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Habit Persistence in Assets Demand

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Abstract

Habit persistence is examined for six asset demand categories using U.S. data and a dynamic forward-looking model. We find habit persistence is greater for more liquid assets compared to riskier assets and may in part explain low holdings of riskier assets. Cash assets are found to be substitutes with other liquid assets under habit formation. Consistent with portfolio analysis, the riskier asset categories of money market mutual funds and bonds are found to be complements in use. The three more risky asset categories have budget elasticities greater than unity indicating that in the long run consumers are more likely to turn to these assets as their wealth increases.

Key Words: asset demand, habit formation, short-run, and long-run estimates, budget elasticities

JEL Codes: E41, C32, E13

* Corresponding author
1. Introduction

Policy makers, particularly central bankers, require estimates of substitution among monetary assets to determine the efficacy of monetary policy. Habits may affect the substitutability among assets. Under habit formation consumers who entered the asset market buying low-risk savings type assets when their income was low may continue to buy those assets as wealth increases. Consequently they be slow to move towards higher risk and return assets as much as indicated by the difference in returns. Habits are likely to impact the demand for various types of assets and accounting for habits is important because they may impact the elasticities of substitution of interest to central bankers. In considering monetary aggregates, central banks should include assets that are substitutes for highly liquid assets.

Estimating substitution among various types of monetary assets using demand system dates back to Chetty (1969) who estimated a constant elasticity of substitution specification. Since a constant elasticity of substitution specification fails to provide arbitrary elasticities of substitution, various flexible functional forms have been used to analyze substitution between monetary assets.

Locally flexible functional forms, that are flexible at a point of approximation, have been frequently used in analyzing substitution between monetary assets.\(^1\) Studies that use locally flexible forms include the Taylor series translog models in Ewis and Fisher (1984) and Serletis (1987, 1988), Almost Ideal Demand System by Barr and Cuthbertson (1991) and Drake (1992), Minflex Laurent specification Barnett and Gaekwad (2018), Chang and Serletis (2019) and Serletis and Xu (2019, 2020), and flexible normalized quadratic specification used by Jadidzadeh and Serletis (2019) and Serletis and Xu (2020). An alternative is to use globally

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\(^1\) A locally flexible functional form provides a local approximation to the data generating function in a delta neighborhood of an unknown and possibly small size.
flexible functional forms such as Gallant’s (1981) Fourier specification and Barnett and Jonas’ (1983) Asymptotically Ideal Model to analyze monetary asset demand. Studies of monetary asset demand using the Fourier include Ewis and Fisher (1985), Fleissig and Swofford (1997), Serletis and Shahmoradi (2005), and Fleissig and Swofford (2020). The Asymptotically Ideal Model has been used to analyze monetary asset demand by Fleissig and Swofford (1996), Drake, Fleissig and Swofford (2003), and Serletis and Shahmoradi (2005).

We follow the approach of using a flexible functional form to estimate substitution between six monetary assets categories, allowing for habit persistence for monetary assets. Previous studies using flexible functional forms to estimate substitution between monetary assets do not allow for habit formation. We examine the impact of habit formation across six groups of U.S. assets that differ from term to non-term deposits having varying degrees of risk, shown previously to be weakly separable from consumption goods. We use the rational habit formation dynamic model approach that has been applied to various types of goods by Spinnewyn (1981), Muellbauer and Pashardes (1992), Pashardes (1986), Lyssiotou (2000), Zhen, Wohlgenant, Karns, and Kaufman (2011), Koksal and Wohlgenant (2016), and Fleissig (2021a, 2021b). The impact that current expenditure on each of the six categories of assets has on future utility allows for an intertemporally rational consumer behavior where current preferences for assets are based on past expenditures captured through preference endogeneity. Expenditure across asset categories is likely to have impacts on future asset expenditure based on habit formation, which will impact estimates of both short-run and long-run price elasticities as well as budget elasticities.

