Inflation, Money Demand and Portfolio Choice

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Motivation

- How does/should inflation affect asset allocation and stock market participation decisions?

- How does/should inflation affect wealth accumulation?

Focus on role of inflation on money demand and asset allocation decisions from household side (in a life-cycle partial equilibrium model).

- How costly is inflation for different groups of households? (Doepke and Schneider, JPE, 2006)
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- Recent household portfolio choice literature assumes households invest in real stocks and real bonds and/or housing (Cocco, Gomes and Maenhout (2005), Gomes and Michaelides (2005), Polkovnichenko (2007) and Wachter and Yogo (2010))

- Money demand literature focusses on the choice between money and nominal bonds but ignores higher-yielding assets (Mulligan and Sala-i-Martin (2000) and Alvarez and Lippi (2009))

- We aim to fill the gap by analyzing the effects of inflation on money demand and portfolio choice across different assets in a nominal model

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- Moments: mean W/Y for stockholders and non-stockholders and mean portfolio shares (bonds, stocks, money)
- Fixed cost of participation to separate wealthier stockholders from poorer non-stockholders
- Ex ante preference heterogeneity used to achieve this, reasonable shopping costs
Findings

- Model can generate fact that the share of wealth in stocks increases as financial wealth rises, providing an alternative explanation to Wachter and Yogo (2010). The young economize on shopping costs by holding money to cover liquidity needs. As saving for retirement begins, they diversify into stocks and bonds.
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- Higher inflation decreases aggregate wealth accumulation and aggregate consumption.
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- Magnitude of hedging demands.
Empirical Evidence

- US SCF triennial surveys 1989-2007 but focus on 2007 only
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- Time-age-cohort identification problem
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- Time-age-cohort identification problem
- But between 1998 and 2007 surveys we get similar stylized facts and interpret the cross sectional results from 2007 as life cycle implications to explain
## Life Cycle Financial Wealth Accumulation

<table>
<thead>
<tr>
<th>Age Group</th>
<th>Mean (Median) Non-Stockholders</th>
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</tr>
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<tbody>
<tr>
<td>20-34</td>
<td>6034 (1100)</td>
<td>56966 (20750)</td>
</tr>
<tr>
<td>35-45</td>
<td>10688 (1200)</td>
<td>158989 (62550)</td>
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<td>46-55</td>
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<td>66+</td>
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- Fixed cost interpretation of limited stock market participation because stockholders are an order of magnitude richer.
- Table also illustrates skewed distribution of wealth in data.
### Life Cycle Financial Wealth Accumulation Relative to Mean Labor Income

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<td>20-34</td>
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</tr>
<tr>
<td>35-45</td>
<td>0.26</td>
<td>1.53</td>
</tr>
<tr>
<td>46-55</td>
<td>0.56</td>
<td>2.65</td>
</tr>
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<td>7.02</td>
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<tr>
<td>66-75</td>
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- These are moments to be matched
Empirical Evidence (cont’d)

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- These are moments to be matched
- Treatment of housing wealth
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Money: LIQ in SCF public extract is defined as the sum of all checking, saving, money market, deposit and call accounts. We use the same definition for money.

<table>
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<tr>
<th>Age Group</th>
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<tbody>
<tr>
<td></td>
<td>$\alpha_m$</td>
<td>$\alpha_b$</td>
</tr>
<tr>
<td>20-34</td>
<td>75.8</td>
<td>24.2</td>
</tr>
<tr>
<td>35-45</td>
<td>67.9</td>
<td>32.1</td>
</tr>
<tr>
<td>46-55</td>
<td>62.5</td>
<td>37.5</td>
</tr>
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Money is a key feature of the household portfolio, despite rate of return dominance.
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Life Cycle Portfolio Choice

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<th>$\alpha_b$</th>
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<td>24.2</td>
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- Money is a key feature of the household portfolio, despite rate of return dominance
- Money a more prominent feature of the portfolio of non-stockholders (as a percentage of total financial wealth)
Role of Money

