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Habit Persistence in Assets Demand

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Abstract

Habit persistence is typically modeled in consumption when investigating implications for asset demands. We test habit persistence in six asset demand categories using U.S. data and a dynamic forward-looking model. We find habit persistence is greater for liquid assets compared to riskier assets and may in part explain low holdings of risky assets. Cash assets are found to be substitutes with other liquid assets. Consistent with portfolio analysis, riskier asset categories, money market mutual funds, and bonds are found to be complements. Those two risky asset categories and a third risky asset category have budget elasticities greater than unity.

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

JEL Codes: E41, C32, E13

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1. Introduction

An early theoretical and empirical study of the impact of habit formation on consumer behavior was from Brown (1952).¹ Following Brown (1952), habit persistence has traditionally been modeled involving consumer behavior in purchasing consumption goods. This focus on habit persistence in consumption has also been evident in research by Sidrauski (1967), Pollak (1970), Mehra and Prescott (1985), Sundaresan (1989), Constantinides (1990), Abel (1990), and Boldrin, Christiano, and Fisher (1997 and 2001) who were looking at issues concerning asset demand.² In these studies, habit formation is only modeled for one or more consumer goods but not for assets.³ In addition, their stylized models usually have one or more consumption goods, but typically one risky asset to transfer consumption over time. This means consumer or saver choices among different assets is lost in aggregation. Moreover, under habit formation for assets demand, as wealth increases the representative agent is more likely to include an asset in their portfolio if the estimated budget elasticity for that asset exceeds unity. Finally, habit formation may differ in the short run and long run. We test for habit formation across assets that have varying degrees of risk and examine habit formation in both the short run and long run.

Purchasing decisions under habit formation differ for nondurable goods, durable goods, and assets. For a non-durable good, a consumer with habit persistence may well buy the same type of pizza each time. If the consumer purchases a different pizza and does not like it, the consumer is just out the price of the unwanted pizza. Habit persistence for durable goods differs compared to a nondurable good because the consumer benefits from the service flow from a durable good over time and the user cost replaces the actual price. When a habit-forming

¹ Habit formation dates back to Veblen (1899) and Duesenberry (1949).

² Havranek, Rusnak, and Sokolova (2017) provide a meta-analysis of various models of habit formation.

³ Faria (2001) and Mansoorian and Michelis (2006) extend the neoclassical model of Sidrauski (1967) and analyze money demand in the presence of habit formation in consumption.

consumer decides to change from the traditionally purchased brand to an alternative make for a durable good, the loss is the remaining years of service flows less any gains from resale. Habit formation for assets is more complex because assets have properties of both a nondurable and durable good. If a consumer with asset habit persistence buys another type of asset and decides it was the wrong choice, the consumer might be out the user cost of that asset and some or the entire value of the asset, but perhaps could even gain if the value of the asset appreciates. Thus, consumers who enter the asset market buying low-risk savings type assets when their income is low, may continue to buy those assets and be slow to move towards higher risk and return assets as much as indicated by the difference in returns. Consequently, habit persistence is likely to be important in asset demand.

This study examines the impact of habit formation across six groups of U.S. assets 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 of Spinnewyn (1981), Muellbauer and Pashardes (1992), Pashardes (1986), Lyssiotou (2000), Zhen, Wohlgenant, Karns, and Kaufman (2011), and Koksai and Wohlgenant (2016). The impact that current expenditure on the six categories of assets has on future utility allows for intertemporally rational consumer behavior where current preferences for assets are based on past expenditures captured through preference endogeneity. Expenditure across asset categories are 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.

We find a relatively high degree of habit persistence among the most liquid assets compared to riskier assets which may in part explain the low level of risky assets holding. Thus, this result may offer an alternative explanation for Mehra and Prescott's (1985) equity premium

puzzle that Constantinides (1990) explained with habit persistence in consumption. Cash assets are found to be substitutes with other liquid assets, savings deposits, and small-time deposits. Consistent with portfolio analysis, the riskier asset groups, money market mutual funds, and bonds are found to be complements in use. Our three more liquid asset 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, in the long run, consumers are more likely to turn to the three riskier 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. The model is set forth in the following section.

2. A Dynamic Flexible Demand System

The forward-looking dynamic model of Muellbauer and Pashardes (1992) and Lyssiotou (2000) is used to model habit formation where current expenditure on asset i in period t (A_{it}) is determined by some desired level of asset service flows ($\tilde{A}_{it}$) and an amount of past asset expenditure (A_{it-1}):

$$A_{it} = \tilde{A}_{it} + \theta_i A_{it-1} \quad (1)$$

for $i=1, \dots, n$, and $0 \leq \theta_i \leq 1$ captures habit formation (θ_i). Habit formation has a larger impact on current asset expenditure as $\theta_i \rightarrow 1$ and no impact of habit formation when $\theta_i = 0$. Preference endogeneity across asset i is captured by the estimate of θ_i . The rational dynamic model has the user cost of the assets capturing the future costs of habit formation. Under static expectations and a real interest rate r , Spinnewyn (1981) and Muellbauer and Pashardes (1992) show that the user cost is:

