Thailand's Car Tax Rebate Scheme and Consumption Responses

The Role of Durable Goods and Adjustment Costs

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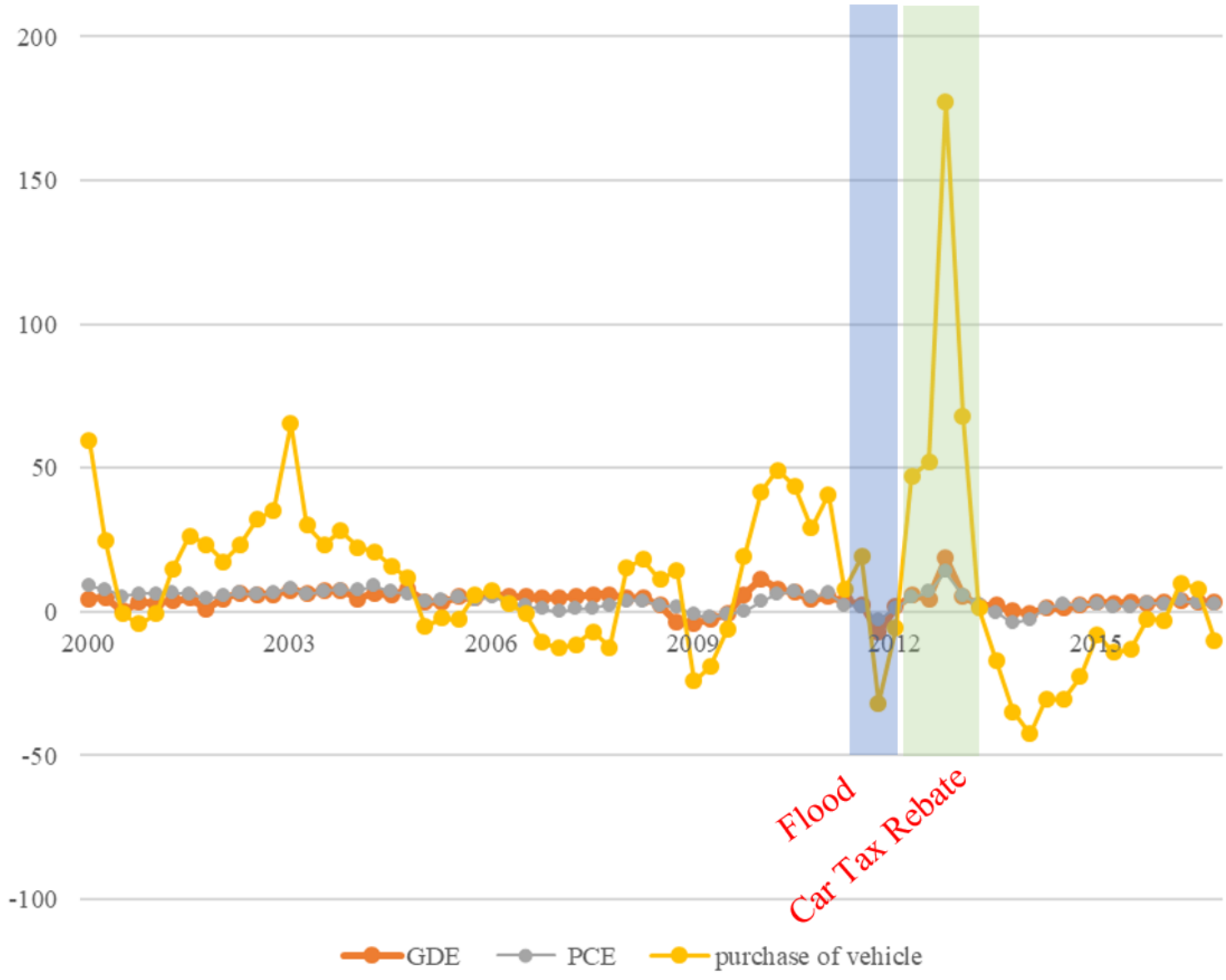
Outline

Thailand's Car-Tax Rebate Scheme

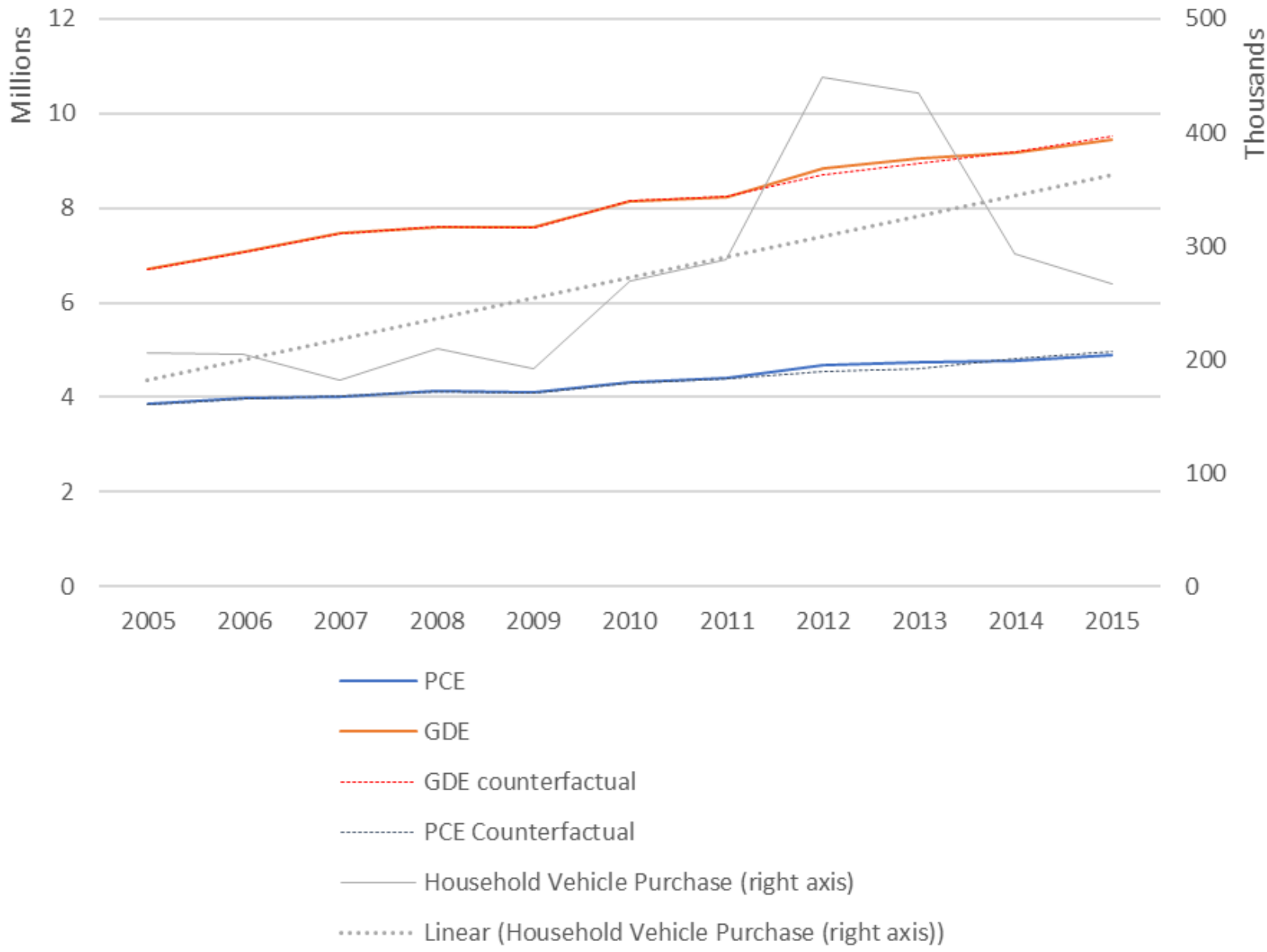
The Thai government rolled out a stimulus package, giving a tax break for those purchasing new personal vehicles.

- The program was *unanticipated* by households
- The excise tax rate ranges from 7 to 25 percent
- Maximum tax rebate is THB100,000 ($\approx$ USD3,000)
- 1.1 million vehicles received tax rebates.
- The program was announced in October 2011 and ended for application in December 2012.
- Fiscal cost of the policy is estimated at THB 28 billion (Thai PBO), which is about 0.3 percent of GDP in 2013.

Stimulus Package



Stimulus Package



In This Paper

Motivation

Individual-level frictions in durable adjustment together with a *distribution of income, wealth and age* matter to aggregate dynamics

In This Paper

Why Model?

Evaluate household consumption response to the tax cut

- Interested Research Questions
  - Informing Aggregate Outcome
  - Distributional impacts (by age, income, and wealth)
  - Tools for future policy predictions
  - Key parameters: Elasticity of intertemporal substitution (EIS)
  - Short to medium run consumption responses

▸ contribution

Life-Cycle Model

Key Features

2 Goods

Durables and Nondurables

Properties of Durables

Dual roles of durables (Automobile)

- Consumable goods: Provide service flow
- Illiquid Assets: Store wealth with adjustment costs

Luxury goods (Non-linear Engel curve)

Income (exogenous process)

- Uninsurable income risks
- Permanent and temporary shocks
- Borrowing constraints

Model

Environment

- One period is one year
- Each household lives for $T = 60$ periods
- Household age starts at 26, and ends at 85.

In each period t, household i consumes two types of goods:

$$U(C_{it}, D_{it}) = \frac{1}{1-\sigma}(C_{it}^{\alpha}(D_{it} + \tau)^{1-\alpha})^{1-\sigma}$$

- C : non-durable consumption
- D : proportional service flow from cars
- τ : car prevalence parameter

Model

Assets

Household i holds two types of assets:

- Asset, A_{it}
  - does not depreciate
  - yields an exogenous return of r in each period
- Automobile, D_{it}
  - depreciates at rate δ
  - Trades at exogenous prices

Budget Constraints

(No adjustment cost case)

$$A_{it+1} + C_{it} + p_t D_{it} = A_{it}(1 + r) + p_t(1 - \delta)D_{it-1}$$

Adjustment costs

If households decide to adjust their car holding, they will incur an adjustment cost.

$$F = F_v P_t D_{t-1} + F_o$$

Note that the transaction cost in this form implies that

- The cost only depends on the current stock of durables, not the new choice.
- Transaction costs encompass
  - the time cost
  - the psychic cost
  - the cost of asymmetric information

Model

Income Process

Household earns exogenous income Y_{it} given by

$$\begin{aligned} Y_{it} &= \exp\{\chi(j_{it}) + y_{it}\}, \\ y_{it} &= z_{it} + \varepsilon_{it}, \\ z_{it} &= \rho z_{it-1} + \mu_{it}. \end{aligned}$$

where

- j_{it} is the age of household i at time t
- $\chi(j_{it})$ is the deterministic age-dependent parameter
- y_{it} is the residue income
- z_{it} is the permanent shock that follows an $AR(1)$ process:

Model
Recursive Form

In recursive form, define a set of state variables as

$$s \equiv (A, D, z, j)$$

The value function given the state variable is

$$V(s) = \max\{V^{adjust}(s), V^{no\ adjust}(s)\}.$$

The problem is a discrete choice (adjust, or not adjust durables) dynamic problem over continuous state variables.