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2 The Fourier specification and Asymptotically Ideal Model are both dense in the Sobolev norm and therefore gives an arbitrarily globally accurate approximation to the underlying continuous assets demand function and its associated partial derivatives, see Gallant (1981) and Barnett and Yue (1988).
We find a relatively high degree of habit persistence among the most liquid assets category. Cash assets are found to be substitutes with other relatively liquid assets, savings deposits, and small-time deposits. Consistent with portfolio analysis, the relatively riskier asset groups in our data set, money market mutual funds, and bonds are found to be complements in use. Our three relatively less risky assets categories have budget elasticities between zero and unity while the three riskier asset categories have budget elasticities greater than unity in the long run. Consequently even allowing for habit persistence in the long run, consumers are more likely to turn to the three relatively more risky assets as their wealth increases.

We use a dynamic flexible asset demand system with habit formation based on Muellbauer and Pashardes (1992) and Lyssiotou (2000) to examine habit persistence in asset demand. This model is set forth in the following section.

2. A Dynamic Flexible Demand System

We begin with describing habit formation for assets. With habit formation, current expenditure on asset $i$ in period $t$ ($A_{it}$) is determined by some desired level of asset service flows ($\bar{A}_{it}$) and an amount of past asset expenditure ($A_{it-1}$):

$$A_{it} = \bar{A}_{it} + \theta_i A_{it-1}$$

for $i=1,\ldots,n$, and $0 \leq \theta_i \leq 1$ captures habit formation ($\theta_i$). Habit formation has a larger impact on current asset expenditure as $\theta_i \to 1$ and no impact of habit formation when $\theta_i = 0$. Preference endogeneity across asset $i$ is captured by the estimate of $\theta_i$. Spinnewyn (1981) shows that for a forward looking decision maker, the future cost of habits depends on the proportion of current purchases.
The rational dynamic model has the user cost of the assets under habit formation \((\widetilde{uc}_{it})\) capturing the future costs of habit formation and Spinnewyn (1981) and Muellbauer and Pashardes (1992) show that:

\[
\widetilde{uc}_{it} = \left(\frac{1+r}{1+r-\theta_i}\right) uc_{it} = \lambda_i uc_{it}
\]  

(2)

with \(uc_{it}\) the user cost of asset \(A_i\) in period \(t\) and \(\lambda_i = \left(\frac{1+r}{1+r-\theta_i}\right)\).

The forward looking decision maker, under habit formation, maximizes utility \(u_t(\widetilde{uc}_{1t}, \ldots, \widetilde{uc}_{nt})\) subject to the budget constraint \(\bar{y}_t = \sum_t \widetilde{uc}_{it} \bar{A}_{it}\) which are used to derive the Marshallian demands. Muellbauer and Pashardes (1992) then use the Marshallian demands in conjunction with the habit formation equation (1) to derive a rational dynamic forward-looking asset demand \(A_{it}\):

\[
A_{it} = g_{it}(uc_t, u_t) + \theta_i A_{it-1}
\]

(3)

These the real asset demands are converted into budget share equations using the corresponding user costs and total expenditure giving:

\[
w_{it} = \bar{w}_{it}(\bar{y}_t/\lambda_i y_t) + \theta_i(uc_{it}A_{it-1}/y_t)
\]

(4)

where \(w_{it} \equiv uc_{it}A_{it}/y_t\) and \(\bar{w}_{it} \equiv \widetilde{uc}_{it} \bar{A}_{it}/\bar{y}_t = f_{it}(\widetilde{uc}_t, \bar{y}_t)\). A functional form must now be selected to approximate the habit data generating function \(f_{it}(\widetilde{uc}_t, \bar{y}_t)\).