$$\widetilde{uc}_{it} = \left(\frac{1+r}{1+r-\theta_i} \right) uc_{it} = \lambda_i uc_{it} \quad (2)$$

with uc_{it} the user cost of A_i in period t and $\lambda_i = \left(\frac{1+r}{1+r-\theta_i} \right)$. Maximizing utility $u(\widetilde{uc}_{1t}, \dots, \widetilde{uc}_{nt})$ subject to the budget constraint $\tilde{y}_t = \sum_i \widetilde{uc}_{it} \tilde{A}_{it}$, the rational dynamic forward-looking model of Muellbauer and Pashardes (1992) gives:

$$A_{it} = g_{it}(uc_t, u_t) + \theta_i A_{it-1} \quad (3)$$

which are converted into budget share equations w_{it} using $uc_{it} / \sum_i uc_{it} A_{it}$

$$w_{it} = \tilde{w}_{it}(\tilde{y}_t / \lambda_i y_t) + \theta_i A_{it-1} (A_{it} / y_t) \quad (4)$$

where $w_{it} \equiv uc_{it} A_{it} / y_t$ and $\tilde{w}_{it} \equiv \widetilde{uc}_{it} \tilde{A}_{it} / \tilde{y}_t$.

The Almost Ideal Model (AIDS) is used and 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. With monthly data, the dynamic AIDS model is:

$$A_{it} = [\alpha_i + \sum_j \gamma_{ij} \ln \widetilde{uc}_{jt} + \beta_i (\ln \tilde{y}_t - \ln \widetilde{uc}_t)] \left(\frac{\tilde{y}_t}{\lambda_i uc_{it}} \right) + \theta_i A_{it-12} \quad (5)$$

where $\ln \widetilde{uc}_t = \alpha_0 + \sum_i \alpha_i \ln \widetilde{uc}_{it} + \frac{1}{2} \sum_i \sum_j \widetilde{uc}_{it} \widetilde{uc}_{jt}$. Adding up requires $\sum_i \alpha_i = 1$,

$\sum_i \beta_i = 0$, $\sum_i \gamma_{ij} = 0$ 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 dynamic AIDS budget share equations are:

$$w_{it} = \left\{ [\alpha_i + \sum_j \gamma_{ij} \ln \widetilde{uc}_{jt} + \beta_i (\ln \tilde{y}_t - \ln \widetilde{uc}_t)] \left(\frac{\tilde{y}_t}{\lambda_i p_{it}} \right) + \theta_i A_{it-12} \right\} uc_{it} / y_t + \mu_{it} \quad (6)$$

where μ_{it} a random error term. Following Lyssiotou (2000), the uncompensated elasticity of demand for asset A_i in period t is:

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

where $\xi_{it} \equiv \frac{\partial \tilde{w}_{it}}{\partial \ln p_{jt}}$ 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:

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

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

$$e_{ij}^{LR} = e_{ij}/(1 - \theta_i) \quad (9)$$

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:

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

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

$$e_i^{LR} = e_i/(1 - \theta_i) \quad (11)$$

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. asset 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)
15. Household 10 Year Constant Maturity U.S. Government Bond Holdings (BONDS).

We obtained assets 1-14 above, from the Centre for Financial Stability.⁴ The ‘risky’ nominal household sector holdings of U.S. government bonds, assets 15, 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) and Binner et. al. (2018),⁵ we further narrowed these assets into six asset categories:

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

⁴ 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.

⁵ 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.

A₆: BONDS.

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 A₅.⁶

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. Following Anderson and Jones (2011) a small premium is added to the benchmark rate so that no user cost is zero.⁷

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 were estimated using TSP International 5.1 FIML with the across equations restrictions imposed. The parameter estimates are shown in Table 1. The Berndt and Savin (1975) test for serial correlation with the cross equation restrictions imposed fails to detect serial correlation.

The model fits the data well. The root-mean-square errors are low. Most of the parameters are statistically significant at the 5% level. The R-squares are relatively high ranging from 83.4% for the A1 liquid assets share equation to 89.4% for the small-time deposit share equation. The parameters measuring habit persistence (θ_i) are all statistically significant at the

⁶ The early theoretical and empirical work of for aggregating monetary assets using a Divisia Index was developed by Barnett (1980), Serletis (1991), Swofford and Whitney (1991), and Barnett, Fisher, and Serletis (1992).

⁷ If any user cost were zero in each period, then that asset would drop out of the calculation of a sub-aggregate.

5% level. Unsurprisingly small-time deposits, A3, 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 A3. Further, habits account for 32.5% of current expenditure on the savings deposits in A2 and 24.4% for the highly liquid assets in A1.

Table 1

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

^a Estimation using TSP International 5.1 FIML with the across equations restrictions imposed.

^b Standard errors are bold face and * statistically significant at 10% level and ** statistically significant at 5% level

^c 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).

^d 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).

^e Test for serial correlation P-value=0.902, Berndt and Savin (1975).