Model
Recursive Form

Define the value function when a household does *not* adjusts its durable as

$$
\begin{aligned}
V^{no\ adjust}(s) &= \max_{C,A'} U(C, D+\tau) + \beta E[V(s')|z] \\
s.t. \quad A' + C &= (1+r)A + y(z) - \delta PD \\
A'(1+r) &\geq \underline{A_t} \\
s' &= (A', (1-\delta)D, z', j+1).
\end{aligned}
$$

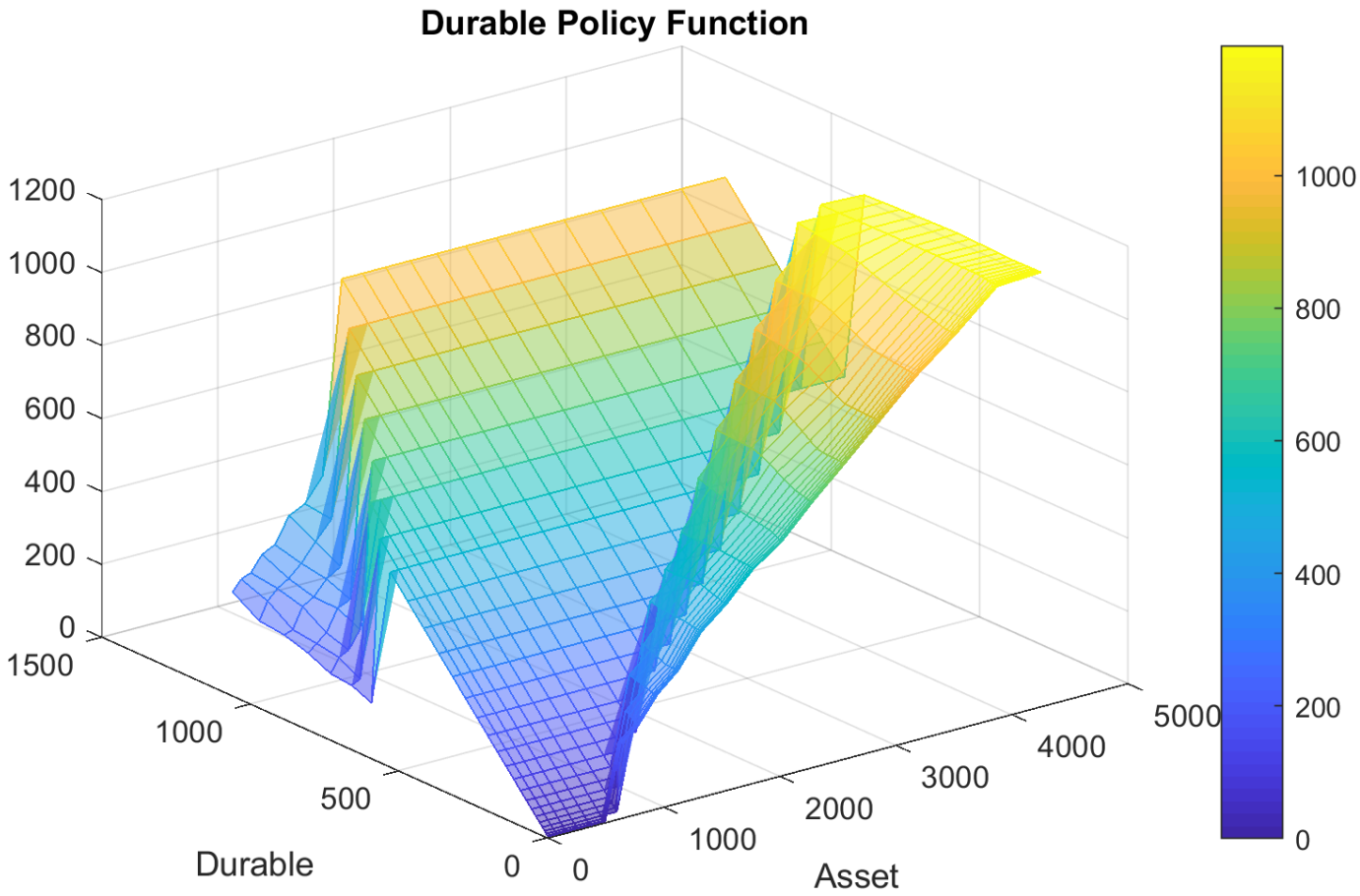
Model
Recursive Form

Define the value function when a household adjusts its durable as

$$\begin{aligned} V^{adjust}(s) &= \max_{C,A',D'} U(C, D' + \tau) + \beta E[V(s')|z] \\ s.t. \quad A' + PD' + C &= (1 + r)A + y(z) + (1 - F_v)(1 - \delta)PD - F_o \\ A'(1 + r) &\geq \underline{A_t} \\ s' &= (A', (1 - \delta)D', z', j + 1). \end{aligned}$$

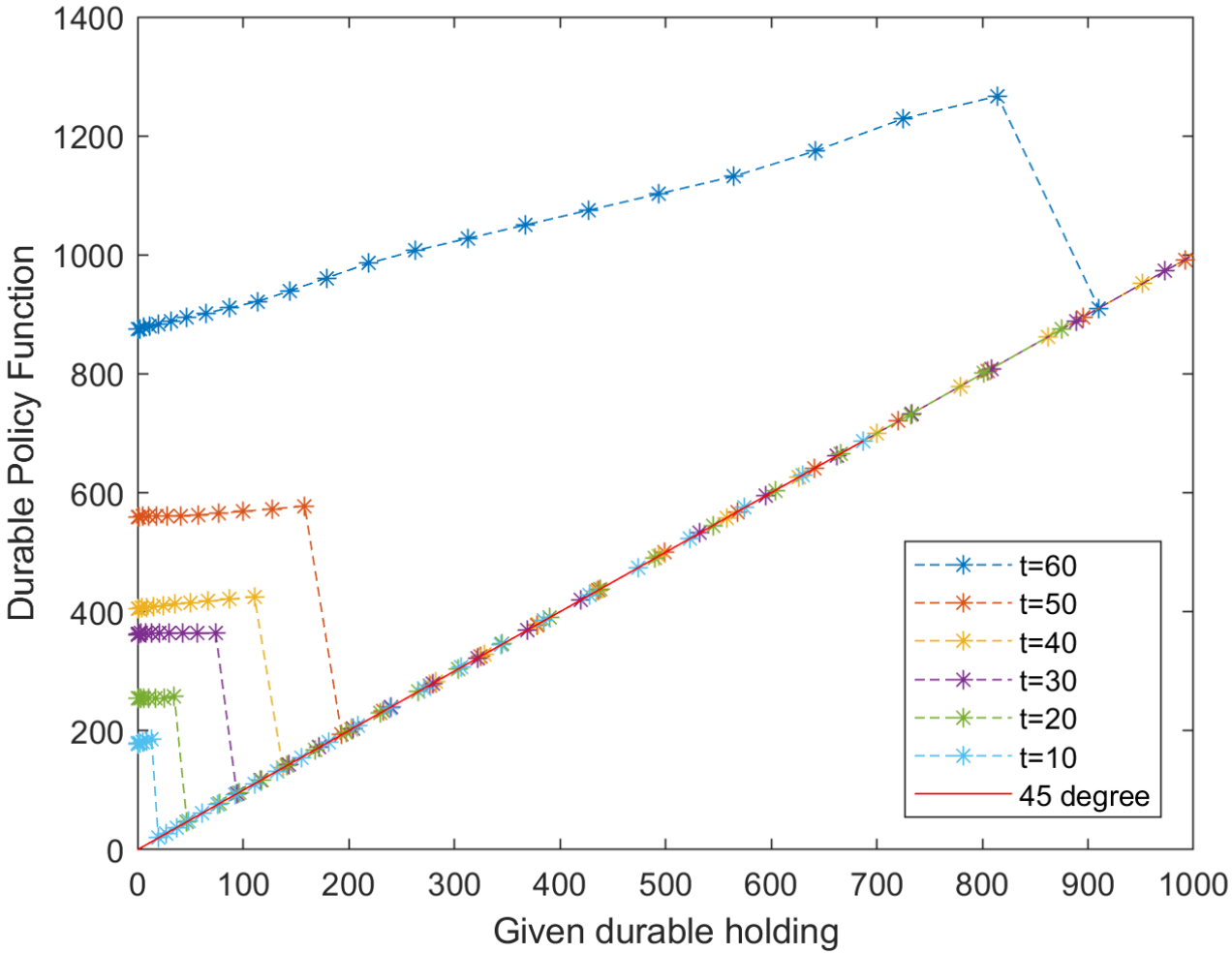
Policy Function

Policy function of durable purchases (D'), for state space ($A \times D$) given z and t.



