_t}
\]

- Regress \( P_t/L_t \) separately on \( 1/r_t, 1/i_t, \) and \( \pi_t \).
A first cut

PV of permanent service flow \[= L + \frac{L}{1+r} + \frac{L}{(1+r)^2} + \ldots \]

\[\frac{P_t}{L_t} = E_t \left[ \sum_{\tau=t+1}^{\infty} \frac{1}{(1 + r_\tau)^{\tau-t-1}} \right] \approx \frac{1}{r_t} \]

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- Regress \( P_t/L_t \) separately on \( 1/r_t \), \( 1/i_t \), and \( \pi_t \).
Forecasting regressions

- Regress $P_t/L_t$ separately on $1/r_t$, $1/i_t$, and $\pi_t$.
- Persistence of $P_t/L_t$ and regressors might lead to spurious results.
- Regress forecasts error on $1/r$, $1/i$, and $\pi$.

\[ \hat{\delta}_{t+1,t+1-s} = \begin{cases} 
  \frac{P_{t+1}}{L_{t+1}} & \text{for } s = 0 \\
  \frac{P_{t+1}}{L_{t+1}} - \hat{E}_{t-s} [\frac{P_{t+1}}{L_{t+1}}] & \text{for } s > 0 
\end{cases} \]

where $\hat{E}_{t-s} [P_t/L_t]$ reduced form VAR for $P_t/L_t$, log gross return, $r_{h,t}$, the rent growth rate $\Delta l_t$ and the log real interest rate, $r_t$. 

Brunnermeier and Julliard (2005) Money Illusion and Housing Frenzies
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Figure 3: \( t \)-statistics and \( R^2 \) of univariate regressions of the forecast error \( \hat{\delta}_{t+1,t+1-\tau} \) on interest rates and interest rate reciprocals (both nominal and real) as well as inflation.
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Decomposing inflation effects
Financial frictions

Price-rent ratio and TIPS implied real interest rates

(standardized series)

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Inflation and predictable component

- Case-Shiller (1989) house price changes are predictable ⇒ inefficiency?
- What explains variation of changes in price-rent ratio?
  - lagged inflation and nominal interest rates explains 6 to 10 percent (significant regressors, consistent with money illusion)
  - real interest rate has no predictive power
- Is inflation in pricing kernel/rent growth predictions for other reasons? (risk-premium, growth prediction, frictions)
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Decomposing inflation effects

\[ R_{h,t+1} = \frac{P_{t+1} + L_{t+1}}{P_t} \]

- Log-linearize around steady state and iterate

\[
p_t - l_t = \lim_{T \to \infty} \left[ \sum_{\tau=1}^{T-1} \rho^{\tau-1} (\Delta l_{t+\tau} - r_{h,t+\tau}) + \rho^T (p_{t+T} - l_{t+T}) \right].
\]

- Note if \( p_t \) is distorted, then so are all realized \( r_{h,t+\tau} \)
- Subtract \( r^f \) to obtain excess \( \Delta l^e \) and excess returns \( r^e \)
- Take expectations: \( E \) (objective), \( \tilde{E} \) (subjective)
Construction of $\psi$-Mispricing

- Taking expectations and assuming that TVCs hold

$$ p_t - l_t = \sum_{\tau=1}^{\infty} \rho^{\tau-1} E_t \left[ \Delta l_{t+\tau}^e \right] - \sum_{\tau=1}^{\infty} \rho^{\tau-1} E_t \left[ r_{h,t+\tau}^e \right] $$
  - rational traders

$$ = \sum_{\tau=1}^{\infty} \rho^{\tau-1} \tilde{E}_t \left[ \Delta l_{t+\tau}^e \right] - \sum_{\tau=1}^{\infty} \rho^{\tau-1} \tilde{E}_t \left[ r_{h,t+\tau}^e \right] $$
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- Hence,

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$$ + \left( \sum_{\tau=1}^{\infty} \rho^{\tau-1} \tilde{E}_t \left[ \Delta l_{t+\tau}^e \right] - \sum_{\tau=1}^{\infty} \rho^{\tau-1} E_t \left[ \Delta l_{t+\tau}^e \right] \right) $$

$\psi_t$-Mispricing measure

$$ \psi_t := \sum_{\tau=1}^{\infty} \rho^{\tau-1} \left( \tilde{E}_t - E_t \right) \left[ \Delta l_{t+\tau}^e \right] $$

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- Problem: How to construct a proxy for $\tilde{E}_t \left[ r_{h,t+\tau}^e \right]$  

  ⇒ use linear subjective risk factor $\lambda_t$

What is the correct risk factor $\lambda_t$?