The forward-looking Almost Ideal Model (AIDS) dynamic model of Muellbauer and Pashardes (1992) and Lyssiotou (2000) is used to model habit data generating function \(f_{it}(\widetilde{uc}_t, \bar{y}_t)\). The Almost Ideal Model (AIDS) is a locally flexible functional form, does not impose any restrictions on the estimates of elasticities, and has sufficient parameters to provide arbitrary estimates of elasticities at any single point. It is not feasible incorporate this habit formation approach into the globally flexible Fourier or Asymptotically Ideal Model. With monthly data, the dynamic AIDS model is:
\[ A_{it} = [\alpha_i + \sum_j \gamma_{ij} \ln \bar{u}c_{jt} + \beta_l (\ln \bar{y}_t - \ln \bar{u}c_t)] \left( \frac{\bar{y}_t}{\lambda_{it}uc_{it}} \right) + \theta_i A_{it-12} \] (5)

where \( \ln \bar{u}c_t = \alpha_0 + \sum_i \alpha_i \ln \bar{u}c_{it} + \frac{1}{2} \sum_i \sum_j \bar{u}c_{it} \bar{u}c_{jt}. \) The dynamic AIDS budget share equations are:

\[ w_{it} = \left\{ [\alpha_i + \sum_j \gamma_{ij} \ln \bar{u}c_{jt} + \beta_l (\ln \bar{y}_t - \ln \bar{u}c_t)] \left( \frac{\bar{y}_t}{\lambda_{it}uc_{it}} \right) + \theta_i A_{it-12} \right\} uc_{it}/y_t + \mu_{it} \] (6)

where \( \mu_{it} \) a random error term which are estimated using the monetary asset data. Adding up requires \( \sum_i \alpha_i = 1, \sum_i \beta_l = 0, \sum_i \gamma_{ij} = 0 \) for all \( j \), homogeneity requires \( \sum_j \gamma_{ij} = 0 \) for all \( i \), and symmetry requires \( \gamma_{ij} = \gamma_{ji} \) for all \( i \) and \( j \).

The share equations (6) are used to derive short-run and long-run elasticities. Following Lyssiotou (2000), the uncompensated elasticity of demand for asset \( A_i \) in period \( t \) is:

\[ e_{ijt} = \left( \frac{1}{w_{it}} \right) \left[ \xi_{ij} \left( \frac{\bar{y}_t}{\lambda_{ij}y_t} \right) + d_{ij} \theta_i \left( \frac{A_{it-1}}{y_t} \right) \right] - d_{ij} \] (7)

where \( \xi_{it} = \frac{\partial \bar{u}c_{it}}{\partial \ln p_{jt}} \) with \( d_{ij}=1 \) for \( i=j \) and \( d_{ij}=0 \) for \( i\neq j \). Since changes in the log \( uc_{jt} \) in period \( t \) impacts asset expenditure for \( k \) periods the elasticity of \( A_{it+k} \) with respect to \( uc_{jt} \) is:

\[ e_{ijk} = \theta_i^k e_{ijt}(A_{it}/A_{it+k}) \] (8)

giving the long-run elasticity as \( k \rightarrow \infty \):

\[ e_{ij}^{LR} = e_{ij}/(1 - \theta_i) \] (9)

with \( A_{it} = A_{it+k} = A_i \) for all \( k \) and \( r=0 \). The budget elasticities evaluated with \( A_{it}=A_i \) for all \( t \) are:

\[ e_i = (1 - \theta_i) \left( \frac{\beta_i}{w_i} + 1 \right) \] (10)

giving long-run budget elasticities as in Lyssiotou (2000):

\[ e_i^{LR} = e_i/(1 - \theta_i) \] (11)
Having specified the model and elasticities, we turn to the issue of data. The data used to estimate the above assets demand specification with habit persistence are described in the following section.