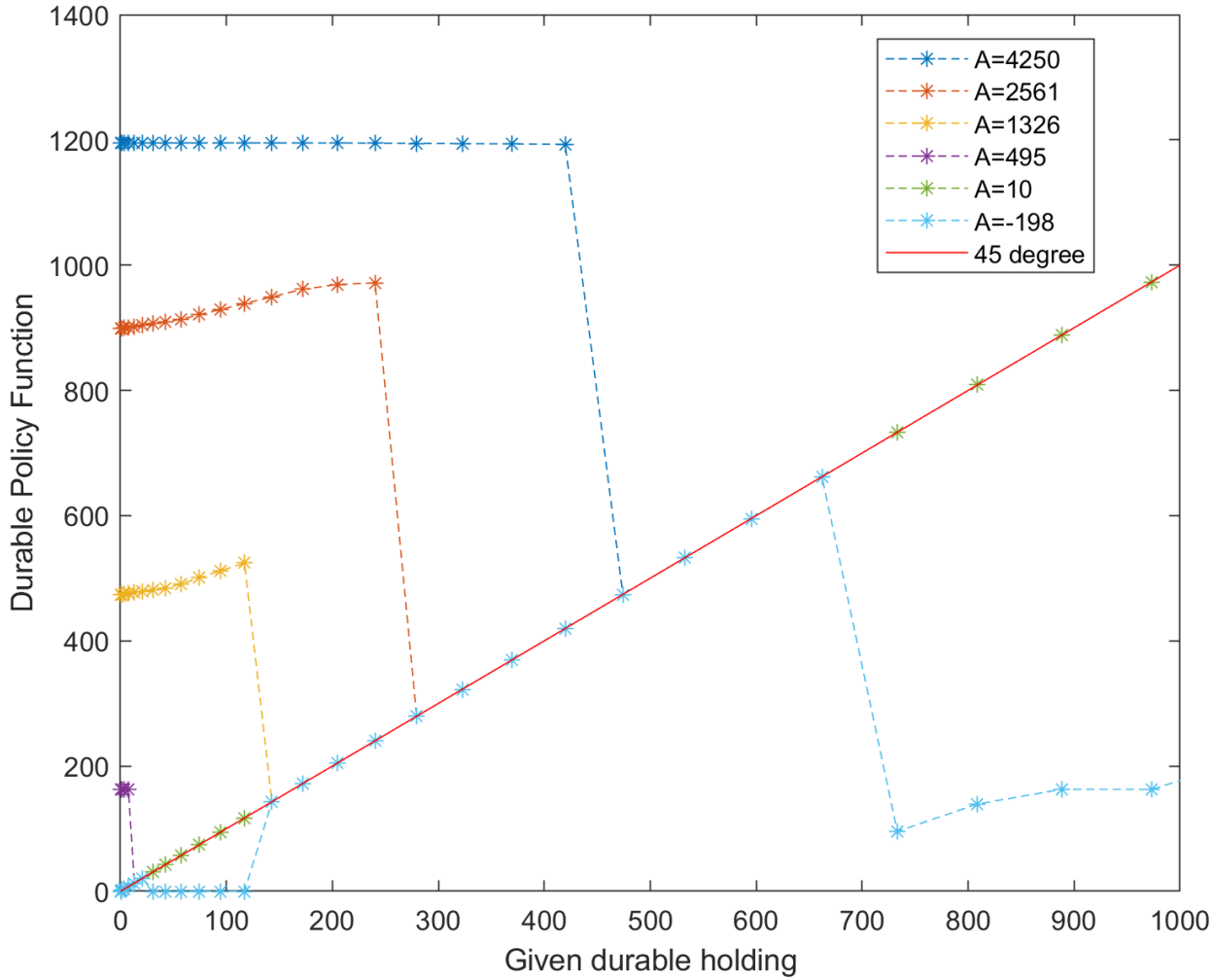
Policy Function

A level set of policy function D' over D at various age (t) given z and A



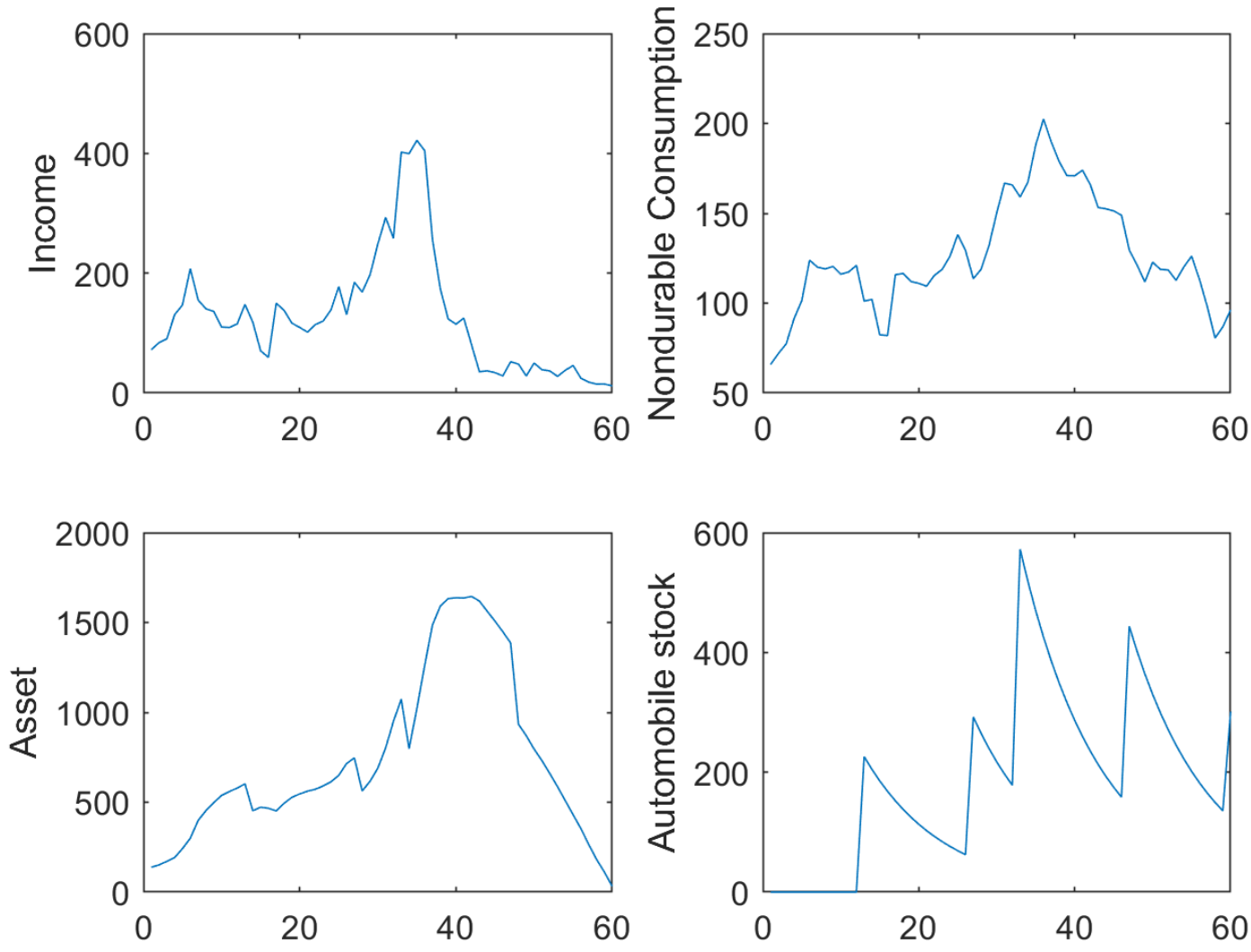
Policy Function

A level set of policy function D' over D at varying wealth (A) given z and t



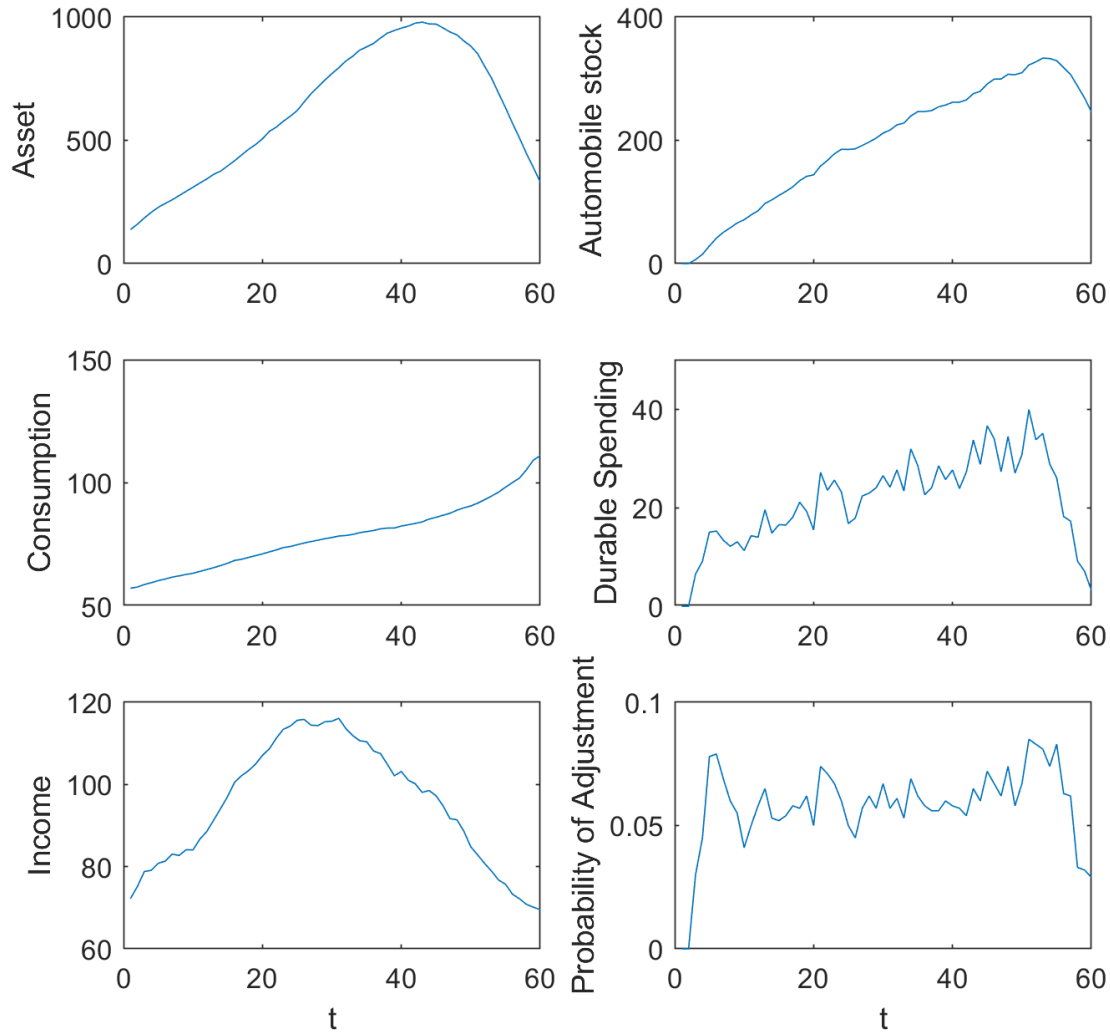
Solution

Example life-cycle pathway with initial median asset and durable holding.



Solution

Average life-cycle pathway with initial median asset and durable holding.



Average Optimal Pathway

Median asset and income households

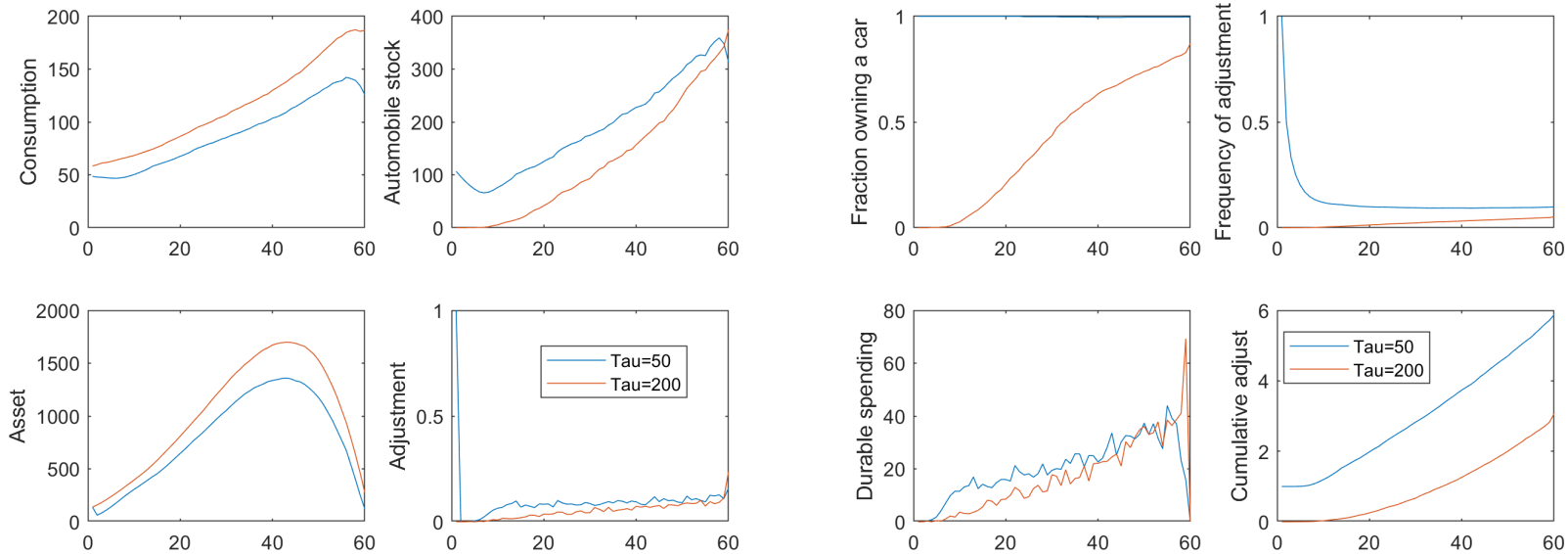


Figure: Comparative Statics for τ, the non-homotheticity parameter: Average Life-Cycle Consumption, Assets, and Durable Adjustment

Average Optimal Pathway

Median asset and income household

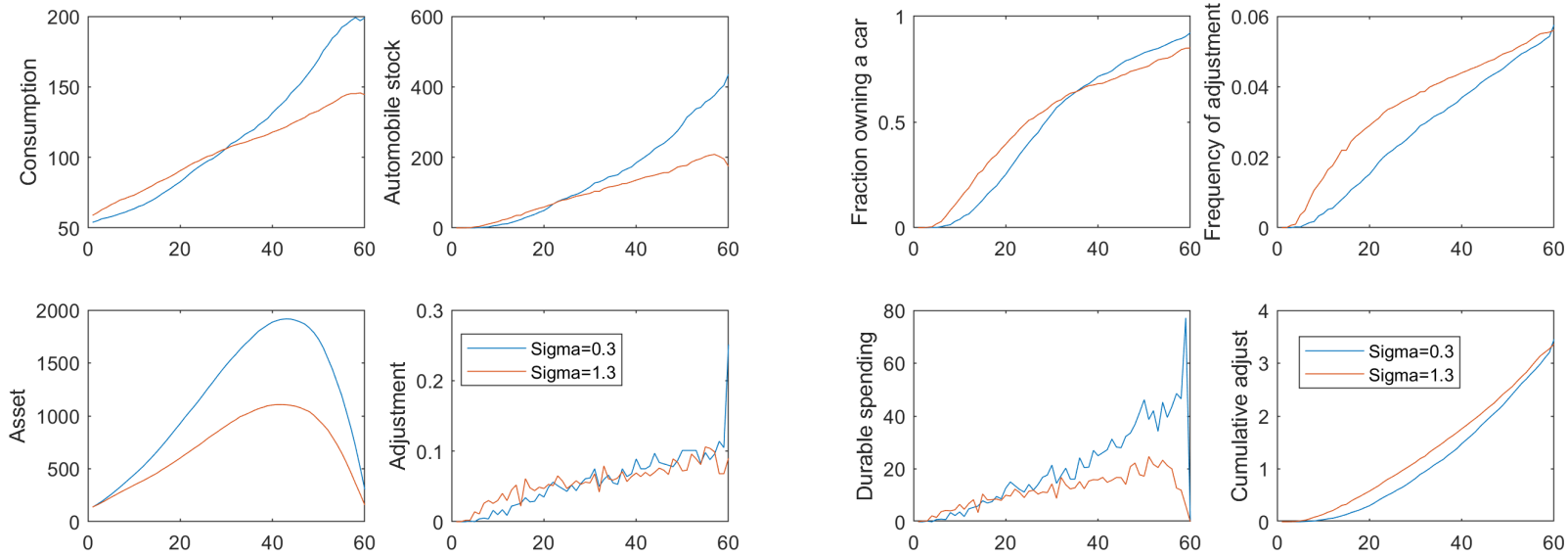


Figure: Comparative Statics for σ, the curvature parameter: Average Life-Cycle Consumption, Assets, and Durable Adjustment

Average Optimal Pathway

Median asset and income household

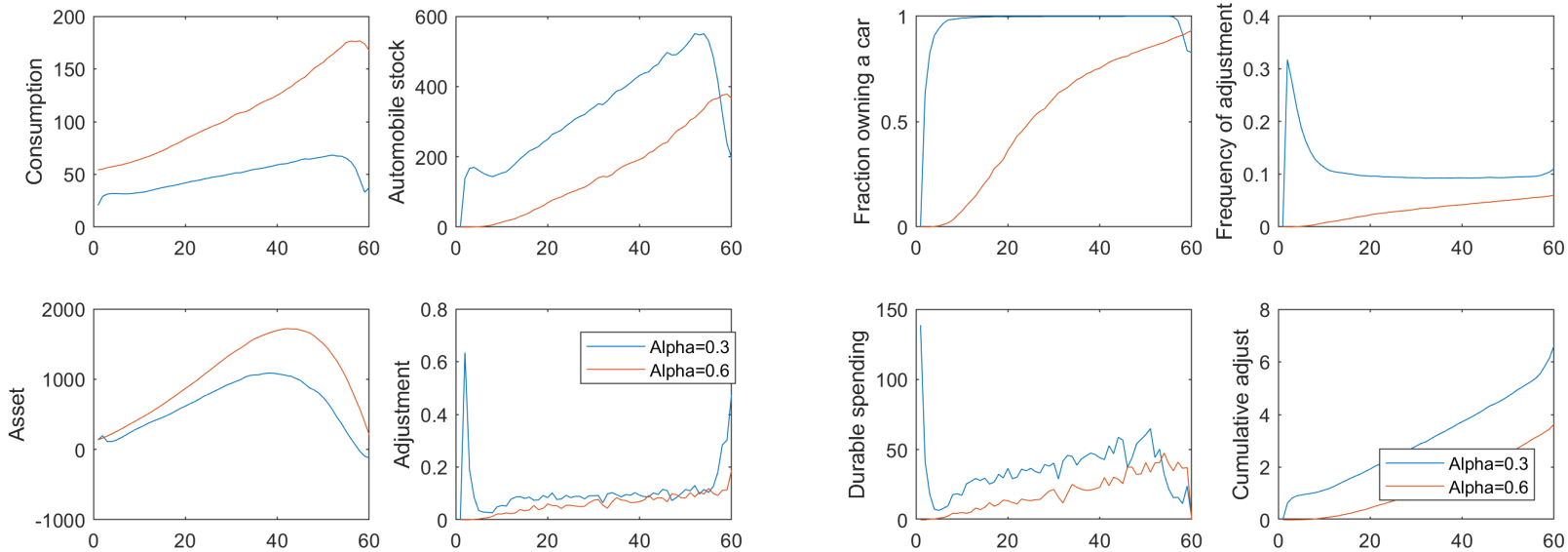


Figure: Comparative Statics for α, the nondurable-share parameter: Average Life-Cycle Consumption, Assets, and Durable Adjustment

Data
Townsend's Thai Data

- Rural and Urban Annual Resurvey, 2005 to 2014
- A panel of 2,640 households
- From 6 provinces in Thailand, representative of the region.
- Detailed household assets, consumption, and income information.

