Intertemporal Substitution in Consumption: Evidence From A European Survey

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Table of Contents

Table of Contents

Motivation

- This thesis aims at estimating the elasticity of intertemporal substitution (EIS) in consumption
- The study also assesses whether households postpone consumption due to income and inflation uncertainty
- The thesis tries to find evidence for heterogeneity at the household and country level
- The work also presents an incomplete markets model to study how EIS impacts on the marginal propensity to consume

Importance of the findings

- The estimation of elasticity of intertemporal substitution (EIS) is crucial from two viewpoints
  1. Studying the impact of monetary and fiscal policy on consumption
  2. EIS is a crucial parameter used in macroeconomic models
- Postponed consumption to income and inflation risk might be evidence for precautionary savings
- Studying heterogeneity is crucial for the analysis of distributional macroeconomic effects

Novelty of the work

- This work is the first using the Euler equation approach with subjective expectations with European data
- The dataset is a new European survey that collects households' expectations of macroeconomic variables
- This is the first analysis that aims at assessing heterogeneity in the estimated parameters using subjective expectations

Literature Review

- Elasticity of intertemporal substitution: Attanasio and Weber (1993), Havranek et al. (2015), Crump et al. (2022)
- Expected consumption and inflation relationship: Ichiue and Nishiguchi (2015), Duca-Radu, Kenny and Reuter (2020), Drägher and Nghiem (2021)
- Precautionary savings and macroeconomic uncertainty: Jappelli, Pistaferri (2000), Ben-David et al. (2018), Coibion et al. (2021)
- Incomplete markets model and MPC: Huggett (1993), Kaplan and Violante (2022)

Table of Contents

Baseline Euler Equation

- The standard intertemporal consumption model is

$$\max_{\{c_t\}_{t=0}^{\infty}} \mathbb{E}_t \left[\sum_{t=0}^{\infty} \beta^t U(c_t) \right] \qquad \text{s.t.} \qquad c_t + a_{t+1} = (1 + r_t)\, a_t + y_t$$

- A CRRA utility function is assumed to get an empirically tractable EIS

$$u(c_t) = \frac{c_t^{1-\frac{1}{\gamma}}}{1 - \frac{1}{\gamma}}$$

- The resulting Euler equation from the optimization problem is

$$\mathbb{E}_t \left[\left(\frac{c_{t+1}}{c_t} \right)^{-\frac{1}{\gamma}} \beta (1 + r_t) \right] = 1$$

Second order approximation

- Not including higher order moments in the log-linear approximation might lead to bias (Carroll (1997))
- The joint conditional distribution of consumption growth and future inflation rate is

$$\begin{bmatrix} \Delta \log c_{t+1} \\ \log(1+\pi_{t+1}) \end{bmatrix} | I_t \sim N \left[\begin{pmatrix} \mu_c \\ \mu_\pi \end{pmatrix} \quad \begin{pmatrix} \sigma_c^2 & \sigma_{c\pi} \\ \sigma_{c\pi} & \sigma_\pi^2 \end{pmatrix} \right]$$

- The traditional approach is to use realization of consumption

$$\Delta \log c_{t+1} = \mathbb{E}_t \left[\Delta \log c_{t+1} \right] + \epsilon_{t+1}$$

- I observe expectations: no need for traditional approach and GMM

Second order approximation

- Not including higher order moments in the log-linear approximation might lead to bias (Carroll (1997))
- The joint conditional distribution of consumption growth and future inflation rate is

$$\begin{bmatrix} \Delta \log c_{t+1} \\ \log(1+\pi_{t+1}) \end{bmatrix} | I_t \sim N \left[\begin{pmatrix} \mu_c \\ \mu_\pi \end{pmatrix} \begin{pmatrix} \sigma_c^2 & \sigma_{c\pi} \\ \sigma_{c\pi} & \sigma_\pi^2 \end{pmatrix} \right]$$

- Rewriting the real interest rate at time t in terms of Fisher equation

$$r_t = i_t - \mathbb{E}_t[\pi_{t+1}]$$

Second order approximation

- Not including higher order moments in the log-linear approximation might lead to bias (Carroll (1997))
- The joint conditional distribution of consumption growth and future inflation rate is

$$\begin{bmatrix} \Delta \log c_{t+1} \\ \log(1+\pi_{t+1}) \end{bmatrix} | I_t \sim N \left[\begin{pmatrix} \mu_c \\ \mu_\pi \end{pmatrix} \quad \begin{pmatrix} \sigma_c^2 & \sigma_{c\pi} \\ \sigma_{c\pi} & \sigma_\pi^2 \end{pmatrix} \right]$$

