CEMMAP Lectures on Contracts & Market Microstructure

1. Competitive Equilibrium and the Social Planning Problem

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- *Competitive equilibrium* is the bedrock of economics:
  - Consumers reveal their preferences through their choices (*founded upon the three axioms of reflexive, transitive and continuous preferences)*;
  - Given the price of each commodity, consumers and producers buy or sell as many units as they wish (*individual optimization*);
  - At those prices the market for each commodity clears, supply matching demand (*existence of equilibrium*).
- A competitive equilibrium:
  - exhausts the *gains from trade*
  - attains *Pareto optimality* in a private-goods economy with complete markets *(all commodities are traded)*
- Before analyzing market microstructure, does the data reject:
  1. the allocation competitive equilibrium predicts?
  2. the complete markets hypothesis?

- Suppose there are J financial securities.
- Let p_{tj} denote the price of the j^{th} security in period t consumption units, and $q_{t-1,j}$ the amount a consumer owns at the beginning of the period.
- Let r_{tj} denote the real return on assets purchased in period $t-1$.
- The investor's budget constraint is:

$$c_t + \sum_{j=1}^{J} p_{tj} q_{tj} \leq \sum_{j=1}^{J} r_{tj} p_{t-1,j} q_{t-1,j}$$

- At t the consumer maximizes a concave objective function with linear constraints, choosing $(q_{s1}, \ldots, q_{sJ})$ to maximize:

$$u(c_t) + E_t \left[\sum_{s=t+1}^{T} \beta^{s-t} u(c_s) \right]$$

subject to the sequence of all the future budget constraints.

A Representative Consumer Model

First order conditions for portfolio choices

- Nonsatiation guarantees:

$$c_t = \sum_{j=1}^{J} \left(r_{tj} p_{t-1,j} q_{t-1,j} - p_{tj} q_{tj} \right)$$

- The interior first order condition for each $k \in \{1, \ldots, J\}$ requires:

$$\begin{aligned} & p_{tk} u' \left(\sum_{j=1}^{J} \left(r_{tj} p_{t-1,j} q_{t-1,j} - p_{tj} q_{tj} \right) \right) \\ \geq \quad & E_t \left[p_{tk} r_{t+1,k} \beta u' \left(\sum_{j=1}^{J} \left(r_{t+1,j} p_{tj} q_{tj} - p_{t+1,j} q_{t+1,j} \right) \right) \right] \end{aligned}$$

with equality holding if $q_{tj} > 0$.

Portfolio Choices in Competitive Equilibrium

The fundamental theorem of portfolio choice (Hansen and Jagannathan, 1991)

- Substituting c_t and c_{t+1} back into the marginal utilities and rearranging yields the fundamental equation of portfolio choice:

$$1 = E_t\left[r_{t+1,k}\beta\frac{u'\left(c_{t+1}\right)}{u'\left(c_t\right)}\right] \equiv E_t\left[r_{t+1,k}MRS_{t+1}\right]$$

- Recall from the definition of a covariance:

$$\begin{aligned} cov\left(r_{t+1,k}, MRS_{t+1}\right) &= E_t\left[r_{t+1,k}MRS_{t+1}\right] - E_t\left[r_{t+1,k}\right]E_t\left[MRS_{t+1}\right] \\ &= 1 - E_t\left[r_{t+1,k}\right]E_t\left[MRS_{t+1}\right] \\ &= 1 - E_t\left[r_{t+1,k}\right]/r_{t+1} \end{aligned}$$

  where the second line uses the fundamental equation of portfolio choice, and the third the definition of the risk free rate.