3. Data

To estimate the dynamic AIDS model, we gathered U.S. assets and returns data from 1993:4 through 2019:7 on:

1. Currency (CUR)
2. Travelers’ Checks (TC)
3. Demand Deposits (DD)
4. Other Checkable Deposits at Commercial Banks (OCDCB)
5. Other Checkable Deposits at Thrift Institutions (OCDTH)
6. Saving Deposits at Commercial Banks (SDCB)
7. Saving Deposits at Thrift Institutions (SDTH)
8. Small Time Deposits at Commercial Banks (STDCB)
9. Small Time Deposits at Thrift Institutions (STDTH)
10. Retail Money Market Funds (MMMF-R)
11. Institutional Money Market Mutual Funds (MMMF-I)
12. Large Time Deposits (LTD)
13. Repurchase Agreements (RP)
14. Commercial Paper (CP)
The assets 1-14 are from the Centre for Financial Stability. The ‘risky’ nominal household sector holdings of U.S. government bonds are from DataStream. The daily 10-year U.S. Treasury Bond data are from DataStream and are converted into monthly averages.

Based on Hjertstrand et.al (2016), Binner et. al. (2018) and following Fleissig and Swofford (2020), we further narrowed these assets into six asset categories:

A₁: CUR, TC, DD, OCDCB, OCDTH
A₂: SDCB, SDTH
A₃: STDCB, SDTTH
A₄: MMMF-R, MMMF-I
A₅: LTD, RP, CP
A₆: BONDS.

For the six asset categories, the most liquid assets and those that have the lowest relative risk are those assets included in category A₁. Savings deposits (A₂) are also fairly liquid assets with a relatively low degree of risk. Small time deposits (A₃) are relatively less liquid than A₁ and A₂ because they are time limited which may further contribute to habit persistence. The remaining three assets categories of A₄, A₅, and A₆ have a typically higher degree of risk compared to the first three categories. All data are converted to real per capita terms using the monthly consumer price index and U.S. monthly population. A Divisia index is used to construct aggregates A₂ through A₅.

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3 Some of the US data is publicly available on the CFS website and some of the data we obtained in personal contact with the CFS.
4 These papers do not cover the exact same time frame as the current paper so their separability results can only be suggestive for our sub-aggregation decisions.
5 The early theoretical and empirical work of for aggregating monetary assets using a Divisisia Index was developed by Barnett (1980), Serletis (1991), Swofford and Whitney (1991), and Barnett, Fisher, and Serletis (1992).
Monthly real user costs for each asset is measured as $uc_{it} = (R_t - r_{it})/(1 + R_t)$, where $r_{it}$ is the rate of return on an asset and $R_t$ is a benchmark rate of return; see Barnett (1978) and Donovan (1978). The benchmark rate ($R_t$) is calculated as the maximum return from all the assets and will not reach the lower bound because of liquidity and risk. When an interest rate approaches zero it is approaching a lower bound and has an opportunity cost of holding that asset, as for highly liquid assets. When a user cost approaches zero the asset is becoming more like the benchmark asset and the opportunity cost of hold that asset is falling. Following Anderson and Jones (2011) and Fleissig and Swofford (2020) a small premium is added to the benchmark rate so that no user cost is zero.\(^6\)

We next present parameter estimates from the dynamic AIDS model that provides estimates for the habit formation as well as the own user cost, cross-price, and budget elasticities based on these estimates.

### 4. Estimation and Results

The dynamic rational AIDS flexible demand system share equations (6) were estimated using the full-information maximum likelihood procedure of TSP International 5.1 assuming Gaussian errors. For estimation, the across equations restrictions from adding up, symmetry, and homogeneity imposed. The parameter estimates are shown in Table 1. To evaluate the adequacy of the model we first test for serial correlation. The Berndt and Savin (1975) test for serial correlation with the cross equation restrictions imposed fails to detect serial correlation. The reported root-mean-square errors for equation are low. Most of the parameters are statistically significant at the 5% level. To further evaluate the fit of the model, we examine the R-squares for each share equation. The R-squares are relatively high ranging from 83.4% for the A1 assets

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\(^6\) If any user cost were zero in each period, then that asset would drop out of the calculation of a sub-aggregate.
share equation to 89.4% for the small-time deposit share equation. The parameters measuring habit persistence ($\theta_i$) are all statistically significant at the 5% level.