- How do we generate any money demand?
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- Kiyotaki and Wright (1989) search models
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Shopping time model

- Tractable model to confront data, therefore use reduced form approach as in shopping time models
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- Our setting nests life cycle portfolio choice models when the transaction cost is zero and money does not circulate in the economy
Model

- Nominal version of life cycle portfolio choice models
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- Households earn labor income subject to uninsurable shocks
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Model

- Nominal version of life cycle portfolio choice models
- Households earn labor income subject to uninsurable shocks
- Borrowing and no short sale constraints exist
- Can save through money holdings, nominal bonds and nominal stocks
- Households can save in money and bonds but need to pay a one-time fixed cost to participate in the stock market
Households: Preferences

- Epstein-Zin-Weil Preferences

\[ V_{it}^j = \begin{cases} 
\beta \left( E_t \left[ (1 - \beta) C_{it}^{1-1/\psi_j} + \xi_t V_{it+1}^{1-\rho_j} \right] + (1 - \xi_t) \phi_j \left( \frac{X_{it+1}}{P_{t+1}} \right)^{1-\rho_j} \right) \right) \frac{1-1/\psi_j}{1-\rho_j} 
\end{cases} \]
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\left. + \frac{(1 - \beta) C_{it}^{1-1/\psi_j}}{1-1/\psi_j} \right. \\
\end{array} \right. \\
\]

- Following Vissing-Jorgensen (2002) households are heterogeneous in their EIS (two equal-sized groups: high and low), also risk aversion and bequest heterogeneity.
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- Stockholders can invest in fiat money \((M_{it})\), nominal bonds \((B_{it})\) and nominal stocks \((S_{it})\) after they have incurred a one-time fixed cost.

Non-stockholders can invest in money and bonds without incurring any cost.
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Identical labor income processes ex ante

$Y_{it} = Y_{p_{it}} U_{it}$

and $Y_{p_{it}} = \exp(f(t, Z_{it}))$

Earnings in retirement are $Y_{it} = \lambda Y_{p_{iK}}$ where $K$ is the exogenous retirement age (65).
Households: Labor Income

- Identical labor income processes ex ante
- Idiosyncratic component has both permanent and transitory components

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Treatment of housing expenditures.
Households: Budget Constraint

- Household budget constraint is given by

\[ X_{it} = P_t C_{it} + S_{it} + B_{it} + M_{it} + 1_t(. )P_t F Y_{it}^p \]
Households: Budget Constraint

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- Total financial wealth evolves as

\[ X_{it+1} = R_{t+1}^s S_{it} + R_{t+1}^b B_{it} + M_{it} \]
\[ + P_{t+1} Y_{it+1} - P_{t+1} \Omega_{it} Y_{it}^p \]
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\]

- \( F \) is the one-time fixed cost of stock market participation and is only paid when the indicator for first time access is one.
To generate money holdings, we assume a shopping cost transaction friction: a direct physical cost in consumption goods:

$$\Omega_{it} Y_{it}^p = \Omega(C_{it}, M_{it} / P_t; \varepsilon), \quad \Omega_C > 0, \quad \Omega_M < 0$$
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In the benchmark case we assume

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which means

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Interpretation: transaction cost is opportunity cost of time
Households: Shopping Cost

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- Interpretation: transaction cost is opportunity cost of time

- Functional form is consistent with Lucas (2000), who shows that the implied money demand function is consistent with Baumol-Tobin type models.
Normalizations