- The resulting second order log-linear approximation is the following

$$\begin{aligned} \mathbb{E}_t \left[\Delta \log c_{t+1} \right] = \gamma \log \beta + \gamma i_t - \gamma \mathbb{E}_t \left(\pi_{t+1} \right) + \\ + \frac{1}{2\gamma} Var \left(\Delta \log c_{t+1} - \gamma \pi_{t+1} \right) \end{aligned}$$

Empirical Strategy

- The empirical model to be estimated can be written in a regression framework as

$$\mathbb{E}_{i,t}\left[\Delta \log c_{i,t+1}\right] = \beta_0 + \beta_1 \mathbb{E}_{i,t}\left[\pi_{t+1}\right] + \beta_2 \sigma^2_{i,y} + \beta_3 \sigma^2_{i,\pi} + \\ + \alpha' c_{fe} + \gamma' t_{fe} + \epsilon_{i,t} \quad (1)$$

- Assumptions:
  1. Income variance as proxy of consumption variance
  2. Controlling for nominal interest rate by country and time fixed effects
  3. Controlling for correlation between income and inflation by vector of controls

Table of Contents

Consumer Expectations Survey

- The Consumer Expectations Survey (CES) is a recent high-frequency panel dataset that is provided by the European Central Bank
- The survey collects information on the households' expectations of the most important macroeconomic variables in the six largest Euro economies
- The main survey questions are conducted on a monthly basis asking for expectations of inflation, net income growth and consumption growth

Expected Consumption Growth

- The question about expectation of consumption growth is *"By what percent do you expect your household spending on all goods and services to change during the next 12 months compared with your spending in the past 12 months?"*
  - *Valid Range: -100.0 to 100.0*
  - *Don't know*
- Drawback: the question is about total spending, including durables
- A rigorous Euler equation approach would imply using expected non-durables consumption growth

Expectation of future inflation

- A question about inflation is

  "Now we would like you to think about how much prices in general in the country you currently live in are likely to change in 12 months from now. Below you see 8 possible ways in which prices could change. Please distribute 100 points among them, to indicate how likely you think it is that each price change will happen."

  - *-8% or less, [-8%,-4%], [-4%,-2%], [-2%,0%], [0%,2%], [2%,4%], [4%,8%], 8% or more*

- The density-implied expectations is measured by taking a weighted average of the expectation of each bin

Expected disposable income growth

- The definition of net household income growth is given in the first question

  "By about what percent do you expect the total net income of your household to increase (decrease)? That is after tax and compulsory deductions."

- The bins for the probabilistic expectations are the same as for inflation expectations

Expectations over time

- The pattern of the expectations of the three main variables is

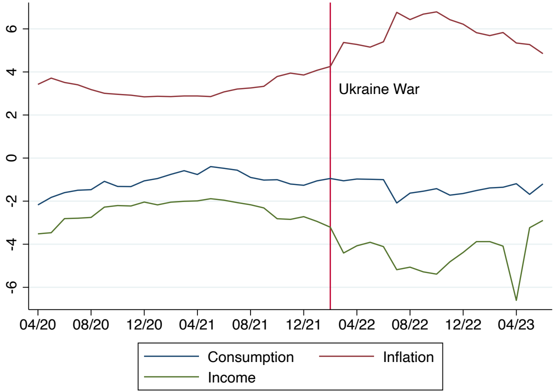

Figure: Inflation, Income and Consumption Expectations

Variance of income and inflation

- This graph shows the distribution of density-implied variances of both variables

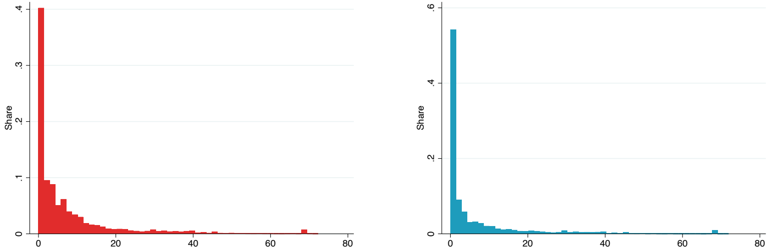

Figure: Inflation vs. Income Density-Implied Variance

Cross-sectional statistics

- The following table shows the descriptive statistics of the expectations across different groups of households.