- Rearranging this equation gives the risk correction for the k^{th} asset:

$$E_t\left[r_{t+1,k}\right] - r_{t+1} = -r_{t+1}cov\left(r_{t+1,k}, MRS_{t+1}\right)$$

Portfolio Choices in Competitive Equilibrium

Estimation and testing (Hansen and Singleton, 1982)

- For any $r \times 1$ vector x_t belonging to the information set at t and all k:

$$0 = E_t \left[r_{t+1,k} \beta \frac{u'(c_{t+1})}{u'(c_t)} - 1 \right] = E \left[r_{t+1,k} \beta \frac{u'(c_{t+1})}{u'(c_t)} - 1 \left| x_t \right. \right]$$

  and hence:

$$0 = E \left\{ x_t \left[r_{t+1,k} \beta \frac{u'(c_{t+1})}{u'(c_t)} - 1 \right] \right\}$$

- Given a sample of length T we can estimate the $1 \times I$ vector (β, α) for a parametrically defined utility function $u(c_t; \alpha)$ by solving:

$$0 = A_T \sum_{t=1}^{T} x_t \left[r_{t+1,k} \beta \frac{u'(c_{t+1}; \alpha)}{u'(c_t; \alpha)} - 1 \right]$$

  where A_T is an $I \times r$ weighting matrix.
- Clearly this estimator easily generalizes to any number of assets with an interior condition.

Representative Consumer Model

Estimates from aggregate consumption data (Hansen and Singleton, 1984, Table I)

INSTRUMENTAL VARIABLE ESTIMATES FOR THE PERIOD 1959:2–1978:12

Cons	Return	*NLAG*	$\hat{\alpha}$	$\widehat{\mathrm{SE}}(\hat{\alpha})$	$\hat{\beta}$	$\widehat{\mathrm{SE}}(\hat{\beta})$	χ^2	DF	Prob
NDS	EWR	1	− 0.9360	2.5550	.9930	.0060	5.226	1	.9774
NDS	EWR	2	0.1529	2.3468	.9906	.0056	7.378	3	.9392
NDS	EWR	4	1.2605	2.2669	.9891	.0059	9.146	7	.7577
NDS	EWR	6	0.1209	2.0455	.9928	.0054	14.556	11	.7963
NDS	VWR	1	− 1.0350	1.8765	.9982	.0045	1.071	1	.6993
NDS	VWR	2	0.1426	1.7002	.9965	.0044	3.467	3	.6749
NDS	VWR	4	− 0.0210	1.6525	.9969	.0043	5.718	7	.4270
NDS	VWR	6	− 1.1643	1.5104	.9997	.0041	11.040	11	.5601
ND	EWR	1	− 1.5906	1.0941	.9930	.0034	7.186	1	.9926
ND	EWR	2	− 0.7127	0.9916	.9918	.0034	12.040	3	.9928
ND	EWR	4	− 0.1261	0.8917	.9921	.0035	14.638	7	.9591
ND	EWR	6	− 0.4193	0.8256	.9936	.0033	18.016	11	.9188
ND	VWR	1	− 1.2028	0.7789	.9976	.0027	1.457	1	.7726
ND	VWR	2	− 0.5761	0.7067	.9975	.0027	5.819	3	.8792
ND	VWR	4	− 0.6565	0.6896	.9978	.0027	7.923	7	.6606
ND	VWR	6	− 0.9638	0.6425	.9985	.0027	10.522	11	.5159

Representative Consumer Model

Estimates from aggregate consumption data (Hansen and Singleton, 1984, Table III)

INSTRUMENTAL VARIABLES ESTIMATION WITH MULTIPLE RETURNS

Equally- and Value-Weighted Aggregate Returns 1959:2–1978:12

Cons	NLAG	$\hat{\alpha}$	$\widehat{SE}(\hat{\alpha})$	$\hat{\beta}$	$\widehat{SE}(\hat{\beta})$	χ^2	DF	Prob.
NDS	1	− 0.5901	1.7331	.9989	.0041	18.309	6	.9945
NDS	2	1.0945	1.4907	.9961	.0040	24.412	12	.9821
NDS	4	0.3835	1.4208	.9975	.0039	40.234	24	.9798
ND	1	− 0.6494	0.6838	.9982	.0025	19.976	6	.9972
ND	2	− 0.0200	0.6071	.9982	.0025	27.089	12	.9925
ND	4	− 0.1793	0.5928	.9986	.0025	42.005	24	.9871