- Need to normalize by growth rate in prices and in permanent component of labor income

\[ x_{it+1} = \frac{r_{it+1}^s}{g_{it+1}} s_{it} + \frac{r_{it+1}^b}{g_{it+1}} b_{it} + \frac{r_{it+1}^m}{g_{it+1}} m_{it} + U_{it+1} - \frac{\Omega_{it}}{g_{it+1}} \]

where

\[ x_{it} = X_{it} / (Y_{it}^p P_t) \]

and the real rates of return are

\[ r_{it+1}^s \equiv R_{it+1}^s \pi_{t+1}^{-1}, \quad r_{it+1}^b \equiv R_{it+1}^b \pi_{t+1}^{-1}, \quad r_{it+1}^m \equiv \pi_{t+1}^{-1} \]

and \( \pi_{t+1} \equiv P_{t+1} / P_t \) denotes gross inflation, and \( g_{it+1} \equiv Y_{it+1}^p / Y_{it}^p \) is the gross growth rate of permanent income.
Estimation

- Estimate preference parameters that can generate model moments
Estimation

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- Given large number of parameters, we calibrate some and estimate preference ones

\[ \sigma_u = 0.1, \sigma_n = 0.08, \lambda = 0.68 \]
Estimation

- Estimate preference parameters that can generate model moments
- Given large number of parameters, we calibrate some and estimate preference ones
- The calibration for labor income uses the estimates in Cocco et al (2005) for educated households and $\sigma_u = 0.1$, $\sigma_n = 0.08$, and $\lambda = 0.68$
Annual CRSP data for US but use shorter period given our cross-sectional calibration (from 1995 to 2008)

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<td>2.5</td>
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</tr>
<tr>
<td>Bond Returns</td>
<td>2.4</td>
<td>2.6</td>
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<td>6.4</td>
<td>18.0</td>
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<tr>
<td>Wage growth</td>
<td>2.7</td>
<td>2.0</td>
</tr>
</tbody>
</table>

Correlations from 1995-2008 period: bond and stock returns correlation is zero, as is correlation between inflation and real wage growth
Annual CRSP data for US but use shorter period given our cross sectional calibration (from 1995 to 2008)

<table>
<thead>
<tr>
<th>Variable</th>
<th>Mean</th>
<th>S. D.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inflation</td>
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<td>1.0</td>
</tr>
<tr>
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<td>2.4</td>
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Correlations from 1995-2008 period: bond and stock returns correlation is zero, as is correlation between inflation and real wage growth.

Correlation between inflation and bond returns is -0.5, inflation and stock returns is 0.25 and wage growth and bond and stock returns at 0.4.
Which moments to match?
Which moments to match?
- 5 age-related financial wealth to labor income ratios for stockholders and non-stockholders and the mean participation rate
Estimation (cont’d)

- Which moments to match?
- 5 age-related financial wealth to labor income ratios for stockholders and non-stockholders and the mean participation rate
- Match the two shares (money and stocks say with bonds determined as a residual) for stockholders and money for non-stockholders.
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Match the two shares (money and stocks say with bonds determined as a residual) for stockholders and money for non-stockholders.
Total of 26 moment conditions.
Which moments to match?

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Calibrated parameters are
\[ \{ \varphi_L = 0.0, \psi_H = 0.5, \psi_L = 0.3, \rho_H = 5.0, \rho_L = 1.3 \} \]


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Estimation: \( \beta, \varepsilon_w, \varepsilon_r, F \) where \( \varepsilon_w \) denotes the shopping cost for workers and \( \varepsilon_r \) the one for retirees and \( F \) is fixed cost.
Results

- Estimated structural parameters

<table>
<thead>
<tr>
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<tbody>
<tr>
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</tr>
<tr>
<td>$F$</td>
</tr>
<tr>
<td>$b$</td>
</tr>
<tr>
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</tr>
<tr>
<td>$\varepsilon_H$</td>
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<tr>
<td>$F$</td>
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<tr>
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<tr>
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- Fixed cost consistent with previous studies (eg Alan (2006), Gomes and Michaelides (2005))
- Bequest consistent with De Nardi (2004)
- Shopping cost between 0.5-2.0% of mean annual labor income: consistent with Lucas (2000) calibration, except during retirement
Aoki, Michaelides, Nikolov ()
Policy Functions: High EIS, high RRA