1. GARCH-estimate of cond. volatility of long housing short $r^f$
2. Housing is like inflation-linked bond, but
   - probability of moving
     (migration, job creation/destruction data)
   - cross-sectional variation of house prices

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Problem: How to construct a proxy for $\tilde{E}_t \left[ r_{h,t+\tau}^e \right]$

Model $\tilde{E}_t \left[ r_{h,t+\tau}^e \right]$ as (and run OLS):

$$\sum_{\tau=1}^{\infty} \rho^{\tau-1} E_t \left[ r_{h,t+\tau}^e \right] = \alpha + \beta \lambda_t + \xi_t + \psi_t$$

$\Rightarrow$ obtain estimate for coefficients and $\hat{\psi}_t$.

Empirical strategy:

1. Obtain $\hat{E} \left[ \Delta l_{t+\tau}^e \right]$ from VAR and $\sum_{\tau=1}^{\infty} \rho^{\tau-1} E_t \left[ r_{h,t+\tau}^e \right]$

2. Add controls to remove $\xi_t$ [from OLS-residual ($\xi_t + \psi_t$)]
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  2. Add controls to remove $\xi_t$ [from OLS-residual ($\xi_t + \psi_t$)]
The different measures of mispricing

- $\psi$-mispricing measure depends on added controls for $\xi$.
  1. $\psi$ with controls (quarterly dummies, VAR(1)-forecast)
  2. $\psi'$ without controls

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\( \varepsilon_t \)-Mispricing measure (very conservative)

\[
\varepsilon_t := \sum_{\tau=1}^{\infty} \rho^{\tau-1} \left( \hat{E}_t - E_t \right) \left[ \Delta l_{t+\tau}^e - r_{h,t+\tau}^e \right] \\
+ \hat{E}_t \left[ \lim_{T \to \infty} \rho^T (p_{t+T} - l_{t+T}) \right]
\]

\[
p_t - l_t = \sum_{\tau=1}^{\infty} \rho^{\tau-1} E_t \left[ \Delta l_{t+\tau}^e - r_{h,t+\tau}^e \right] + E_t \left[ \lim_{T \to \infty} \rho^T (p_{t+T} - l_{t+T}) \right] =: \varepsilon_t
\]

- violation of the TVC under the objective measure
$\varepsilon$-Mispricing

- $\varepsilon$-Mispricing measure ($H_1 : \varepsilon = 0$)
  - non-neglectable
  - martingale property cannot be rejected
  - analysis holds in first differences

Figure 4: Price-rent ratio and mispricing measures

Fraction of the variation in the price-rent ratio. Third, as argued in the methodological section, the $\varepsilon$-mispricing measure seems to attribute a too large a fraction of the movements in the price-rent ratio to the mispricing.

Next, we analyze the explanatory power of the inflation illusion proxies for the $\varepsilon$-mispricing. Panel B of Table 1 shows that $^\varepsilon t$ – as inflation illusion would imply – covaries negatively (and significantly) with inflation $^t$. Similarly, the univariate regressions with nominal interest rate $i^t$ and $\log (1 + i^t)$ also deliver significant results consistent with money illusion. Overall, the explanatory power of the inflation illusion proxies is reduced for the $\varepsilon$-mispricing. This is not surprising, since $^\varepsilon t$ seems to overstate the time-variation of the mispricing.

3.2.3 Robustness Analysis

Assessing Uncertainty. To assess the robustness of these results, we next consider the uncertainty due to the fact that we do not directly observe expected future returns on housing and rent growth rates, but instead we use the estimated VAR to construct their proxies.

Under a diffuse prior, the posterior distribution of the estimated VAR can be factorized as the product of an inverse Wishart and, conditional on the covariance matrix, $20$.
## Empirical evidence

<table>
<thead>
<tr>
<th>Dependent Variables:</th>
<th>Regressors:</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\pi_t$</td>
<td>$i_t$</td>
</tr>
<tr>
<td>$\log (1/i_t)$</td>
<td></td>
</tr>
</tbody>
</table>

### Panel A

<table>
<thead>
<tr>
<th></th>
<th>coeff.</th>
<th>$R^2$</th>
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<th>$R^2$</th>
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<td>$-6.80$</td>
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<td>$\sum_{\tau=1}^{\infty} \rho^{\tau-1} \hat{E}<em>t \Delta l</em>{t+\tau}^e$</td>
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### Panel B