Unsurprisingly small-time deposits, $A_3$, that are time-limited and usually not tradeable on a secondary market, exhibit the largest degree of habit persistence. Specifically, habits account for 37.4% of current expenditure on the assets in $A_3$. Further, habits account for 32.5% of current expenditure on the relatively liquid savings deposits in $A_2$ and only 24.4% for the highly liquid assets in $A_1$ which typically have a relatively low degree of risk.

Habit formation has a smaller effect on the current expenditure on the relatively riskier assets and declines as the consumer moves up the asset categories. Specifically, habits explain 18.4% of current expenditure on $A_4$ (MMMF-R, MMMF-I) and 16.4% of current expenditure on $A_5$ (LTD, RP, CP). The least amount of habit formation is 12.6% of current expenditure on $A_6$ (BONDS). Thus, the representative agent is more habitual with the relatively lower risk assets in $A_1$, $A_2$ and the time limited assets in $A_3$ that are entry assets for savers and less a creature of habit with the relatively riskier assets in $A_4$, $A_5$, and $A_6$. 
### Table 1

Parameter Estimates

<table>
<thead>
<tr>
<th>Equation</th>
<th>Parameter</th>
<th>(a_i)</th>
<th>(\beta_i)</th>
<th>(\gamma_{i1})</th>
<th>(\gamma_{i2})</th>
<th>(\gamma_{i3})</th>
<th>(\gamma_{i4})</th>
<th>(\gamma_{i5})</th>
<th>(\gamma_{i6})</th>
<th>(\theta_i)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A1:CUR, TC, DD, OCD</td>
<td>(a_i)</td>
<td>0.1825**</td>
<td>-0.0035**</td>
<td>0.0148**</td>
<td>0.0153**</td>
<td>0.0264**</td>
<td>0.0115**</td>
<td>-0.1211</td>
<td>0.0532**</td>
<td>0.2435**</td>
</tr>
<tr>
<td></td>
<td>(\beta_i)</td>
<td>0.0583</td>
<td>0.0008</td>
<td>0.0069</td>
<td>0.0045</td>
<td>0.0058</td>
<td>0.0034</td>
<td>0.1182</td>
<td>0.0165</td>
<td>0.0554</td>
</tr>
<tr>
<td>A2: SDCB, SDTH</td>
<td>(a_i)</td>
<td>0.1735*</td>
<td>-0.0634**</td>
<td>0.0474**</td>
<td>0.0602**</td>
<td>0.0125**</td>
<td>-0.1433</td>
<td>0.0079**</td>
<td>0.3254**</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(\beta_i)</td>
<td>0.0895</td>
<td>0.0185</td>
<td>0.0160</td>
<td>0.0187</td>
<td>0.0023</td>
<td>0.4116</td>
<td>0.0023</td>
<td>0.0608</td>
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</tr>
<tr>
<td>A3: STDCB, SDTTH</td>
<td>(a_i)</td>
<td>0.2174**</td>
<td>-0.0064**</td>
<td>0.0105**</td>
<td>0.0015**</td>
<td>-0.1201</td>
<td>0.0215**</td>
<td>0.3743**</td>
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</tr>
<tr>
<td></td>
<td>(\beta_i)</td>
<td>0.0727</td>
<td>0.0022</td>
<td>0.0028</td>
<td>0.0003</td>
<td>0.1197</td>
<td>0.0051</td>
<td>0.0585</td>
<td></td>
<td></td>
</tr>
<tr>
<td>A4: MMMF-R, MMMF-I</td>
<td>(a_i)</td>
<td>0.1738**</td>
<td>0.0325**</td>
<td>0.0535**</td>
<td>0.1821**</td>
<td>-0.2611**</td>
<td>0.1837**</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(\beta_i)</td>
<td>0.0506</td>
<td>0.0121</td>
<td>0.0124</td>
<td>0.0618</td>
<td>0.0782</td>
<td>0.0445</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>A5: LTD, RP, CP</td>
<td>(a_i)</td>
<td>0.1249</td>
<td>0.0244**</td>
<td>0.0855**</td>
<td>0.1169**</td>
<td>0.1644**</td>
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<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(\beta_i)</td>
<td>0.0838</td>
<td>0.0073</td>
<td>0.0257</td>
<td>0.0291</td>
<td>0.0461</td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>A6: BONDS</td>
<td>(a_i)</td>
<td>0.1279**</td>
<td>0.0165</td>
<td>0.0615**</td>
<td>0.1256**</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(\beta_i)</td>
<td>0.0483</td>
<td>0.0174</td>
<td>0.0145</td>
<td>0.0402</td>
<td></td>
<td></td>
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</tbody>
</table>