Data

A: Net wealth

- Liquid: saving/ cash on hand
- Illiquid: house, land, household assets, business asset, farm assets, loans
- net liability

Y: Non-asset income

- wages and salaries
- share of farm and business profit
- transfer

D: Personal vehicles: cars and pick-ups

C: Nondurable

- food, alcohol, tobacco, gasoline, ceremony expenses, household repair, vehicle repair, education expense, clothing expense, eating outside.

Sample Characteristics
Townsend VS SES data

Year/Data set	**SES**	**Townsend Urban**	**Townsend Rural**
Variables	2009	2010	2010
Male	0.67	0.56	0.64
	(0.47)	(0.50)	(0.48)
Age	51.7	54.87	55.99
	(14.65)	(11.39)	(12.40)
College	0.11	0.17	0.04
	(0.32)	(0.38)	(0.19)
Gross Income (THB)	250,832	286,993	194,827
	(427,440)	(323,263)	(247,116)
Number of household members	NA	4.08	3.89
		(1.91)	(1.78)
Saving	NA	45,031	36,362
		(280,436)	(154,095)
Number of passenger cars owned	0.12	0.17	0.06
	(0.39)	(0.43)	(0.26)
Number of pick-up trucks owned	0.25	0.25	0.24
	(0.51)	(0.48)	(0.48)
Number of cars and pick-up trucks owned	0.37	0.42	0.30
	(0.65)	(0.64)	(0.57)

Standard errors in parenthesis

*Weighted average and standard errors so that SES is representative of the kingdom

Summary Statistics
By carownership

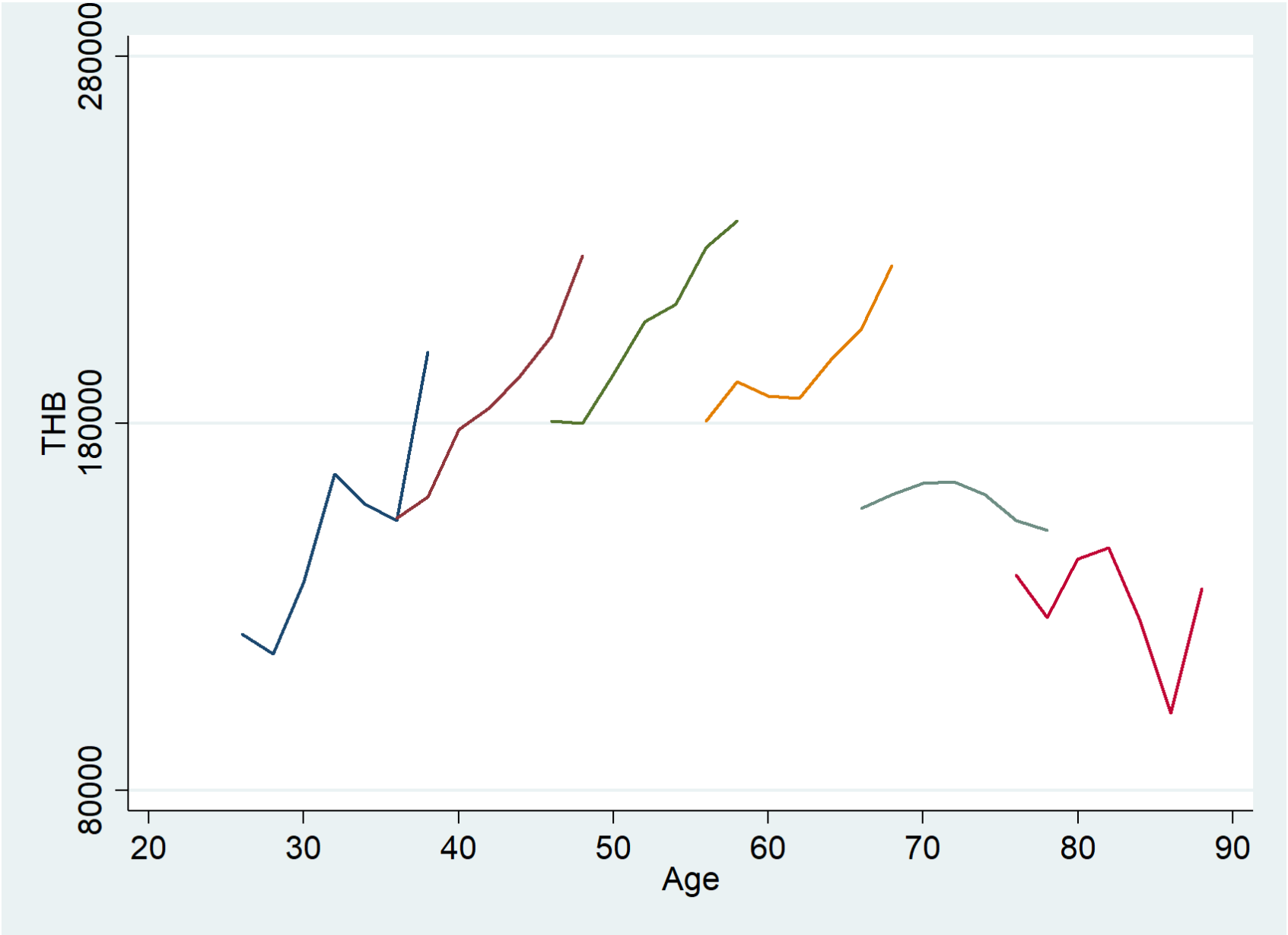
		Mean	Median	SD
Non-car owners (N=1604)				
Male		0.56	1	0.50
Age in 2010		55.89	55	12.27
College		0.02	0	0.13
Number of household members		3.77	4	1.83
Income		131,776	100,411	121,574
Net wealth		408,091	210,206	739,034
Saving		25,138	5,000	151,287
Car owners (N=1036)				
Male		0.65	1	0.48
Age in 2010		54.54	54	11.24
College		0.10	0	0.29
Number of household members		4.34	4	1.84
Income		290,105	214,984	316,923
Net wealth		1,035,283	567,603	1,884,392
Saving		75,608	12,440	316,382
Numer of cars		0.94	1	0.66
Frequency of automobile adjustment per year		0.10	0	0.30
Frequency of purchasing an automobile each year		0.06	0	0.24
Frequency of selling an automobile each year		0.05	0	0.22

Household Assets

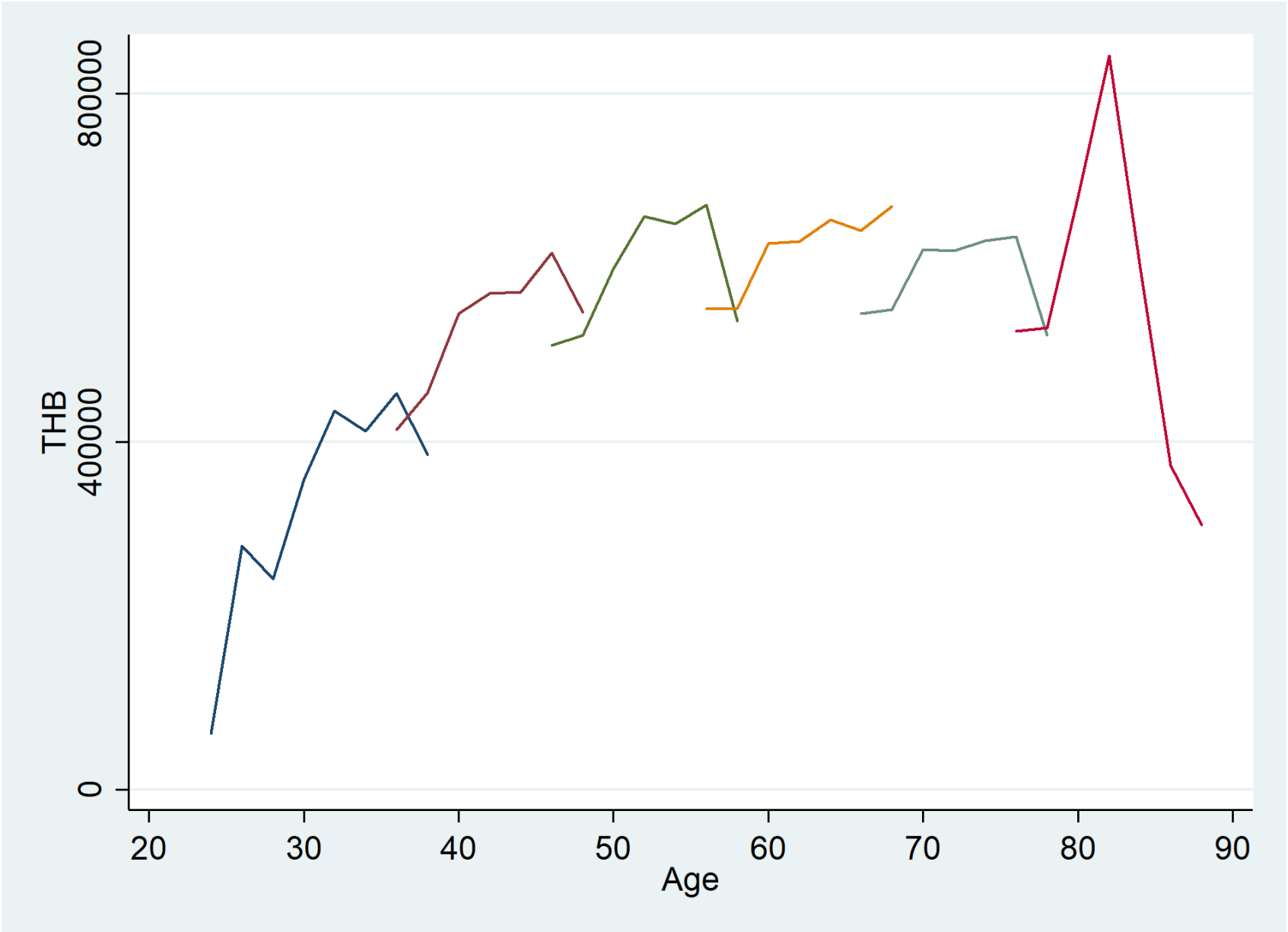
Table: Household Asset Portfolio Composition in 2005

	Mean (2002THB)	Mean Fraction of wealth	Median (2002THB)	Median Fraction of wealth
Income	163,153	0.37	100,640	0.92
Net wealth	436,012		109,195	
Net Liquid asset	27,322	0.06	3,660	0.03
Illiquid assets net liability	408,690	0.94	95,952	0.88
Household fixed asset	112,200	0.26	27,905	0.26
Vehicles	63,650	0.15	0	0.00
Land	400,974	0.92	0	0.00
Land with housing	42,990	0.10	0	0.00
Agricultural assets	11,096	0.03	0	0.00
Business assets	15,824	0.04	0	0.00
Borrowing	134,499	0.31	39,524	0.36
Lending	3,095	0.00	0	0.01