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<tbody>
<tr>
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<td>$-6.15$</td>
<td>.17</td>
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<td>(2.66)</td>
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<td>(2.82)</td>
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</tr>
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<td>$-6.3$</td>
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<td>$0.129$</td>
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<td>(7.946)</td>
<td></td>
<td>(6.927)</td>
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<td>(5.991)</td>
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Table 1: Univariate Regressions, Newey-West (1987) corrected $t$-statistics in brackets.
## Empirical evidence

<table>
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<td>( \hat{\psi}_t )</td>
<td>( -4.09 )</td>
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<tr>
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<tr>
<td>( \sum_{\tau=1}^{\infty} \rho^{\tau-1} \hat{E}<em>t \Delta l^{e}</em>{t+\tau} )</td>
<td>( -2.58 )</td>
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<tr>
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<td>( - \sum_{\tau=1}^{\infty} \rho^{\tau-1} \hat{E}<em>t r^{e}</em>{h,t+\tau} )</td>
<td>( 1.92 )</td>
</tr>
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<td>(1.066)</td>
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</table>

### Panel B

| \( \hat{\psi}'_t \) | \( -6.15 \) | .17 | \( -10.85 \) | .17 | \( .241 \) | .19 |
| (2.48) | | | (2.66) | | (2.82) | |
| \( \hat{\varepsilon}_t \) | \( -3.90 \) | .65 | \( -6.3 \) | .55 | \( .129 \) | .52 |
| (7.946) | | | (6.927) | | (5.991) | |

Table 1: Univariate Regressions, Newey-West (1987) corrected \( t \)-statistics in brackets.
### Table 1: Univariate Regressions, Newey-West (1987) corrected t-statistics in brackets.

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</tbody>
</table>
Robustness analysis - Methodology

Posterior of estimated VAR (under diffuse prior, sample size $n$ and $m$ parameters)

$$\beta | \Sigma \sim N \left( \hat{\beta}, \Sigma \otimes (X'X)^{-1} \right)$$

$$\Sigma^{-1} \sim \text{Wishart} \left( \left( n\hat{\Sigma} \right)^{-1}, n - m \right)$$

1. Draw covar-matrices $\hat{\Sigma}$ from inverse Wishart with $\hat{\Sigma}$, $n$ and $m$
2. Cond. on $\hat{\Sigma}$ draw VAR-coefficients $\hat{\beta} \sim N \left( \hat{\beta}, \hat{\Sigma} \otimes (X'X)^{-1} \right)$
3. Use $\hat{\beta}$ to construct $\sum_{\tau} \rho^{\tau-1} \hat{E}_t \Delta l_{t+\tau}^e$, $\sum_{\tau} \rho^{\tau-1} \hat{E}_t r_{h,t+\tau}^e$, and $\hat{\psi}_t$
4. Regress $\hat{\psi}_t$, $\sum_{\tau} \rho^{\tau-1} \hat{E}_t \Delta l_{t+\tau}^e$, $\sum_{\tau} \rho^{\tau-1} \hat{E}_t r_{h,t+\tau}^e$ on $\pi_t$, $i_t$, $1/i_t$
5. Iterate and compute confidence intervals for OLS coefficients and $R^2$ from their percentiles

Brunnermeier and Julliard (2005) Money Illusion and Housing Frenzies
Robustness analysis - Results

<table>
<thead>
<tr>
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<td>coeff.</td>
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<tr>
<td>$\hat{\psi}_t$</td>
<td>$-3.10$</td>
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<tr>
<td>$\Delta l$-terms</td>
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<tr>
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<td>$[-11.8, 9.08]$</td>
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<td>$-r$-terms</td>
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<td>$[-10.41, 9.61]$</td>
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<td>$[-11.1, -.19]$</td>
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Table 2: Median and 95 percent confidence intervals for slope coefficients and $R^2$. 

Brunnermeier and Julliard (2005) Money Illusion and Housing Frenzies
**Robustness analysis - Results**

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Table 2: Median and 95 percent confidence intervals for slope coefficients and $R^2$. 
1. Money illusion - Related literature

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   - Real versus nominal - A first-cut
   - Decomposing inflation effects
   - Financial frictions

3. Cross-country evidence
   - U.S. evidence

4. Conclusion
Tilt effect of inflation

- inflation tilts real mortgage repayment scheme

\[ \text{without inflation} \]
\[ \text{with inflation} \]

- can’t afford initial mortgage payments
- **BUT** more flexible mortgage schemes
  - Price level adjusted mortgage (PLAM)
  - Graduate payment mortgage (GPM)
  - Interest only mortgages

are available since 1970’s in UK and mortgages became more flexible over the years

**PREDICTION OF TILT EFFECT:**

- inflation effect less negative over time

Lessard-Modigliani + Tucker (1975)
Figure 6: Point estimates and 95 percent Newey and West (1987) corrected confidence bounds of slope coefficients as sample size increases.