Expectations	$\mathbb{E}_t[\pi_{t+1}]$	$\mathbb{E}_t[\Delta \log Y_{t+1}]$	$\mathbb{E}_t[\Delta \log c_{t+1}]$	Observations
	Mean	Mean	Mean	
Average	4.55	−3.43	−1.23	383.076
Education				
ISCED 0-2	4.36	−2.98	−1.06	47.942
ISCED 3-4	4.68	−3.63	−1.31	122.191
ISCED 5-8	4.52	−3.42	−1.22	212.943
Gender				
Male	4.37	−3.08	−1.29	195.392
Female	4.74	−3.80	−1.16	187.684
Age				
18-34	3.75	−1.99	−0.88	78.344
35-49	4.54	−3.37	−1.15	170.198
50-70	4.99	−4.34	−1.50	113.131
71+	5.25	−4.38	−1.70	21.403
Income				
I Quantile	4.52	−3.54	−1.09	73.269
II Quantile	4.69	−3.55	−1.36	74.467
III Quantile	4.60	−3.52	−1.33	75.687
IV Quantile	4.56	−3.37	−1.32	76.250
V Quantile	4.39	−3.21	−1.05	83.403

Table of Contents

Baseline EIS

- The results of the regression are the following

Table: Elasticity of Intertemporal Substitution

	(1)	(2)	(3)
$\mathbb{E}_t\left[\pi_{t+1}\right]$	-0.554***	-0.558***	-0.560***
	(0.0220)	(0.0213)	(0.0215)
σ_π^2	0.0189***	0.0182***	0.0179***
	(0.00345)	(0.00344)	(0.00346)
σ_y^2	0.0178***	0.0180***	0.0185***
	(0.00358)	(0.00360)	(0.00361)
Observations	383,076	383,076	383,076
Demos Controls	·	✓	✓
Interaction Term	·	·	✓
R-squared	0.064	0.064	0.066

- The elasticity of intertemporal substitution is about 0.5
- Households postpone for income and inflation risk

Table of Contents

Cross-sectional heterogeneity

- The empirical strategy aims at studying the potential heterogeneity across groups of households
- The following table shows the results

Table: A Cross-Sectional Analysis

	(1)	(2)	(3)	
	$\mathbb{E}_t[\pi_{t+1}]$	σ^2_π	σ^2_y	Observations
Education				
ISCED 0-2	-0.586***	0.0145	0.0236*	47,942
	(0.0319)	(0.0122)	(0.0131)	
ISCED 3-4	-0.526***	0.0208***	0.0128*	122,191
	(0.0274)	(0.0064)	(0.0075)	
ISCED 5-8	-0.563***	0.0197***	0.0189***	212,943
	(0.0239)	(0.0047)	(0.0040)	
Age				
18-34	-0.608***	0.0140**	0.0114**	78,344
	(0.0283)	(0.0055)	(0.0046)	
35-49	-0.543***	0.0274***	0.0160***	170,198
	(0.0280)	(0.0051)	(0.0049)	
50-70	-0.532***	0.0069	0.0302**	113,131
	(0.0249)	(0.0092)	(0.0119)	
71+	-0.583***	0.0241	0.0127	21,403
	(0.0375)	(0.0159)	(0.0119)	

- The empirical strategy aims at studying the potential heterogeneity across groups of households
- The following table shows the results

Table: A Cross-Sectional Analysis

	$\mathbb{E}_t\left[\pi^p_{t+1}\right]$	$\mathbb{E}_t\left[\Delta \log Y^d_{t+1}\right]$	Observations	
Income				
Quantile I	-0.525***	0.0172**	0.0204***	73,269
	(0.0308)	(0.0066)	(0.0064)	
Quantile II	-0.571***	0.0240***	0.0182*	74,467
	(0.0303)	(0.0083)	(0.0095)	
Quantile III	-0.546***	0.0233***	0.0228***	75,687
	(0.0316)	(0.0071)	(0.0078)	
Quantile IV	-0.547***	0.0147*	0.0126	76,250
	(0.0272)	(0.0084)	(0.0081)	
Quantile V	-0.580***	0.0157*	0.0136*	83,403
	(0.0295)	(0.0087)	(0.0075)	
Financial Literacy				
0	-0.459***	0.0174***	0.0315***	154,100
	(0.0269)	(0.0052)	(0.0061)	
1	-0.672***	0.0123**	0.0049	220,177
	(0.0205)	(0.0046)	(0.0039)	