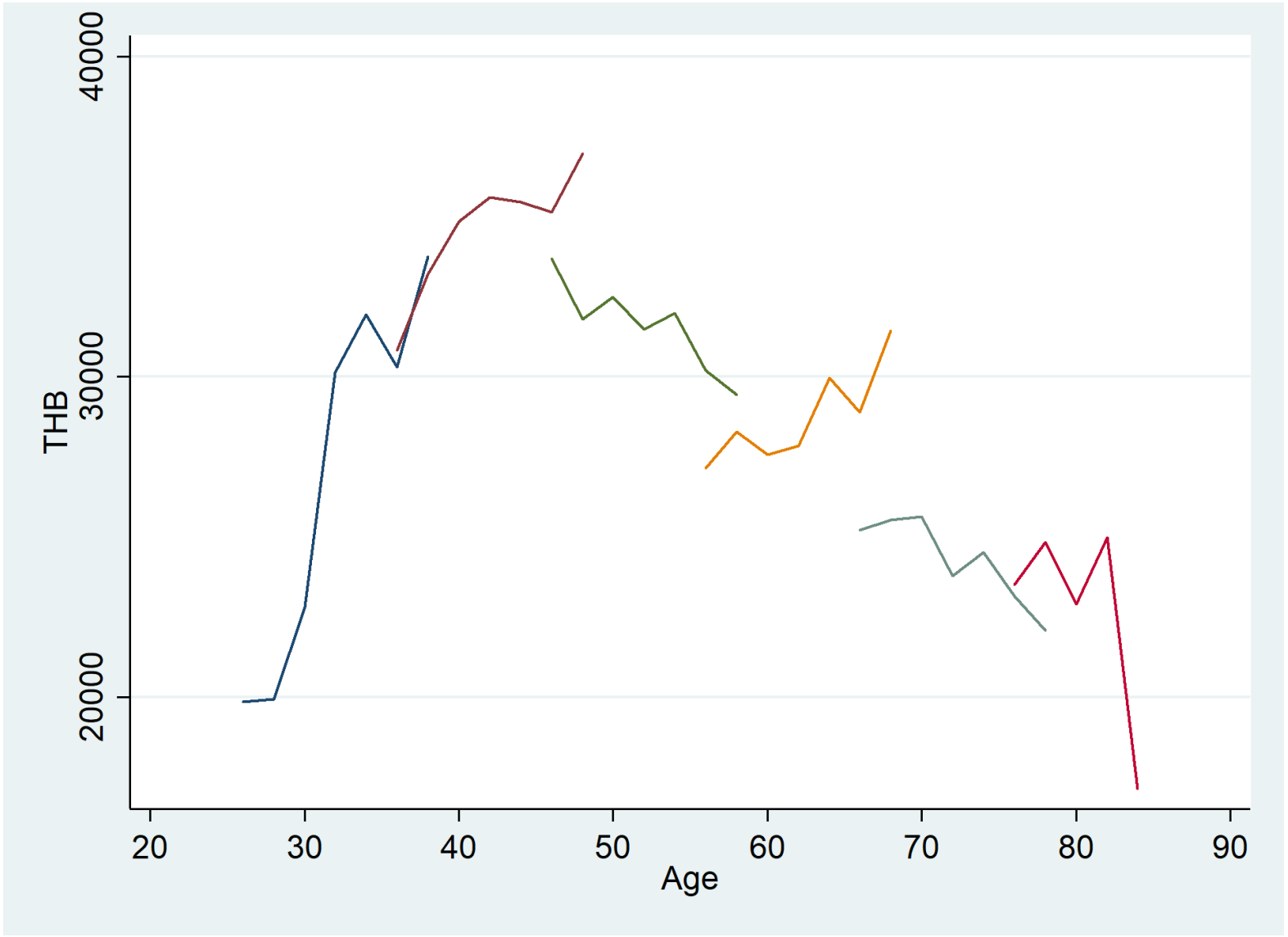
Household Income



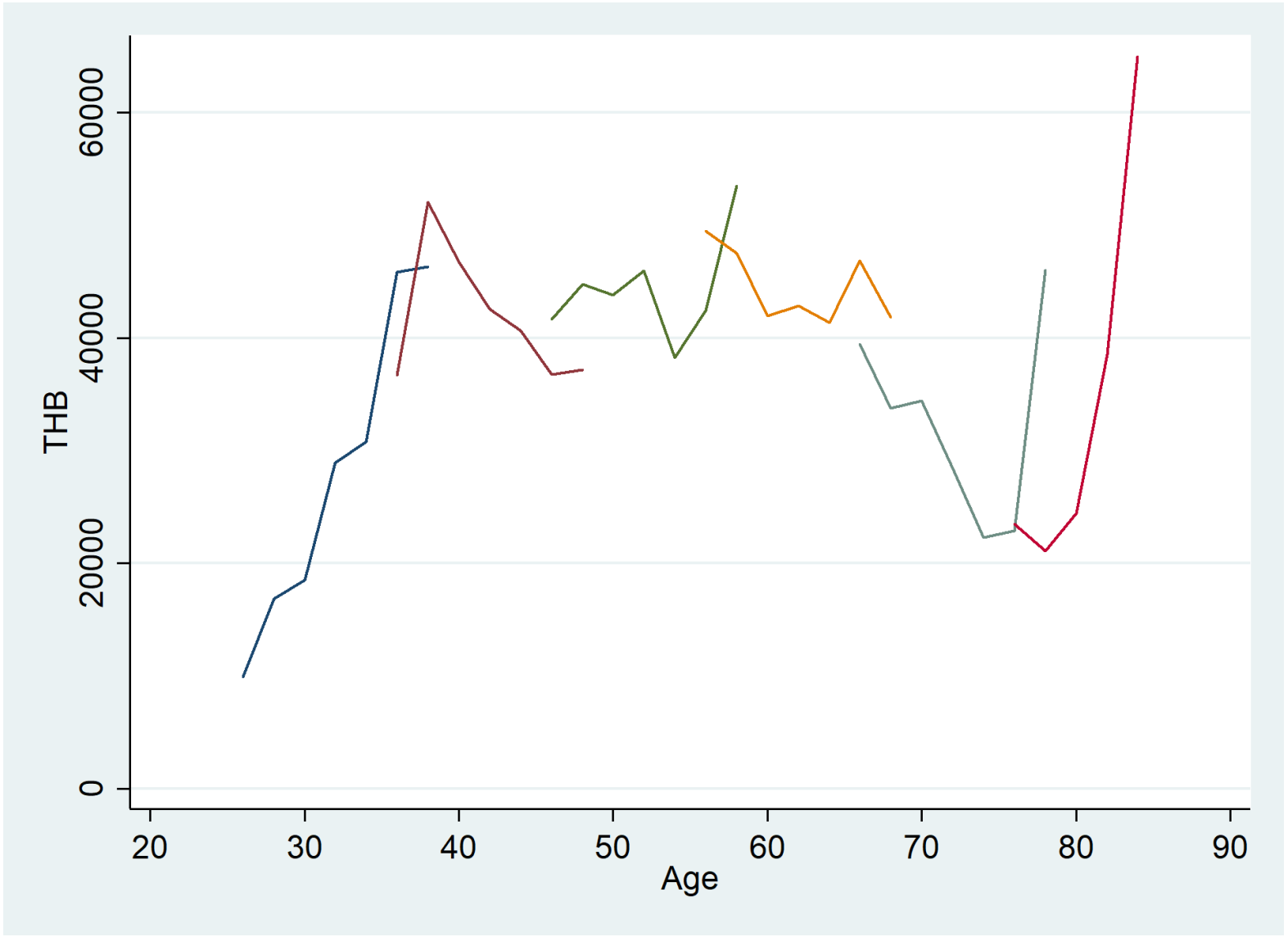
Household Assets



Nondurable Spending



Automobile Holding



Estimation Strategy

Step 1 Income process parameters are estimated exogenously, while some parameters are chosen outside the model.

Step 2 Given previously selected and estimated parameters, The rest of parameters are estimated using Method of Simulated Moments.

- Initialize simulated households with initial asset, and car holding and income from Townsend's data in 2005.
- Simulate household consumption and saving decisions given policy function of a set of parameters
- Search over parameters to minimize the distance between moments of household data and simulated data in 2006 to 2011.
- Moments are targeted at $Age \times Income \times Year$ cells.

Parameterization

Step 1

Parameters estimated or chosen outside of the model

Table: Chosen parameter values

r	0.05
δ	0.094
β	0.95
F_o	8
F_v	0.10

Income Process

Table: Estimates

ρ_z	0.9316
σ^2_μ	0.0959
σ^2_ε	0.2962

Parameterization

Step 2

Parameters left to estimates

$\tau_{young,old}$	public good/outside option parameter
α	Share of nondurable consumption
σ	Curvature (CRRA if homothetic preference)
Ψ	Bequest motive parameter

Targeted Moments

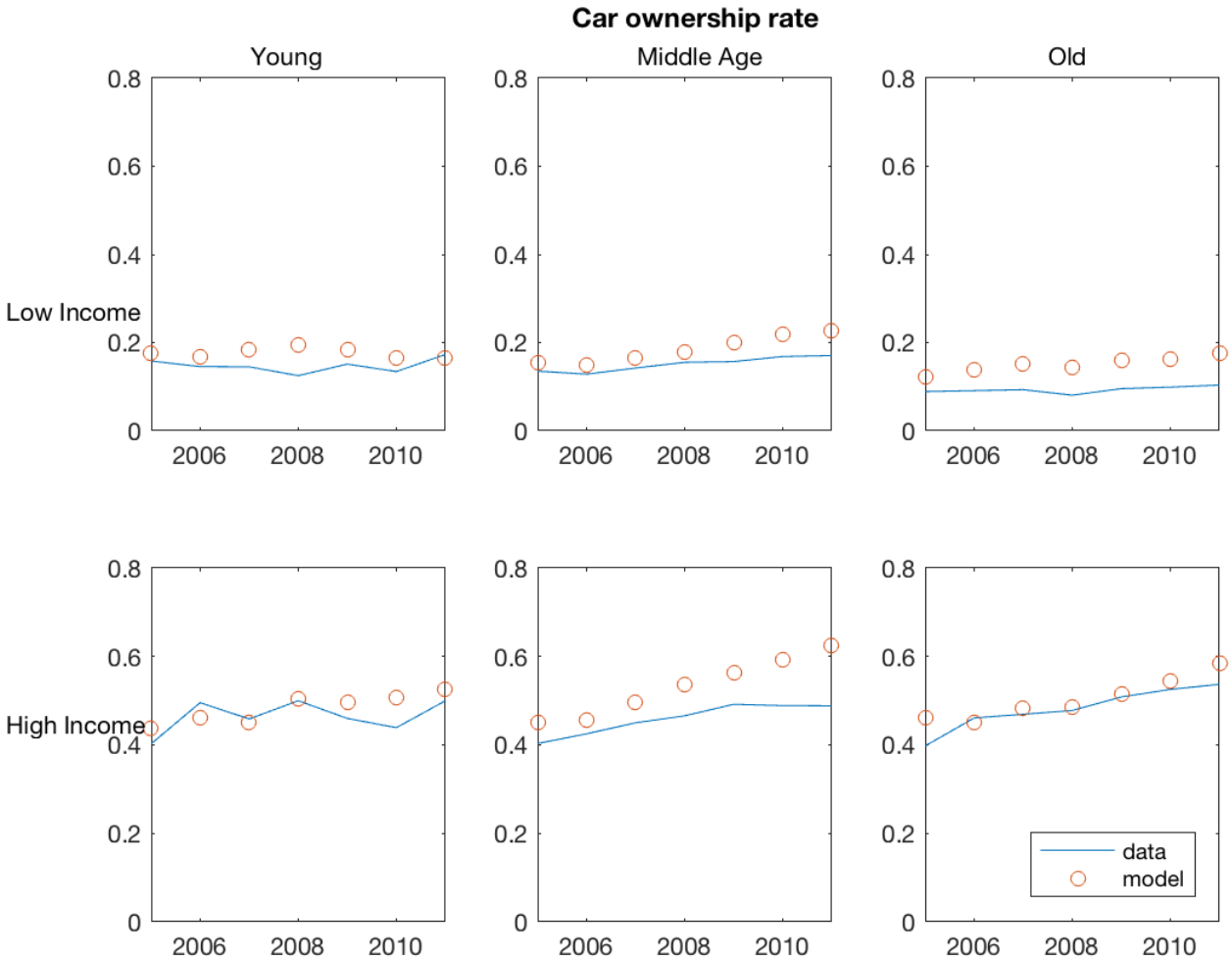
1. Car ownership rates
2. Frequency of adjustment
3. Probability of adjustment
4. Asset
5. Non-durable spending
6. Durable spending.