- Tilt effect is unlikely to explain inflation effect.
Lock-in effect

- locked in low fixed nominal rate on existing mortgage
  ⇒ reluctant to buy better house if mortgage is not portable

PREDICTION OF LOCK-IN EFFECT

- for the full sample estimates

\[ \psi_t = \hat{a} + \hat{b}_1 d_t i_t + \hat{b}_2 (1 - d_t) i_t + \hat{e}_t \Rightarrow \hat{b}_1 \neq \hat{b}_2 \]

where \( d_t \) is an indicator function of upward movements in \( i_t \)

- for rolling samples estimates:
  - \( \text{Corr}[R^2, d_t] \neq 0 \)
  - \( \text{Corr}[R^2, i_t] \neq 0 \)
  - \( \text{Corr}[R^2, p_t - l_t] \neq 0 \)

- Can be rejected!

- Surprising? No, since most mortgages in the UK are portable (and flexible interest rate mortgages)
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Brunnermeier and Julliard (2005) Money Illusion and Housing Frenzies
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  \psi_t = \hat{a} + \hat{b}_1 d_t i_t + \hat{b}_2 (1 - d_t) i_t + \hat{e}_t \Rightarrow \hat{b}_1 \neq \hat{b}_2
  \]
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Brunnermeier and Julliard (2005) 
Money Illusion and Housing Frenzies
During booms (busts) high quality houses appreciate (de-) more than smaller houses
- house prices reflect all types of dwellings
- rent index tends to overweigh lower quality dwellings

⇒ Price-rent ratio might move over business cycle

Control for business cycle proxy
- $\hat{c}_t$ Hodrick-Prescott (1997) filter

Figure 5: U.K. business cycle and inflation measures (i) does not drive out the statistical significance of $t_t$, $i_t$ and $\log (1/i_t)$, (ii) does not significantly change the point estimates of the elasticities of the mispricing reported in Table 1, (iii) does not significantly increase our ability to explain the time variation in the mispricing, (iv) and that the business cycle alone has very little (in the case of $\hat{c}_t$ and $\hat{c}_0$) or no (in the case of $\hat{c}_0$) explanatory power for the mispricing measures.

3.3 Tilt Effect

Our empirical results are consistent with money illusion. Nevertheless, we could also be capturing the tilt effect of inflation. Recall from Section 3.1 that the reciprocal of the nominal interest rate, $1/i_t$, is proportional to the amount agents can borrow under a fixed nominal payment mortgage. Such a contract generates a financing constraint that varies with the nominal interest rate and hence with inflation. However, agents could use multiple alternative financing schemes available on the market, that are not affected by the tilt effect. This is for example the case for flexible interest rate mortgages, price level adjusted mortgages (PLAM) or the graduate payment mortgages.
### Mispricing measures and the business cycle

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<th>( i_t )</th>
<th>( \log(1/i) )</th>
<th>( R^2 )</th>
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<tr>
<td>(1)</td>
<td>( \hat{\psi}_t )</td>
<td>0.81 ( (1.959) )</td>
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<td>(2)</td>
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<td>0.32 ( (2.135) )</td>
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<tr>
<td>(3)</td>
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<td>0.378 ( (2.168) )</td>
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<td>-6.64 ( (11.137) )</td>
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<td>1.11 ( (0.963) )</td>
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<td>(6)</td>
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<td>0.36 ( (0.349) )</td>
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<td>(7)</td>
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<td>0.41 ( (0.369) )</td>
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<td>(9)</td>
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<td>0.85 ( (2.201) )</td>
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<td>0.07</td>
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<td>(10)</td>
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<td>0.41 ( (2.281) )</td>
<td>-3.80 ( (7.801) )</td>
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<tr>
<td>(11)</td>
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<td>0.49</td>
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<td>-6.10</td>
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<td>0.57</td>
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</table>

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4. Conclusion
## U.S. Decomposition of inflation effects