Value-Weighted Aggregate Stock Returns and Risk-Free Bonds Returns 1959:2–1978:12

Cons	NLAG	$\hat{\alpha}$	$\widehat{SE}(\hat{\alpha})$	$\hat{\beta}$	$\widehat{SE}(\hat{\beta})$	χ^2	DF	Prob.
NDS	1	−.1405	.0420	.9998	.0001	31.800	8	.9999
NDS	2	−.1472	.0376	.9998	.0001	44.083	16	.9998
NDS	4	−.1405	.0320	.9996	.0001	65.250	32	.9995
ND	1	−.0962	.0461	.9995	.0001	25.623	8	.9988
ND	2	−.1150	.0377	.9995	.0001	39.874	16	.9991
ND	4	−.1611	.0364	.9994	.0001	60.846	32	.9985

Three Industry-Average Stock Returns 1959:2–1977:12

Cons	NLAG	$\hat{\alpha}$	$\widehat{SE}(\hat{\alpha})$	$\hat{\beta}$	$\widehat{SE}(\hat{\beta})$	χ^2	DF	Prob.
NDS	1	1.5517	1.8006	.9906	.0046	13.840	13	.6147
NDS	4	0.6713	1.2466	.9940	.0035	88.211	49	.9995
ND	1	0.7555	0.7899	.9924	.0029	13.580	13	.5959
ND	4	0.5312	0.5512	.9939	.0024	89.501	49	.9996

- To interpret these results, lifetime utility is:

$$\sum_{t=1}^{\infty} \beta^t u(c_t) = (1+\alpha)^{-1} \sum_{t=1}^{\infty} \beta^t c_t^{1+\alpha}$$

  - NDS (nondurables plus services)
  - ND (nondurables)
  - EWR (NYSE equally weighted average returns)
  - VWR (NYSE value weighted average returns)
  - Chemicals, transportation and equipment, and other retail, comprised the three industries.

- Note that:
  - 10 out of 12 specifications in Table III are rejected at the 0.05 level.
  - Since $\alpha > 0$ implies convex increasing $u(c_t)$, the 2 remaining specifications in Table III not rejected in a statistical sense do not make economic sense.

Representative Consumer Model

Possible explanations for the rejections

- There are several ways of interpreting these rejections:
  1. Competitive equilibrium does not adequately model outcomes from market microstructure.
  2. Different goods are not perfect substitutes (do not aggregate).
  3. The preferences of the representative consumer are not CRRA.
  4. The representative consumer . . .
     - does not obey the expected utility hypothesis (Epstein and Zin, 1990).
     - is time inconsistent, and has hyperbolic discounting (Laibson, 1997)
  5. The primitives are optimizing individuals belonging to a population and their aggregate behavior does not map into a representative consumer when markets are . . .
     - incomplete.
     - complete but there is time varying heterogeneity over the life cycle.

Relaxing the Assumption of a Representative Consumer

Why Euler equation estimation methods fail on a cross section (Altug and Miller, 1990)

- Can Euler equation methods be adapted to a panel data setting?
- Suppose $\{r_{tk}, x_{nt}, c_{nt}, c_{n,t+1}\}_{n=1}^{N}$ comes from households $n = 1, 2, \ldots$
- Write the utility for n as $u(c_{nt})$ for $u(c_t)$.
- Note the Euler equation holds for each person.
- Define ϵ_{nt}, the forecast error of n, and the average v_t, as:

$$\epsilon_{nt} \equiv r_{tk}\beta \frac{u'(c_{n,t+1})}{u'(c_{nt})} - 1$$

$$v_t \equiv \operatorname*{p\,lim}_{N\to\infty} \frac{1}{N} \sum_{n=1}^{N} x_{nt} \left[r_{tk}\beta \frac{u'(c_{n,t+1})}{u'(c_{nt})} - 1 \right] = \operatorname*{p\,lim}_{N\to\infty} \left[\frac{1}{N} \sum_{n=1}^{N} x_{nt}\epsilon_{nt} \right]$$

- If v_t depends on an *aggregate shock* to the economy hitting everyone in the economy, then $v_t \neq 0$.
- Note v_t is instrument specific, so treating v_t as a time dummy in estimation requires as many time dummies as there are instruments.
- Hence neither $u(\cdot)$ nor β are not identified off this panel.