- **Estimation equations (6) using TSP International 5.1 FIML with the across equations restrictions.**
- Standard errors are bold face and * statistically significant at 10% level and ** statistically significant at 5% level.
- R-squares A1: CUR, TC, DD, OCDCB, OCDTH (0.894), A2: SDCB, SDTH (0.843), A3: STDCB, SDTTH (0.834), A4: MMMF-R, MMMF-I (0.854), A5: LTD, RP, CP (0.865), A6: BONDS (0.846).
- RMSE A1: CUR, TC, DD, OCDCB, OCDTH (0.0134), A2: SDCB, SDTH (0.0145), A3: STDCB, SDTTH (0.0143), A4: MMMF-R, MMMF-I (0.0275), A5: LTD, RP, CP (0.0252), A6: BONDS (0.0123).
- Test for serial correlation P-value=0.902, Berndt and Savin (1975).
The short-run uncompensated own-price or own-user-cost elasticities calculated at the mean of the data are in Table 2. These user cost elasticities are conditional on habit formation estimated from a system of demand equations with across equation restrictions imposed. The own-price elasticities for all six assets are negative and statistically significant at the 5% level. All own-price elasticities are elastic indicating that the representative agent is sensitive to changes in returns on these assets. The most elastic own-price elasticity of -3.9 is for the assets in \( A_5 \) (LTD, RP, CP), while the least elastic own-price elasticity is -2.3 for the highly liquid assets in \( A_1 \) (CUR, TC, DD, OCD).

The cross-price elasticities under habit persistence show evidence of both substitution and complementarity. Using the same U.S. data set, Fleissig and Swofford (2020) find that all assets are substitutes for each other from the Fourier flexible form. The three asset groups \( A_1 \), \( A_2 \), and \( A_3 \) are all statistically significant substitutes for each other. Substitution between aggregates \( A_1 \) and \( A_2 \) is less than unity for a change in the user cost of \( A_2 \) (0.883) and greater than unity in response to changes in the user cost of \( A_1 \) (1.379), which are consistent with the mean of the elasticities of substitution on Fleissig and Swofford (2020). The highly liquid assets in \( A_1 \) (CUR, TC, DD, OCD) are also substitutes for both \( A_4 \) (MMMF-R, MMMF-I) and \( A_6 \) (BONDS). Additionally, the elasticity estimates are statistically insignificant with a relatively small amount of complementarity (-0.021 and -0.034) between \( A_1 \) and \( A_5 \) (LTD, RP, CP).

Assets in \( A_4 \) (MMMF-R, MMMF-I) and \( A_5 \) (LTD, RP, CP) are statistically significant substitutes. In contrast, assets in \( A_4 \) (MMMF-R, MMMF-I) and \( A_6 \) (BONDS) are statistically insignificant.