Parameter estimates

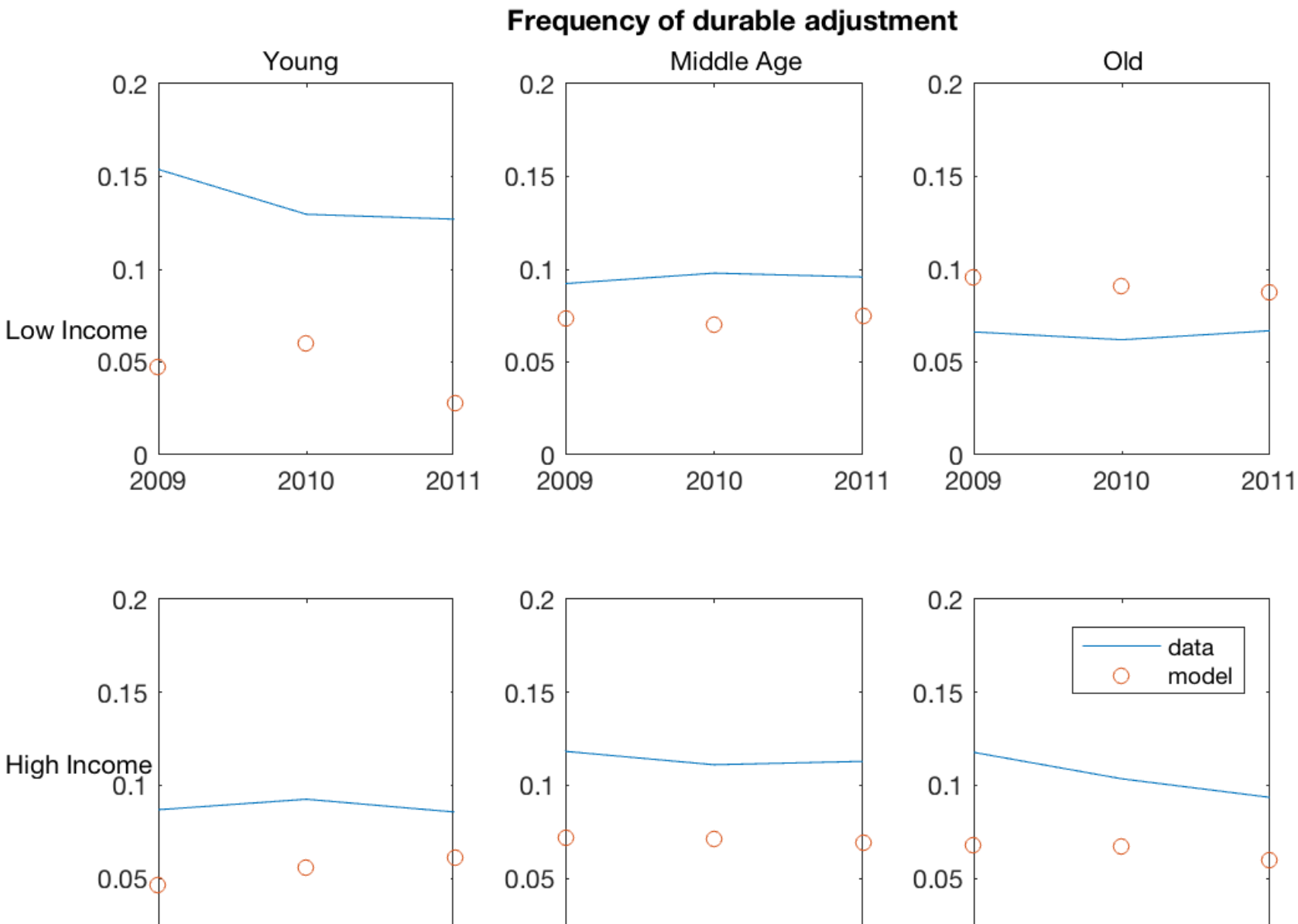
τ_1	589.76
τ_2	652.32
α	0.2654
σ	0.9453
ψ	2.3402

Table: Estimates

Targeted Moments
Car Onwership Rates

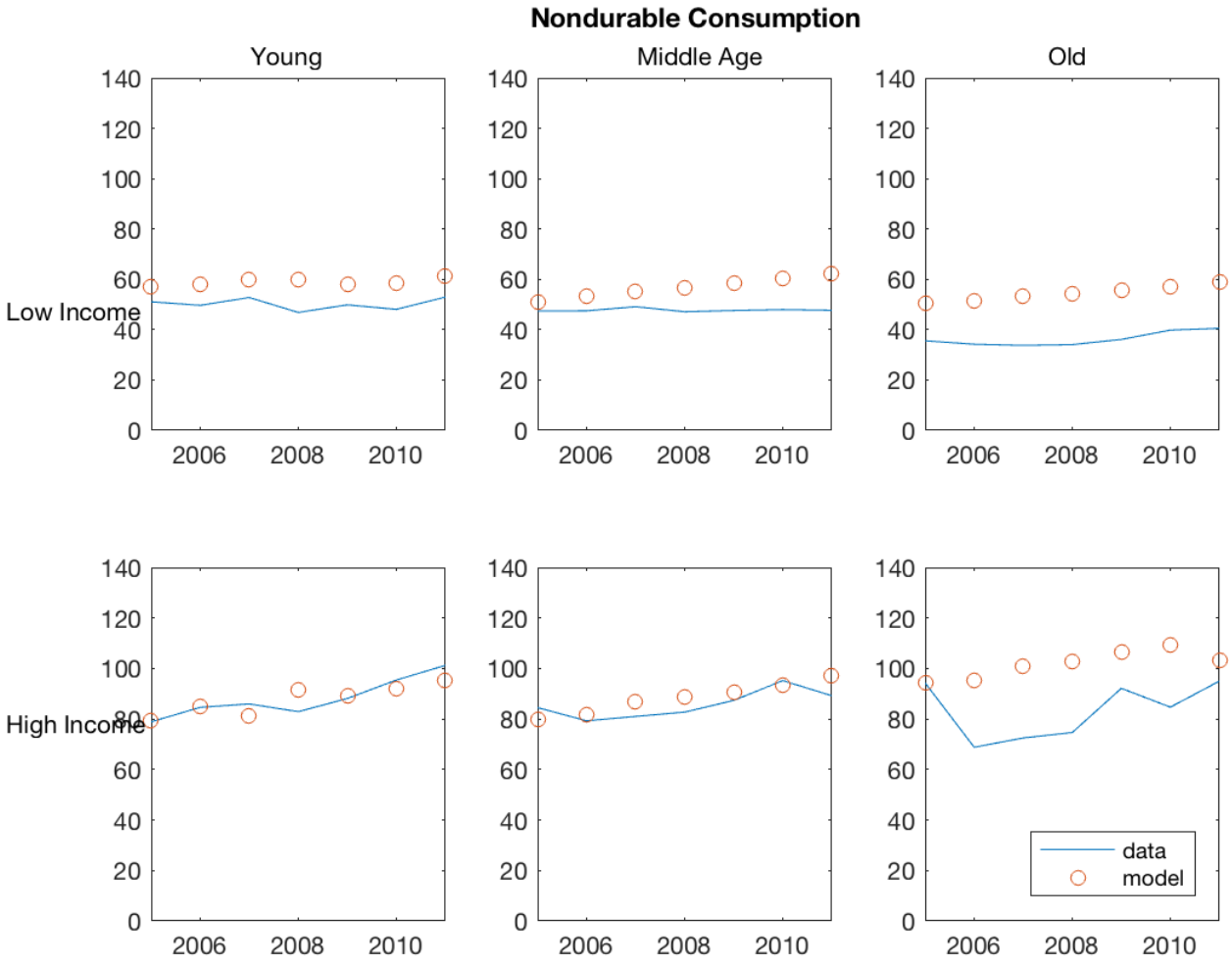


Targeted Moments
Frequency of Adjustment

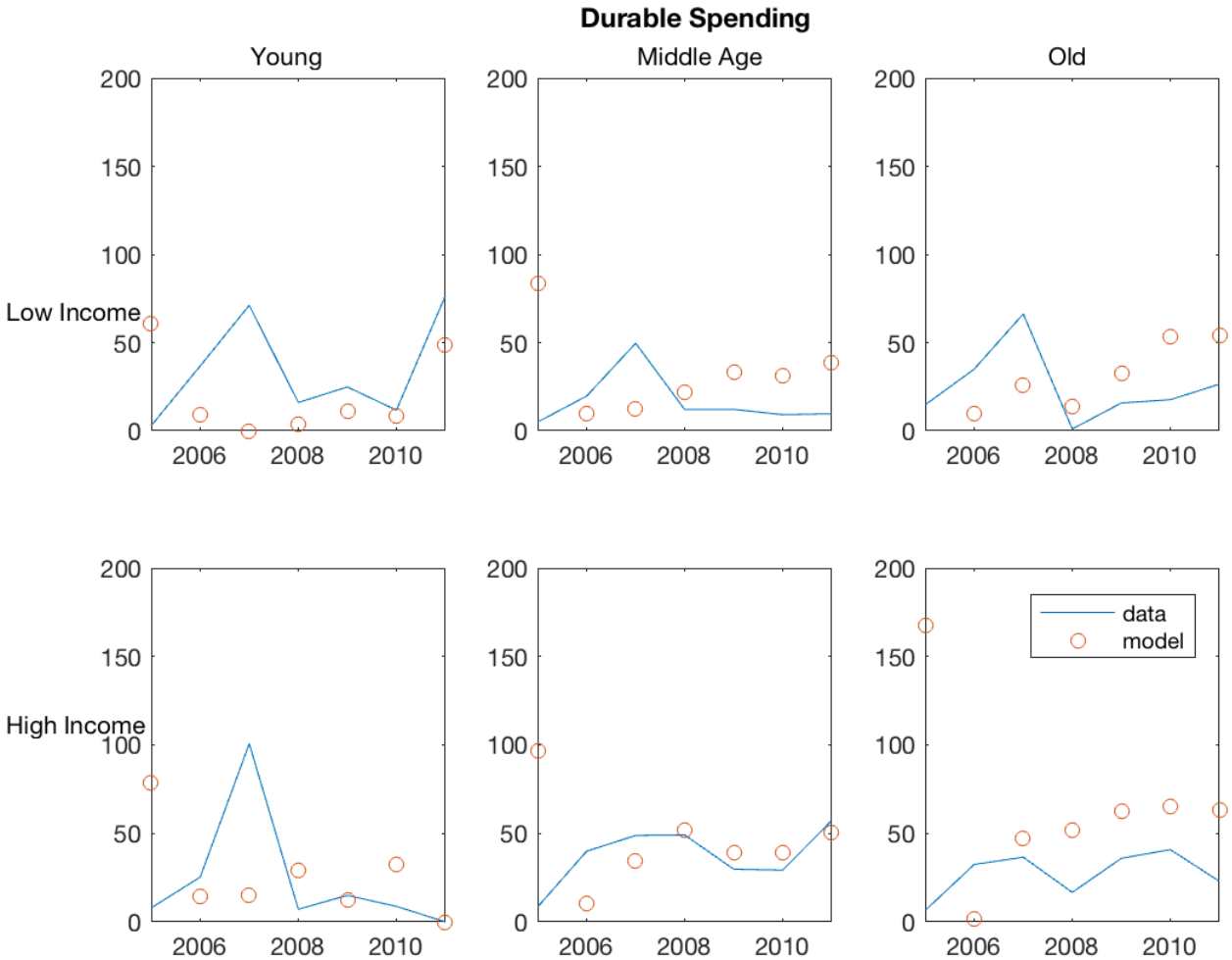


Targeted Moments
Assets

Targeted Moments
Non-durable Consumption



Targeted Moments
Durable Spending



Non-Targeted Moments
Durable Stock

Thai Economy Simulation

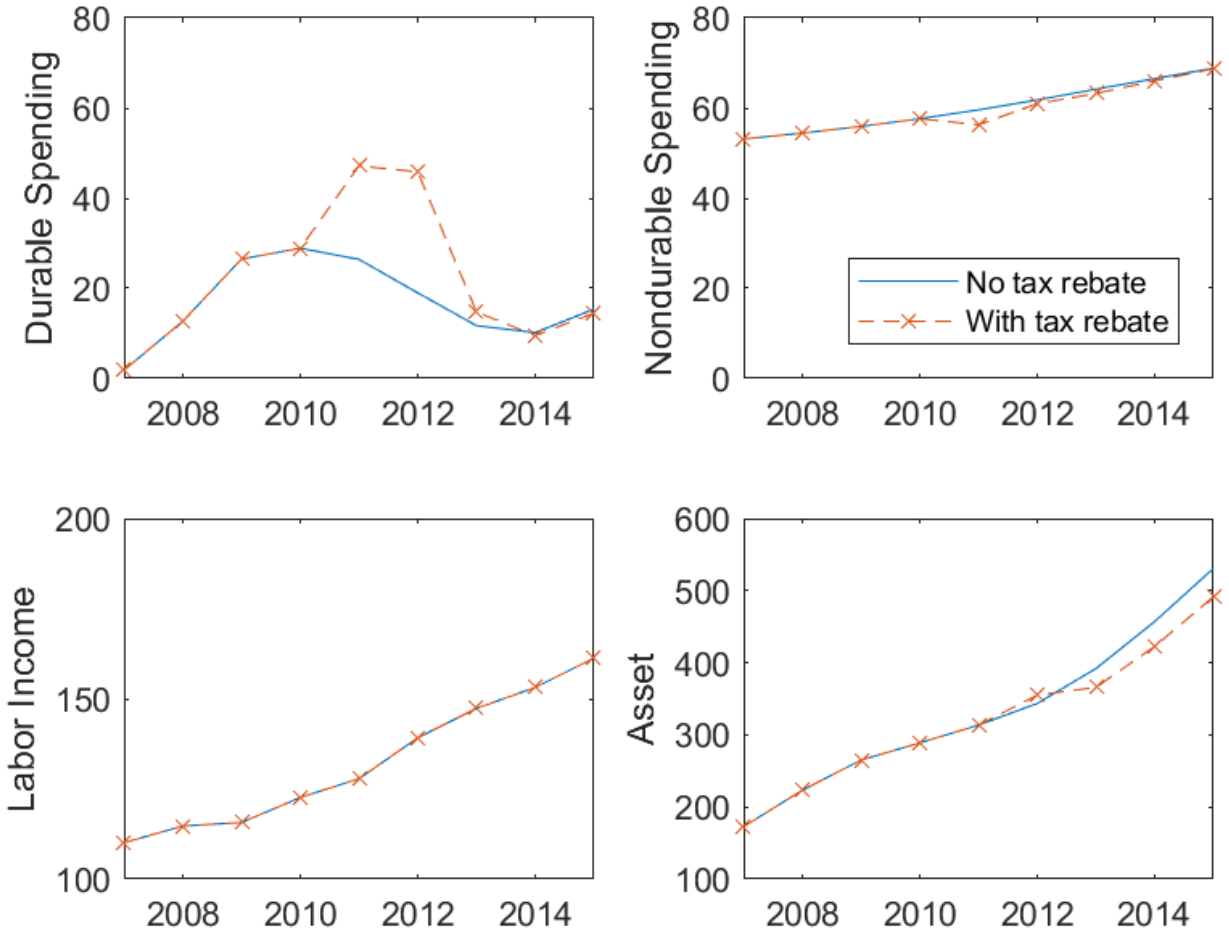
Start from simulating economy in 2005 by using initial distribution of state variables $(A, D, t, z)$from 1) Townsend's Thai Data, 2) Thailand Population Data, and 3) Annual Compensation of Employees from National Income in 2005 to 2015