Complete Markets

Commodity prices

- Let $\{\mathcal{F}_t\}_{t=0}^{\infty}$ denote a sequence of σ-algebras with measure $\mathcal{P}$ that reflects how history unfolds as the economy evolves.
- Each period $t \in \{\underline{n}, \ldots, \overline{n}\}$ household n consumes $(c_{nt1}, \ldots, c_{ntK})$.
- Define a commodity by the triplet (k, t, A).
- Let $p_{tk}(A)$ denote the date zero price of receiving a unit of k at t in the event of $A \in \mathcal{F}_t$ occurring:

$$p_{tk}(A) = \int_A \lambda_{tk}(\omega) \mathcal{P}(d\omega)$$

- The Radon-Nikodym derivative $\lambda_{tk}(\omega)$ converts the probability of events into a commodity price measure.

- Assume there are complete markets, that is an Arrow-Debreu economy where there is a competitive market for every commodity defined on k, t, and $\{\mathcal{F}_t\}_{t=0}^{\infty}$.
- The assumption of complete markets allows us to model the consumer budget set with one single lifetime budget constraint, rather than a sequence of period-specific budget constraints.
- The lifetime budget constraint for n is:

$$E_0 \left[\sum_{t=\underline{n}}^{\overline{n}} \sum_{k=1}^{K} \lambda_{tk} c_{ntk} \right] \leq B_n \tag{1}$$

- Suppose households obey the expected utility hypothesis, preferences taking the time additive form:

$$E_0\left[\sum_{t=\underline{n}}^{\overline{n}} \beta^{t-\underline{n}} u_{t-\underline{n}}\left(c_{nt1},\ldots,c_{ntK}\right)\right] \tag{2}$$

- Let:
  1. η_n denote the Lagrange multiplier associated with (1)
  2. p_{tk} denote the spot price of k at t (conditional the state)
  3. the first good be a numeraire and define $\lambda_t \equiv \lambda_{t1}$.
  4. $t_n \equiv t - \underline{n}$ denote the age of the household
  5. $c_{nt} \equiv \left(c_{nt1},\ldots,c_{ntK}\right)$ denote the consumption vector of n at t.
- Household n maximizes (2) subject to (1).
- Then the first order condition for an interior solution for k is:

$$\beta^{t_n} u_{t_n,k}\left(c_{nt}\right) \equiv \beta^{t_n}\frac{\partial u_{t_n}\left(c_{nt}\right)}{\partial c_{ntk}} = \eta_n\lambda_{tk} \equiv \eta_n\lambda_t p_{tk} \tag{3}$$

Complete Markets

Marginal rates of substitution in equilibrium

- Temporarily dropping for convenience the subscript n, the individual identifier, and setting $p_{t1} \equiv 1$, there are:
  1. $(K-1)(\overline{n}-\underline{n})$ equations corresponding to the spot markets:

$$MRS_{tk}(c_t) \equiv \frac{u_{tk}(c_t)}{u_{t1}(c_t)} = p_{tk}$$

  2. $(\overline{n}-\underline{n})-1$ equations pertaining to the numeraire that intertemporally balance consumption:

$$MRS_t(c_t, c_{t+1}) \equiv \frac{\beta u_{t+1,1}(c_{t+1})}{u_{t1}(c_t)} = \frac{\lambda_{t+1}}{\lambda_t}$$

- Given η_n, these $K(\overline{n}-\underline{n})-1$ marginal rates of substitution equations fully characterize an interior equilibrium consumption of n.