Cross-country heterogeneity

- The table shows the estimate of the EIS across countries

Table: EIS: A Cross-Country Analysis

	(1)	(2)	(3)	
	$\mathbb{E}_t[\pi_{t+1}]$	$\mathbb{E}_t[\pi_{t+1}]$	$\mathbb{E}_t[\pi_{t+1}]$	Observations
Countries				
Belgium	-0.347***	-0.363***	-0.361***	32,200
	(0.0449)	(0.0432)	(0.0434)	
Germany	-0.518***	-0.524***	-0.523***	71,459
	(0.0444)	(0.0424)	(0.0429)	
Spain	-0.566***	-0.570***	-0.570***	85,353
	(0.0294)	(0.0287)	(0.0288)	
France	-0.639***	-0.639***	-0.638***	69,775
	(0.0286)	(0.0278)	(0.0282)	
Italy	-0.589***	-0.588***	-0.588***	91,694
	(0.0302)	(0.0299)	(0.0299)	
Netherlands	-0.468***	-0.482***	-0.481***	32,595
	(0.0387)	(0.0371)	(0.0375)	

- There is heterogeneity in the EIS across countries

Table of Contents

Incomplete Markets Model

- How does this parameter affects the aggregate MPC? What are the channels through which it influences it?
- I take the workhorse model of heterogenous agents and solve it for different levels of the EIS coefficients
- I can decompose the impact in a direct effect of EIS and an effect mediated through the stationary distribution.

Household's problem

- The sequential household's problem admits a recursive representation with two-dimensional state $\mathrm{x} = (a, y) \in \mathbb{R}^2_+$ and a consumption choice $c \in \mathbb{R}_+$. The representative agents' Bellman equation is

$$V(\mathrm{x}) = \max_{c \geq 0} u(c) + \beta \mathbb{E}\left(V(\mathrm{x}')\right)$$

$$\begin{aligned} &\text{s.t.} \\ a' &= y + (1+r)a - c \\ \log y' &= \rho \log y + \epsilon \\ a' &\geq 0 \end{aligned}$$

Calibration

- I parametrize the income process using data from the GRID (Global Repository of Income Dynamics), the real interest rate $r_t = 0.01$
- I calibrate the discount factor β matching the data on wealth
- I simulate two economies, using different the EIS of Germany and France, i.e. $\gamma_G = 0.52$ and $\gamma_F = 0.64$

MPC

- The MPC out of an unexpected shock to cash-on-hand is defined as

$$MPC\left(\mathrm{x}\right) = \lim_{\varepsilon \to 0} \frac{c\left(\mathrm{x}+\varepsilon\right) - c\left(\mathrm{x}\right)}{\varepsilon}$$

- The aggregate MPC is determined as

$$\overline{MPC}\left(\gamma\right) = \mathbb{E}_{\mu_\gamma}\left[MPC_\gamma\left(\mathrm{x}\right)\right] = \int_{\mathbb{R}^2_+} MPC_\gamma\left(\mathrm{x}\right) \mathrm{d}\mu_\gamma\left(\mathrm{x}\right)$$

- In order to quantify the impact of the EIS on the MPC, we can compare the aggregate MPC in the two countries with heterogeneous EIS γ

MPC decomposition

- The difference in the aggregate MPC is

$$\int MPC_{\gamma_G}(x)\, d\mu_{\gamma_G}(x) - \int MPC_{\gamma_F}(x)\, d\mu_{\gamma_F}(x) =$$
$$= \int MPC_{\gamma_G}(x)\, d\mu_{\gamma_G}(x) - \int MPC_{\gamma_F}(x)\, d\mu_{\gamma_G}(x) +$$
$$+ \int MPC_{\gamma_F}(x)\, d\mu_{\gamma_G}(x) - \int MPC_{\gamma_F}(x)\, d\mu_{\gamma_F}(x)$$

- which can be rewritten as

$$\int \underbrace{MPC_{\gamma_G}(x) - MPC_{\gamma_F}(x)}_{\text{Direct effect}}\, d\mu_{\gamma_G}(x) +$$
$$+ \int MPC_{\gamma_F}(x)\, d\Bigg(\underbrace{\mu_{\gamma_G}(x) - \mu_{\gamma_F}(x)}_{\text{Distribution effect}}\Bigg)$$

Direct and distribution effect

- The *Direct Effect* shows that the EIS affects the individual propensity to consume for each fixed state $x = (a, y)$, namely it impacts the function inside the expectation operator
- The *Distribution effect* shows that the EIS affects the stationary distribution, i.e. the distribution under which this expectation is taken
- The overall effect is

$$\Delta MPC = 0.02 - 0.04 = -0.02$$

- The distribution effect dominates the direct effect

Table of Contents

Conclusion

- This thesis aims at estimating the elasticity of intertemporal substitution and whether consumption responds to income and inflation risk
- The estimated elasticity of intertemporal substitution in the benchmark specification is 0.5
- Households postpone consumption out of income and inflation uncertainty
- There is evidence of heterogeneity in the estimates of the EIS across groups and countries
- The EIS affects the MPC through two counteractive channels in an incomplete markets model