Percentile	Young	Middle Age	Old
Income			
10th	20.3742	21.2512	12.5640
30th	45.9021	49.9741	34.8406
50th	79.9840	82.0556	60.3843
70th	117.2353	135.2242	113.9034
90th	216.1224	252.5160	239.1180
Asset			
10th	-83.2559	-100.6770	-57.9023
30th	-25.3541	-31.0156	-4.9154
50th	-5.5769	-1.7940	23.0558
70th	27.6121	65.4760	151.1958
90th	410.2276	475.8174	798.6896
Personal Vehicles			
10th	0	0	0
30th	0	0	0
50th	0	0	0
70th	0	0	0
90th	197.6870	256.1757	198.6870

Value in real term in year 2002 thousand THB

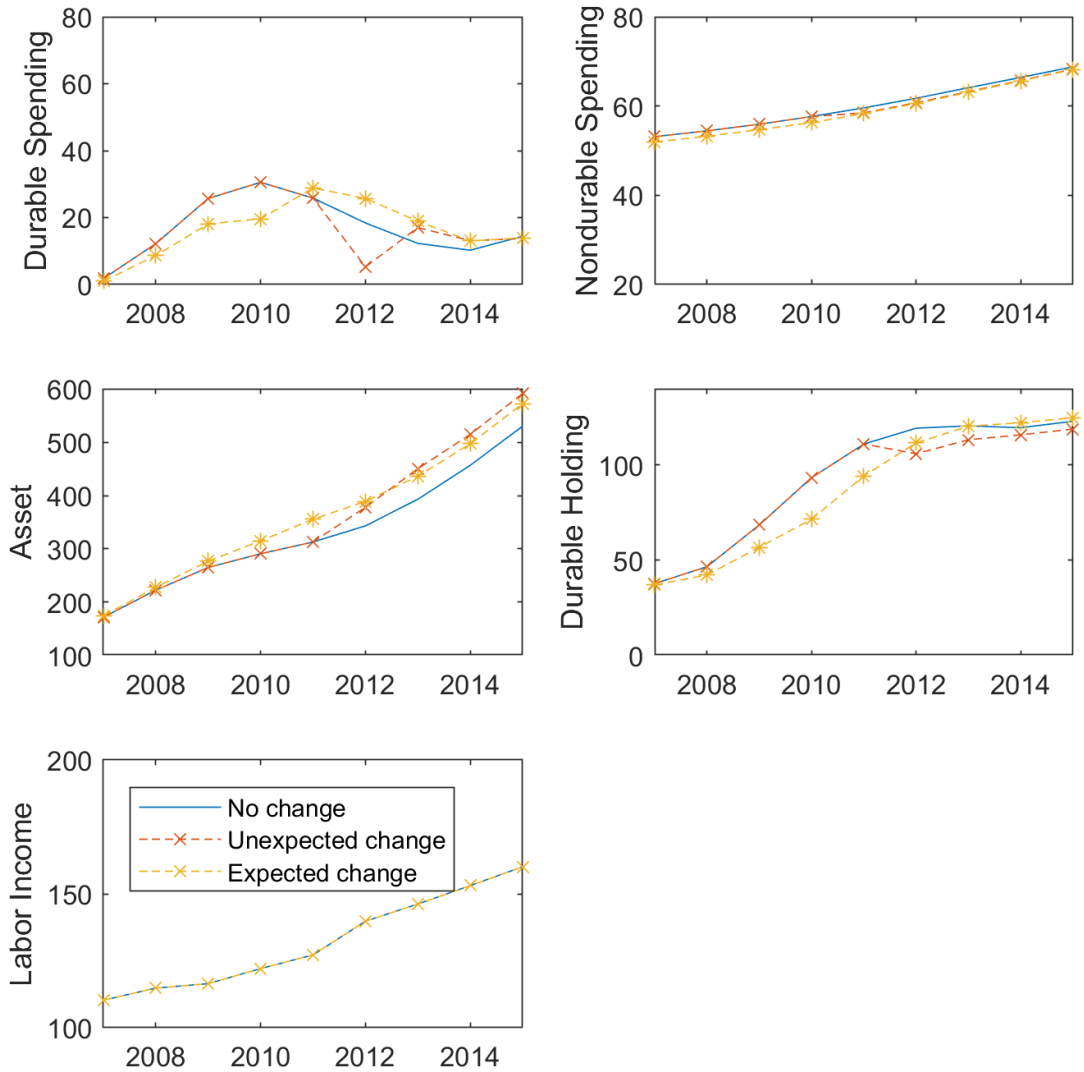
Model Predictions

Thailand's Tax Rebate Simulation



Interest Rate Change

The asset rate of return, r, changes from 5% to 5.5%.



Elasticity of intertemporal Substitution

Years after the rate change	Unexpected change (1)	No change (2)	(1)-(2)	**EIS**
t=0				
Nondurable+Durable	-0.069	-0.0319	-0.038	**-3.98**
Nondurable	0.0142	0.035	-0.0231	**-3.98**
Durable	-0.167	-0.1677	0	**0**
t=1				
Non-durable+Durable	-0.318	-0.096	-0.222	**-46.71**
Non-durable	0.0521	0.0687	-0.0166	**-3.489**
Durable	-0.507	-1.762	-1.594	**-264.04**

Consumption growth rate is calculated from $\ln C_{it}/C_{it-1}$

Aggregate EIS is calculated from $\ln(\frac{\sum C_{it}^{r=0.055}}{\sum C_{it}^{r=0.05}})/\ln(\frac{1+0.055}{1+0.05})$

Note that changes in durable shown here only reflect durable spending only. If household adjust their durable stock downward, this is not reflected in the EIS of durable calculated.

Table: Aggregate consumption growth given an unexpected and permanent change of 0.5% in real interest rate.

Heterogeneity in Responses to Interest Rate Change

Income quintile	1	2	3	4	5
Years after the rate change					
t=0	*Non-durable consumption*				
Young	-15.3838	-10.7006	-7.4673	-3.9251	0.0755
Middle Age	-9.6155	-7.5859	-4.4405	-4.4971	2.8819
Old	-2.1101	-2.0258	1.4505	3.7915	-2.1139
t=1					
	Non-durable consumption				
Young	-11.9989	-9.7911	-6.3606	-2.4030	-1.3866
Middle Age	-8.5881	-6.7969	-3.2335	-1.7099	0.6227
Old	-1.1840	-1.0907	1.0421	4.3409	-0.7523
	Durable spending				
Young	NA	NA	-332.5354	-246.0743	-388.0935
Middle Age	NA	-90.4792	-179.2275	-177.5845	-222.9534
Old	NA	NA	-163.0574	-88.2789	-61.3172
	Non-durable + Durable spending				
Young	-23.4761	-19.2970	-29.5814	-50.7130	-104.6438
Middle Age	-19.3670	-13.6164	-36.6854	-14.9088	-70.4760
Old	-2.8300	-1.3115	1.6549	-21.9404	-1.4356

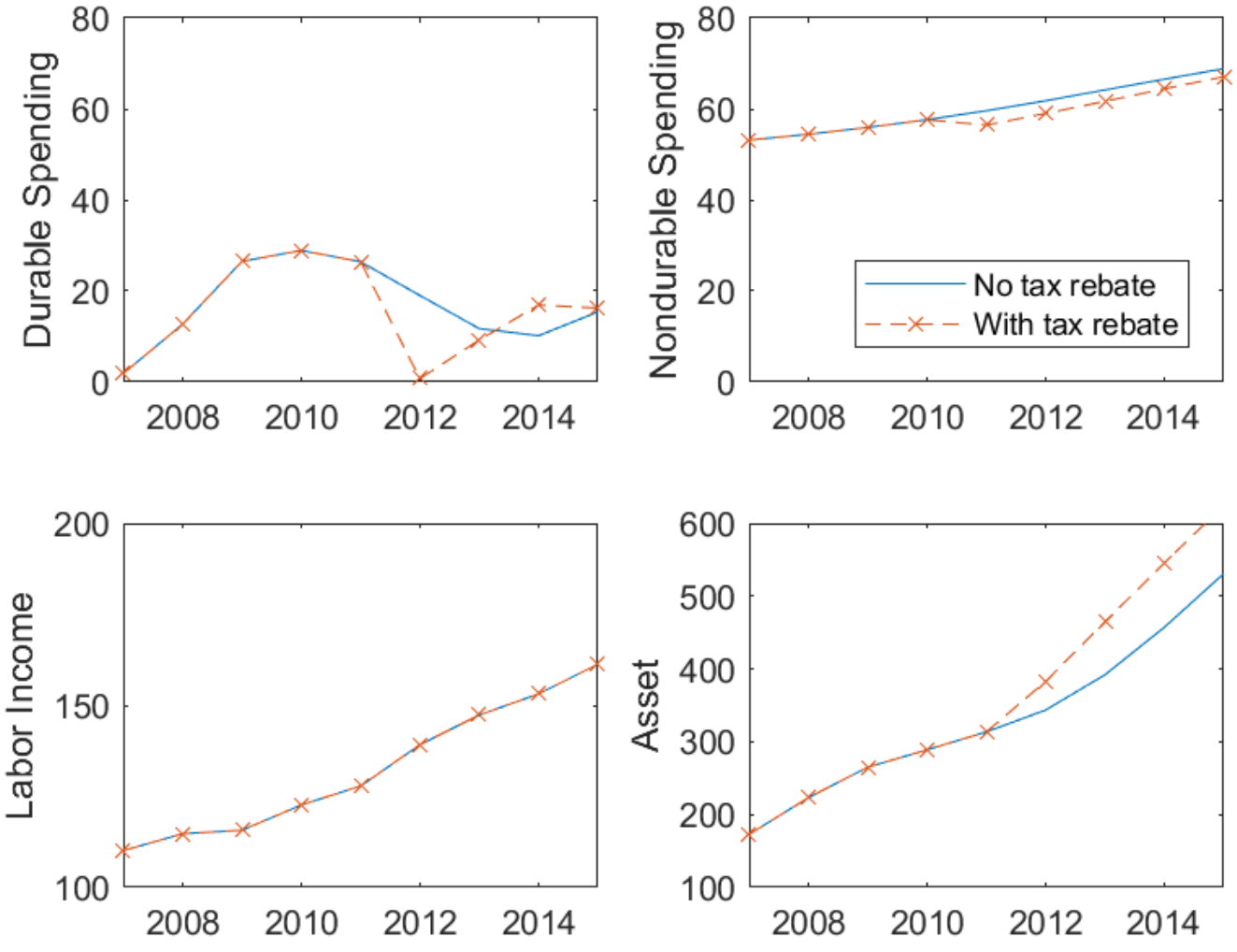
EIS is calculated from $\ln(\frac{\sum C_{it}^{r=0.055}}{\sum C_{it}^{r=0.05}}) / \ln(\frac{1+0.055}{1+0.05})$

Table: Heterogeneity in Consumption Responses from a Simulation Given Unexpected Real Interest Rate Change of 0.5%