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7 Including habit formation is not feasible using the approach of Spinnewyn (1981) and Muellbauer and Pashardes (1992) and Lyssiotou (2000).
significant complements for each other. Complementarity between assets is consistent with using them together in a portfolio of assets. The results suggest that allowing for habit formation may be the reason why these assets are found to be complements in use in contrast to Fleissig and Swofford (2020) finding these asset categories are substitutes in use.

The long-run user cost elasticities conditional on habits are presented in Table 3. As expected, the absolute values of the long-run own-price elasticities are larger than the corresponding short-run own-user-cost elasticities for each of the six asset categories, even under habit formation. Own-user cost elasticities for each of the asset categories are more elastic in the long-run reflecting the ability for people to more easily change portfolio holdings in the long run in the presence of habit formation. This is particularly true for savings deposits asset A2 (SDCB, SDTH) and small-time deposits asset A3 (STDCB, SDTTH). The ability to substitute small-time deposits increases for periods greater than the term of typical small-time deposits.

Table 2
Uncompensated Short-Run User-Cost Elasticities

<table>
<thead>
<tr>
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<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>A1:CUR,TC, DD, OCD</td>
<td>-2.264**</td>
<td>0.883**</td>
<td>1.439**</td>
<td>0.736**</td>
<td>-0.021</td>
<td>0.653*</td>
</tr>
<tr>
<td></td>
<td>0.533</td>
<td>0.282</td>
<td>0.490</td>
<td>0.247</td>
<td>0.029</td>
<td>0.388</td>
</tr>
<tr>
<td>A2:SDCB, SDTH</td>
<td>1.379**</td>
<td>-2.845**</td>
<td>1.828**</td>
<td>1.249**</td>
<td>-0.096</td>
<td>1.329**</td>
</tr>
<tr>
<td></td>
<td>0.367</td>
<td>0.671</td>
<td>0.526</td>
<td>0.474</td>
<td>0.083</td>
<td>0.337</td>
</tr>
<tr>
<td>A3:STDCB, SDTTH</td>
<td>1.243**</td>
<td>1.624**</td>
<td>-2.546**</td>
<td>1.786*</td>
<td>-0.213</td>
<td>0.680**</td>
</tr>
<tr>
<td></td>
<td>0.415</td>
<td>0.520</td>
<td>0.697</td>
<td>0.942</td>
<td>0.218</td>
<td>0.383*</td>
</tr>
<tr>
<td>A4:MMMF-R, MMMF-I</td>
<td>1.123**</td>
<td>1.325**</td>
<td>1.946**</td>
<td>-3.544**</td>
<td>0.597**</td>
<td>-0.690**</td>
</tr>
<tr>
<td></td>
<td>0.359</td>
<td>0.457</td>
<td>0.703</td>
<td>1.088</td>
<td>0.159</td>
<td>0.159</td>
</tr>
<tr>
<td>A5:LTD, RP, CP</td>
<td>-0.034</td>
<td>-0.477</td>
<td>-0.537</td>
<td>0.249**</td>
<td>-3.949**</td>
<td>0.632**</td>
</tr>
<tr>
<td></td>
<td>0.035</td>
<td>0.406</td>
<td>0.474</td>
<td>0.096</td>
<td>0.902</td>
<td>0.234</td>
</tr>
<tr>
<td>A6:BONDS</td>
<td>1.128*</td>
<td>0.673**</td>
<td>1.327**</td>
<td>-0.535**</td>
<td>0.879**</td>
<td>-3.650**</td>
</tr>
<tr>
<td></td>
<td>0.602</td>
<td>0.215</td>
<td>0.484</td>
<td>0.151</td>
<td>0.260</td>
<td>0.776</td>
</tr>
</tbody>
</table>