**Dependent Variables:**

<table>
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<tr>
<th></th>
<th>$\pi_t$</th>
<th>$i_t$</th>
<th>$\log(1/i_t)$</th>
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<tr>
<td>$\hat{\psi}_t$</td>
<td>-6.65</td>
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<td>(4.525)</td>
<td>(3.182)</td>
<td>(4.256)</td>
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<td>$\sum_{\tau=1}^{\infty} \rho^{\tau-1} \hat{E}<em>t \Delta l</em>{t+\tau}^e$</td>
<td>-2.87</td>
<td>0.65</td>
<td>0.066</td>
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<tr>
<td>(6.572)</td>
<td>(6.170)</td>
<td>(4.693)</td>
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<td>$- \sum_{\tau=1}^{\infty} \rho^{\tau-1} \tilde{E}<em>t r</em>{h,t,t+\tau}^e$</td>
<td>0.76</td>
<td>0.01</td>
<td>-0.066</td>
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<tr>
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Table 3: Univariate Regressions, Newey-West (1987) corrected $t$-statistics in brackets.
### U.S. Robustness analysis

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<td>$\hat{\epsilon}_t$</td>
<td>-10.2</td>
<td>.48</td>
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</table>

Table 4: Median and 95 percent confidence intervals for slope coefficients and $R^2$. 
Money Illusion arises if e.g. investors simply compare current rent with current mortgage payment

- Inflation affects house prices
- Rational channels alone do not explain inflation effects
  - Low inflation leads to higher expected rent growth
  - Inflation impact on expected housing returns is insignificant
  - Inflation explains substantial part of “mispricing”
- Frictions are unlikely to fully rationalize the empirical findings
  - Tilt effect should decline as mortgages became more flexible
  - Lock-in effect does not arise — mortgages are portable in UK

⇒ Evidence in favor of money illusion

Money illusion and mortgage markets have important implications for monetary economics

Brunnermeier and Julliard (2005) Money Illusion and Housing Frenzies
Money Illusion arises if e.g. investors simply compare current rent with current mortgage payment

Inflation affects house prices

Rational channels alone do not explain inflation effects
- Low inflation leads to higher expected rent growth
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First difference estimation

<table>
<thead>
<tr>
<th></th>
<th>Slope coeff.</th>
<th>$R^2$</th>
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Lock-in effect

- locked in low fixed nominal rate on existing mortgage
  ⇒ reluctant to buy better house if mortgage is not portable

PREDICTION OF LOCK-IN EFFECT

- for the full sample estimates
  \[ \psi_t = \hat{a} + \hat{b}_1 d_t i_t + \hat{b}_2 (1 - d_t) i_t + \hat{e}_t \Rightarrow \hat{b}_1 \neq \hat{b}_2 \]

  where \( d_t \) is an indicator function of upward movements in \( i_t \)

- for rolling samples estimates:
  - \( \text{Corr}[R^2, d_t] \neq 0 \)
  - \( \text{Corr}[R^2, i_t] \neq 0 \)
  - \( \text{Corr}[R^2, p_t - l_t] \neq 0 \)

- Can be rejected!

- Surprising? No, since most mortgages in the UK are portable (and flexible interest rate mortgages)
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- for rolling samples estimates:
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  - Corr\[R^2, i_t\] \( \neq 0\)
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- Surprising? No, since most mortgages in the UK are portable (and flexible interest rate mortgages)
During booms (busts) high quality houses appreciate (de-) more than smaller houses
- house prices reflect all types of dwellings
- rent index tends to overweigh lower quality dwellings

⇒ Price-rent ratio might move over business cycle

Control for business cycle proxy
- \( \hat{c}_t \) Hodrick-Prescott (1997) filter

Figure 5: U.K. business cycle and inflation measures (i) does not drive out the statistical significance of \( t; i_t \) and \( \log (1/i_t) \), (ii) does not significantly change the point estimates of the elasticities of the mispricing reported in Table 1, (iii) does not significantly increase our ability to explain the time variation in the mispricing, (iv) and that the business cycle alone has very little (in the case of \( \hat{c}_t \) and \( \hat{c}_0 \)) or no (in the case of \( \hat{c}_0 \)) explanatory power for the mispricing measures.

3.3 Tilt Effect

Our empirical results are consistent with money illusion. Nevertheless, we could also be capturing the tilt effect of inflation. Recall from Section 3.1 that the reciprocal of the nominal interest rate, \( 1/i_t \), is proportional to the amount agents can borrow under a fixed nominal payment mortgage. Such a contract generates a financing constraint that varies with the nominal interest rate and hence with inflation. However, agents could use multiple alternative financing schemes available on the market, that are not affected by the tilt effect. This is for example the case for flexible interest rate mortgages, price level adjusted mortgages (PLAM) or the graduate payment mortgages.

\( \text{Brunnermeier and Julliard (2005)} \)
## Mispricing measures and the business cycle

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Brunnermeier and Julliard (2005) Money Illusion and Housing Frenzies