Policy Experiment

Consumption Tax Exemption

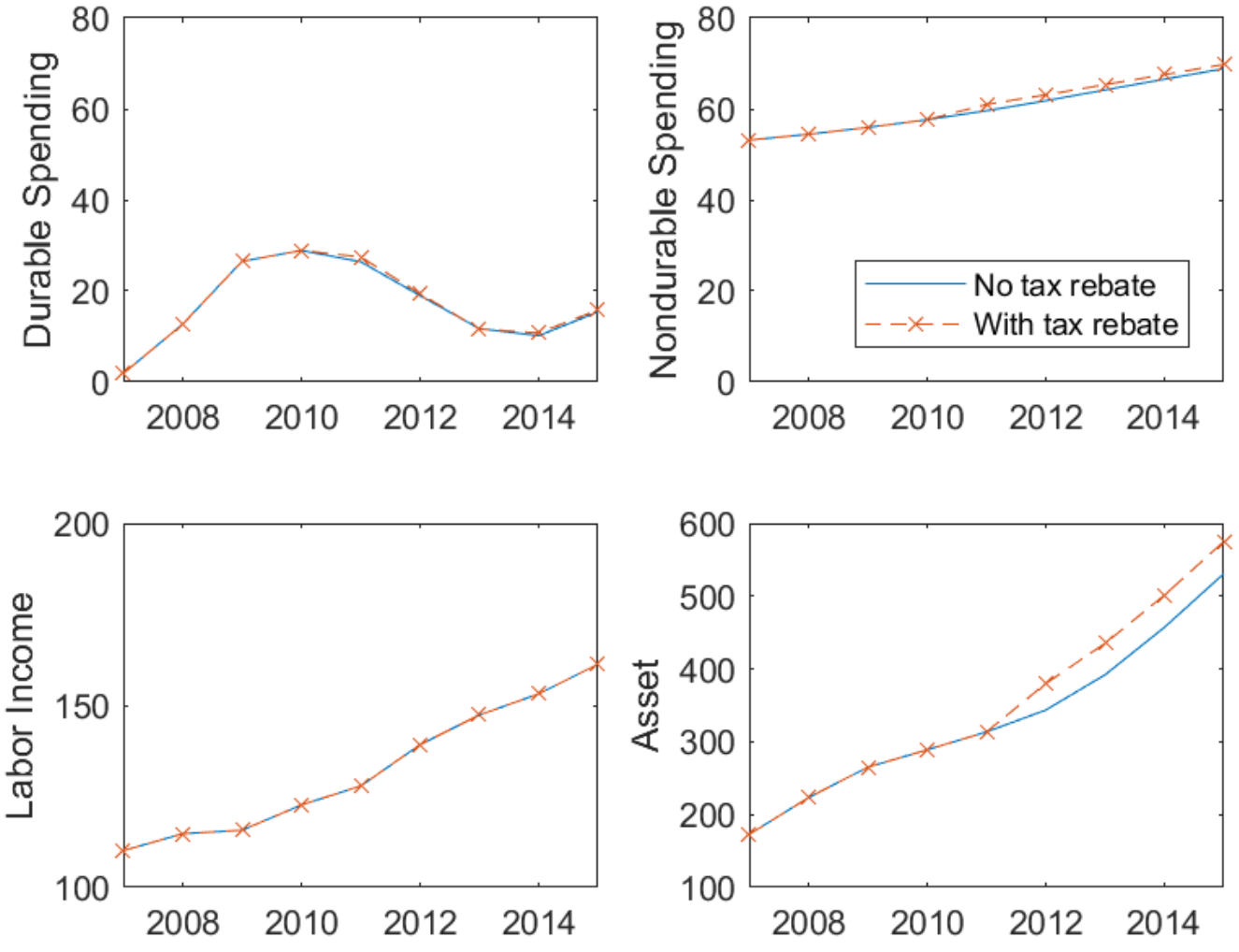
The consumption tax exemption is *unexpected* and *temporary* in year 2011 and 2012.



Policy Experiment

Income Tax Exemption

The labor income tax exemption is *unexpected* and *temporary* in year 2011 and 2012.



Policy Experiment

Comparison of Policy Impacts

Years after the policy introduction	0	1	2	3	4
Car Tax Break					
Non-durable spending	-0.0573	-0.0135	-0.0149	-0.0076	-0.0019
Durable spending	0.5794	0.8817	0.2308	-0.0646	-0.0592
Assets	0.0329	-0.0691	-0.0786	-0.0767	-0.0747
Nondurable Consumption Tax Break					
Non-durable spending	0.0853	0.0821	0.0118	0.0099	0.0088
Durable spending	0.0140	-0.0139	-0.0115	-0.0033	0.0205
Assets	0.0869	0.0788	0.0699	0.0622	0.0557
Income Tax Break					
Non-durable spending	0.0228	0.0207	0.0179	0.0151	0.0135
Durable spending	0.0385	0.0232	-0.0082	0.0575	0.0281
Assets	0.1007	0.1044	0.0920	0.0801	0.0712

Changes reported are calculated from $\ln(\sum X_{it}^{taxbreak} / \sum X_{it}^{notaxbreak})$

Table: Policy Experiments: Comparison of Aggregated Optimal Consumption and Assets

Policy Experiment Results

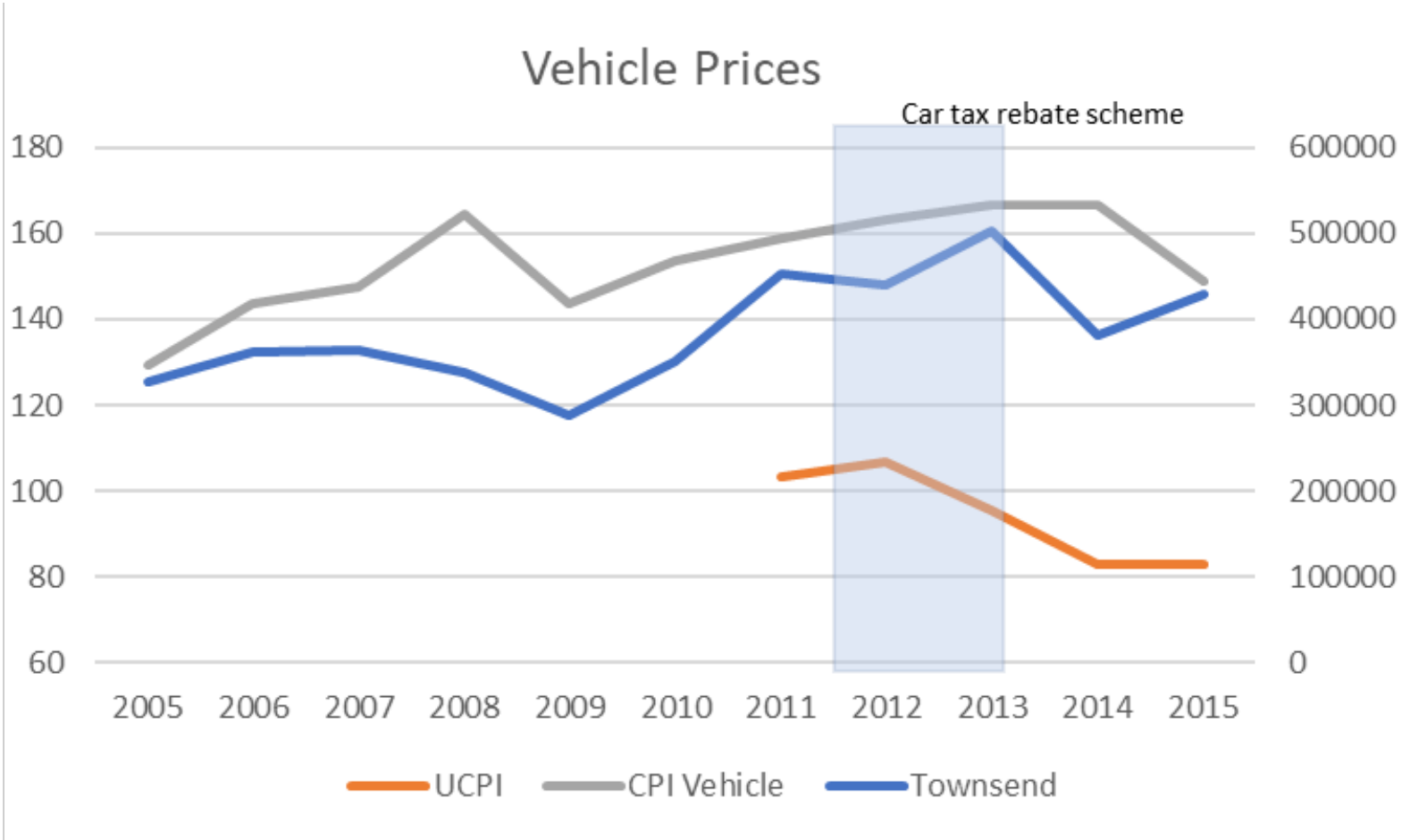
- Durable tax exemption is predicted to result in reversal impacts on nondurable consumption and saving. This operates through substitution, income and wealth effects of durables.
- Alternative policy, including unexpected and temporary consumption tax break and income tax break, lead to higher saving (i.e. improvement of household balance sheet) and higher overall consumption

Conclusions

- The model renders reasonable prediction in comparison to historical aggregate data
- Thai households are estimated to have very high EIS, i.e. high willingness to substitute consumption between periods
- High EIS is consistent with recent and prominent works that structurally estimate EIS (Hansen et. at, 2007), (Bansal and Yaron, 2004), and (Barro, 2009)
- Seemingly 'reckless' spending during the first car is in fact potentially in line with the rational and optimal pathways

Back up

Policy Experiment
Vehicle prices



Contributions

This paper is related to a few strands of literature.

Fiscal Stimulus During Recession

- How policy-induced changes in real income translate into consumption.

Permanent Income Hypothesis:

- The tax cut was sizable and *unanticipated*, which lead to a revision in permanent income of participated households.

Life-cycle asset allocation:

- durables (illiquid) vs. liquid assets

Closely related works:

- Kaplan and Violante (2015)
- Berger and Vavra (2015)

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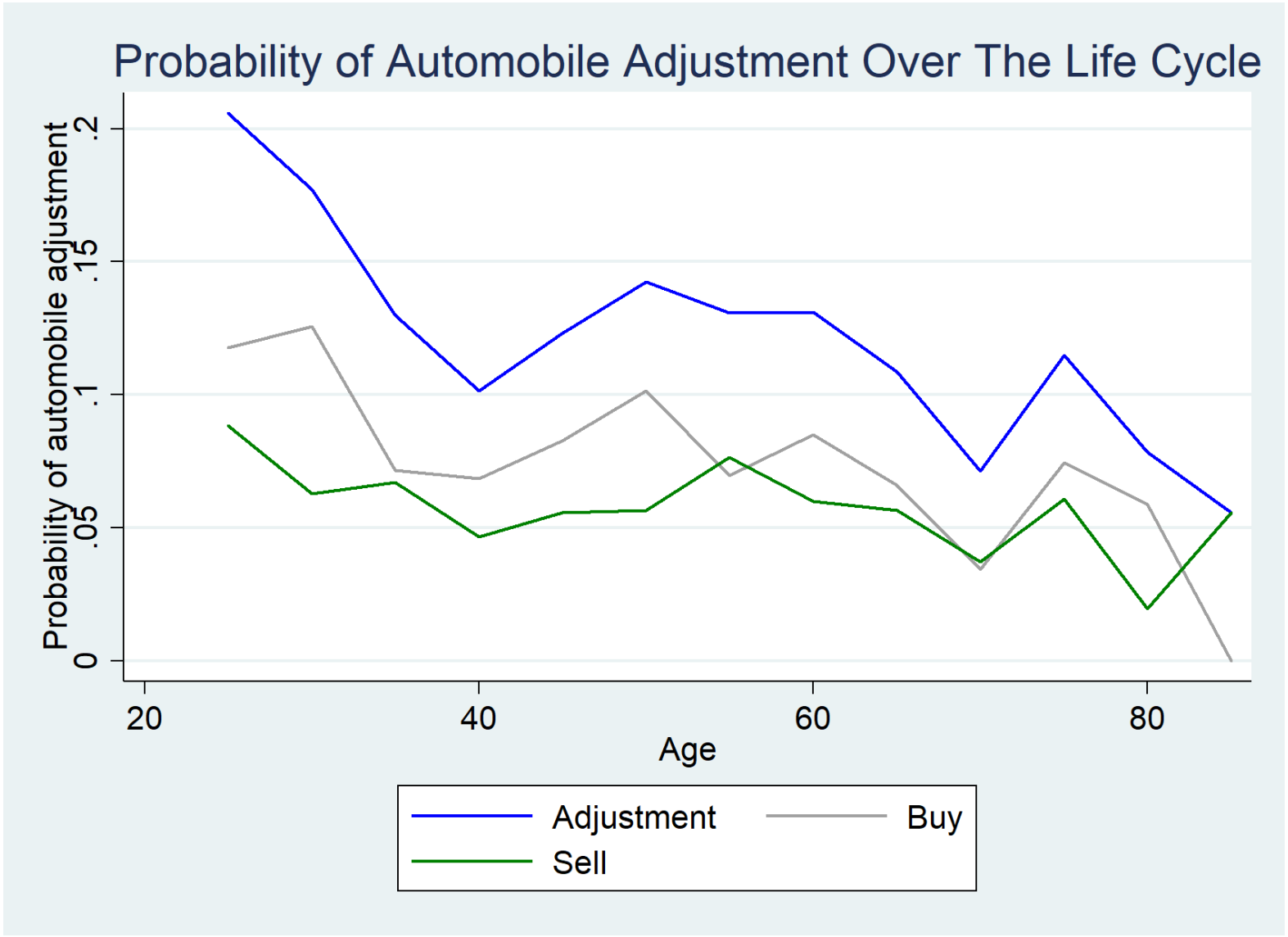
Frequency of adjustment



Moments
Year X Income X Age

Fraction of households that owns a car for each (year X income X age) cell

	Young (25-40)	Middle Age (41-60)	Old 61+
Low Income	0.13	0.16	0.10
(1-3rd quintiles)	(67)	(475)	(435)
High Income	0.44	0.49	0.53
(4-5th quintiles)	(67)	(475)	(435)

Table: Fraction in 2010.Number of observations in parenthesis

Moments
Year X Income X Age

Household assets for each (year X income X age) cell

	Young (25-40)	Middle Age (41-60)	Old 61+
Low Income	241	324	301
(1-3rd quintiles)	(67)	(475)	(435)
High Income	410	530	738
(4-5th quintiles)	(41)	(405)	(196)

Table: Household assets in 2010, unit in 1000 THB
Number of observations in parenthesis