Habit formation has a smaller effect on the current expenditure on riskier assets and declines as the consumer moves up the asset categories. Specifically, habits explain 18.4% of current expenditure on A4 (MMMF-R, MMMF-I) and 16.4% of current expenditure on A5 (LTD, RP, CP). The least amount of habit formation is 12.6% of current expenditure on A6 (BONDS). Thus, the representative agent is more habitual with the lower risk assets in A1, A2, and A3 that are entry assets for savers and less a creature of habit with the more-risky assets in A4, A5, and A6. The relative amounts of habit persistence among asset categories may be why consumers hold few higher-risk assets. Thus, these results may offer an alternative explanation for Mehra and Prescott's (1985) equity premium puzzle that Constantinides (1990) explained with habit persistence in consumption.

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. 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 A5 (LTD, RP, CP), while the least elastic own-price elasticity is -2.3 for the highly liquid assets in A1 (CUR, TC, DD, OCD).

The cross-price elasticities show evidence of both substitution and complementarity. The three asset groups A1, A2, and A3 are all statistically significant substitutes for each other.⁸ Substitution between aggregates A1 and A2 is less than unity for a change in the user cost of A2 (0.883) and greater than unity in response to changes in the user cost of A1 (1.379). The highly

⁸ Most asset demand studies typically find substitution between these assets as in Barnett, Fisher, and Serletis (1992), Fisher and Fleissig (1997), Fleissig and Swofford (1996), Jones, Fleissig, Dutkowsky, and Elger (2008), Serletis (1988, 1991), Fleissig and Jones (2015), and Serletis and Xu (2019). Jadidzadeh and Serletis (2019) do find some evidence of complementarity in use.

liquid assets in A1 (CUR, TC, DD, OCD) are also substitutes for both A4 (MMMF-R, MMMF-I) and A6 (BONDS). Additionally, the parameter estimates are statistically insignificant with a relatively small amount of complementarity (-0.021 and -0.034) between A1 and A5 (LTD, RP, CP).

Assets in A4 (MMMF-R, MMMF-I) and A5 (LTD, RP, CP) are statistically significant substitutes. In contrast, assets in A4 (MMMF-R, MMMF-I) and A6 (BONDS) are statistically significant complements for each other. Complementarity between assets is consistent with using them together in a portfolio of assets. This is one of a few papers to find complementarity between asset categories, for example, see Jadidzadeh and Serletis (2019).

Table 2
Uncompensated Short-Run User-Cost Elasticities

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

^a ϵ_{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

The long-run user cost elasticities are presented in Table 3. As expected, the absolute values of the long-run own-price elasticities are larger than the 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.

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.

Table 3 User-Cost and Budget Elasticities			
	LR User Cost Elasticity (e_{ij}^{LR})	SR Budget Elasticity (e_i)	LR Budget Elasticity (e_i^{LR})
A1 (CUR,TC,DD,OCD)	-2.994** 0.926	0.741** 0.236	0.979** 0.342
A2 (SDCB, SDTH)	-4.218** 1.299	0.526** 0.160	0.780** 0.274
A3 (STDCB, SDTTH)	-4.069** 0.912	0.565** 0.133	0.903** 0.301
A4 (MMMF-R,MMMF-I)	-4.341** 0.849	1.060** 0.270	1.298** 0.284
A5 (LTD, RP, CP)	-4.725** 1.472	0.965** 0.307	1.155** 0.272
A6 (BONDS)	-4.174** 0.900	0.943** 0.308	1.079** 0.315
^a Long-run price elasticities are from equation (9)			
^b Long-run budget elasticities are from equation (11)			
^c * statistically significant at 10% level and ** statistically significant at 5% level			

Consistent with economic theory, the estimated long-run budget elasticities for assets are greater than the estimated short-run budget elasticities across asset groups A1 through A6. For the safer assets A1, A2, and A3 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 more risky assets, A4, A5, and A6, 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.

5. Summary and Conclusion

We allow for habit persistence in a forward-looking dynamic model of asset demand. We estimate this model for six asset categories using U.S. data from 1993:4 through 2019:7 and find:

- Habits formation is important in asset demand ranging from 37.4% for the small-time deposits in A3 to 12.6% for the bonds in A6.
- Habit persistence is greater for the less risky asset categories, A1: (CUR, TC, DD, OCDCB, OCDTH), A2: (SDCB, SDTH) and A3: (STDCB, SDTTH) than for the riskier asset categories A4: (MMMF-R, MMMF-I), A5: (LTD, RP, CP), A6: (BONDS).
- Habit persistence may be an alternative explanation for the liquidity premium puzzle and the representative agent holding fewer risky assets.
- Complementarity is found between riskier asset categories A4 (MMMF-R, MMMF-I) and A6 (BONDS). Complementarity between risky assets is consistent with portfolio analysis.
- Long-run budget elasticities are less than unity for the less risky asset categories, A1: (CUR, TC, DD, OCDCB, OCDTH), A2: (SDCB, SDTH) and A3: (STDCB, SDTTH), but greater than unity for the riskier asset categories A4: (MMMF-R, MMMF-I), A5: (LTD, RP, CP), A6: (BONDS). This indicates the representative agent is more willing to move towards risky assets as wealth increases.

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