a $\varepsilon_{ij}$ is the long run unconditional elasticity of substitution between asset i and j for a price change in asset j.
b Standard errors are boldface.
c * statistically significant at 10% level and ** statistically significant at 5% level
Both the short-run and long-run budget elasticities conditioned on habit formation are in Table 3. Each of these estimated budget elasticities is statistically significant at the 5% level. For the relatively more liquid assets $A_1$ and $A_2$ as well as the time limited small time deposits in $A_3$, the budget elasticities are between zero and unity in the short-run and long-run indicating that holdings of these assets increase with an increase in the representative agent’s budget for assets, but by less than the change in the budget. For the relatively riskier assets, $A_4$, $A_5$, and $A_6$, the budget elasticities are either below unity or slightly above unity in the short run, but are above unity for all three riskier asset categories in the long-run. This indicates that in the long run, holdings of these assets increase by more than the representative agent’s budget for these assets. This is consistent with the idea that as wealth increases the representative agent buys more assets and is more willing to move toward riskier assets, even under habit formation.

Table 3

<table>
<thead>
<tr>
<th></th>
<th>LR User Cost Elasticity ($\epsilon_{LR}^P$)</th>
<th>SR Budget Elasticity ($\epsilon_l$)</th>
<th>LR Budget Elasticity ($\epsilon_{LR}^R$)</th>
</tr>
</thead>
<tbody>
<tr>
<td>$A_1$ (CUR,TC,DD,OCD)</td>
<td>-2.994**</td>
<td>0.741**</td>
<td>0.979**</td>
</tr>
<tr>
<td></td>
<td>0.926</td>
<td>0.236</td>
<td>0.342</td>
</tr>
<tr>
<td>$A_2$ (SDCB, SDTH)</td>
<td>-4.218**</td>
<td>0.526**</td>
<td>0.780**</td>
</tr>
<tr>
<td></td>
<td>1.299</td>
<td>0.160</td>
<td>0.274</td>
</tr>
<tr>
<td>$A_3$ (STDCB, SDTTH)</td>
<td>-4.069**</td>
<td>0.565**</td>
<td>0.903**</td>
</tr>
<tr>
<td></td>
<td>0.912</td>
<td>0.133</td>
<td>0.301</td>
</tr>
<tr>
<td>$A_4$ (MMMF-R,MMMF-I)</td>
<td>-4.341**</td>
<td>1.060**</td>
<td>1.298**</td>
</tr>
<tr>
<td></td>
<td>0.849</td>
<td>0.270</td>
<td>0.284</td>
</tr>
<tr>
<td>$A_5$ (LTD, RP, CP)</td>
<td>-4.725**</td>
<td>0.965**</td>
<td>1.155**</td>
</tr>
<tr>
<td></td>
<td>1.472</td>
<td>0.307</td>
<td>0.272</td>
</tr>
<tr>
<td>$A_6$ (BONDS)</td>
<td>-4.174**</td>
<td>0.943**</td>
<td>1.079**</td>
</tr>
<tr>
<td></td>
<td>0.900</td>
<td>0.308</td>
<td>0.315</td>
</tr>
</tbody>
</table>

$^a$ Long-run price elasticities are from equation (9) and long-run budget elasticities are from equation (11)

$^b$ * statistically significant at 10% level and ** statistically significant at 5% level
5. Conclusions

We allow for habit persistence in a forward-looking dynamic model of the demand for six assets categories having varying degrees of liquidity and risk. We estimate this model using U.S. data from 1993:4 through 2019:7. Habit formation is important ranging from 12.6% for relatively higher risk bonds to 37.4% for the small-time deposits. Habit persistence is greater for the relatively liquid cash assets category and savings deposits as well as time limited small time deposits compared to the riskier asset categories. Complementarity in use is found between riskier asset categories money market mutual funds and bonds which is consistent with portfolio analysis. Long-run budget elasticities are less than unity for the relatively less risky asset categories, but greater than unity for the riskier asset categories. These estimated budget elasticities indicate the representative agent is more willing to move towards risky assets as wealth increases.

References