Figure 2: Policy functions: high IES, high RRA

Aoki, Michaelides, Nikolov ()
Simulations

Figure 3: Consumption, financial wealth and income over the life cycle: Baseline model
Figure 3: Consumption, financial wealth and income over the life cycle: Baseline model

Aoki, Michaelides, Nikolov
Figure 4: Portfolio choice over the life cycle: Baseline model
Figure 5: Stock market participation over the life cycle: Baseline model
## The Wealth Moments

Mean Financial Wealth/Income: Data vs Model

<table>
<thead>
<tr>
<th>Age Group</th>
<th>NonStockholders</th>
<th></th>
<th>Stockholders</th>
<th></th>
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<tbody>
<tr>
<td></td>
<td>Data</td>
<td>Model</td>
<td>Data</td>
<td>Model</td>
</tr>
<tr>
<td>20-34</td>
<td>0.31</td>
<td>0.11</td>
<td>0.85</td>
<td>1.34</td>
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<tr>
<td>35-45</td>
<td>0.26</td>
<td>0.08</td>
<td>1.53</td>
<td>2.18</td>
</tr>
<tr>
<td>46-55</td>
<td>0.56</td>
<td>0.08</td>
<td>2.65</td>
<td>3.88</td>
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<tr>
<td>56-65</td>
<td>0.77</td>
<td>0.04</td>
<td>7.02</td>
<td>5.80</td>
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<tr>
<td>66-75</td>
<td>2.48</td>
<td>0.03</td>
<td>15.7</td>
<td>8.34</td>
</tr>
</tbody>
</table>
### Life Cycle Portfolio Choice by Age

<table>
<thead>
<tr>
<th>Age</th>
<th>Non-Stockholders</th>
<th>Stockholders</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group</td>
<td>Data</td>
<td>Model</td>
</tr>
<tr>
<td>20-34</td>
<td>75.8</td>
<td>77.9</td>
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<tr>
<td>35-44</td>
<td>67.9</td>
<td>57.6</td>
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<tr>
<td>45-54</td>
<td>62.5</td>
<td>58.3</td>
</tr>
<tr>
<td>55-64</td>
<td>59.1</td>
<td>78.9</td>
</tr>
<tr>
<td>65+</td>
<td>63.3</td>
<td>98.4</td>
</tr>
</tbody>
</table>

Aoki, Michaelides, Nikolov ()
Figure 6: Stockholder portfolios over the life-cycle: No shopping and participation costs versus Baseline Model

Aoki, Michaelides, Nikolov
Comparative Statics: High inflation for stockholders

Figure 7: Stockholder portfolios over the life cycle: High Mean Inflation (10% per annum) versus Baseline Model (2.5% per annum)
Comparative Statics: High inflation for non-stockholders

Figure 8: Non-stockholder portfolios over the life cycle: High Mean Inflation (10% per annum) versus Baseline Model (2.5% per annum)
Comparative Statics: High inflation and stock market participation

Figure 10: Stock market participation: High Mean Inflation (10% per annum) versus Baseline Model (2.5% per annum)
Figure 11: Stockholder Portfolios over the life cycle: Zero Mean Inflation versus Baseline Model (2.5% per annum)
Comparative Statics: Zero Inflation for Non-Stockholders

Figure 12: Non-stockholder portfolios over the life cycle: Zero Mean Inflation versus Baseline Model (2.5% per annum)
Comparative Statics: Zero inflation and stock market participation

Figure 14: Stock Market Participation: Zero Mean Inflation versus Baseline Model (2.5% per annum)
Hedging demands

- Higher inflation volatility
Hedging demands

- Higher inflation volatility
- Correlation of inflation with stock returns set to zero

Further work needed to understand interaction between aggregate and idiosyncratic uncertainty, what agents know and how they form expectations (for instance, separating aggregate from idiosyncratic shocks and learning)
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- Hedging demands very low. Presumably idiosyncratic uncertainty key.
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Summary/Conclusions

- Structural model of stock market participation, money demand and portfolio choice over the life cycle
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- Work in progress: Estimation and persistent processes to investigate hedging demand results