- For example suppose:

$$u_t\left(c_{nt}\right) \equiv \sum_{k=1}^{K} \frac{\exp\left(x_{nt} B_k + \epsilon_{ntk}\right)}{\alpha_k + 1} c_{ntk}^{\alpha_k + 1}$$

- Focusing on the first two goods we have:

$$\begin{aligned} p_{t2} &= MRS_{t2}\left(c_{nt}\right) \\ &= \exp\left[x_{nt}\left(B_2 - B_1\right) + \epsilon_{nt2} - \epsilon_{nt1}\right] \frac{c_{nt2}^{\alpha_2}}{c_{nt1}^{\alpha_1}} \end{aligned}$$

Taking logarithms:

$$\begin{aligned} & \epsilon_{nt2} - \epsilon_{nt1} \\ = \;& x_{nt}\left(B_1 - B_2\right) + \alpha_1 \ln\left(c_{nt1}\right) - \alpha_2 \ln\left(c_{nt2}\right) + \ln p_{t2} \end{aligned}$$

- For any instrument vector z_{nt} satisfying:

$$E\left[\epsilon_{nt}\left|z_{nt}\right.\right] = 0$$

we have:

$$E\left\{z_{nt}\left[x_{nt}\left(B_1 - B_2\right) + \alpha_1 \ln\left(c_{nt1}\right) - \alpha_2 \ln\left(c_{nt2}\right) + \ln p_{t2}\right]\right\} = 0$$

- A GMM estimator now comes from setting

$$0 = A\sum_{n=1}^{N} z_{nt}\left[x_{nt}\left(B_1 - B_2\right) + \alpha_1 \ln\left(c_{nt1}\right) - \alpha_2 \ln\left(c_{nt2}\right) + \ln p_{t2}\right]$$

- The usual large sample properties apply.

Complete Markets

Estimating intertemporal rates of substitution

- Similarly:

$$\frac{\lambda_{t+1}}{\lambda_t} = \beta \exp\left[\left(x_{n,t+1} - x_{nt}\right) B_1 + \epsilon_{n,t+1,1} - \epsilon_{nt1}\right] \left(\frac{c_{nt+1,1}}{c_{n,t+1,1}}\right)^{\alpha_1}$$

or in logarithmic form:

$$\Delta \ln \lambda_t - \ln \beta = \Delta x_{nt} B_1 + \Delta \epsilon_{nt1} + \alpha_1 \Delta \ln c_{nt1}$$

where:

$$\begin{aligned} \Delta x_{nt} &\equiv (x_{n,t+1} - x_{nt}) & \quad \Delta \epsilon_{nt1} &\equiv (\epsilon_{n,t+1,1} - \epsilon_{nt1}) \\ \Delta \ln \lambda_t &\equiv \ln \lambda_{t+1} - \ln \lambda_t & \quad \Delta \ln c_{nt1} &\equiv \ln c_{nt+1,1} - \ln c_{nt1} \end{aligned}$$

- If $E\left[\epsilon_{nt} \left| z_{nt} \right.\right] = 0$ then:

$$E\left\{z_{nt}\left[\Delta \ln \lambda_t - \ln \beta - \alpha_1 \Delta \ln c_{nt1} - \Delta x_{nt} B_1\right]\right\} = 0$$

- A GMM estimator with the usual large sample properties can be formed from the sample analogue.

An International Comparison (Miller and Sieg, 1997)

Descriptive statistics for the U.S. and Germany

Table 1. Descriptive Statistics for the GSOEP Subsample

Variables	Year: 1983	1984	1985	1986	1987	1988	1989	1990
Household size	3.45	3.48	3.50	3.53	3.53	3.53	3.53	3.49
	(1.06)	(1.04)	(1.06)	(1.07)	(1.04)	(1.06)	(1.09)	(1.08)
Number of children under 16	1.10	1.09	1.04	1.03	1.01	.96	.93	.89
	(.97)	(.99)	(1.02)	(1.05)	(1.05)	(1.08)	(1.08)	(1.07)
Number of rooms	4.14	4.19	4.19	4.14	4.16	4.19	4.16	4.18
	(1.38)	(1.36)	(1.40)	(1.38)	(1.40)	(1.43)	(1.39)	(1.41)
Rent[a]	—	705.92	745.59	787.36	813.38	850.08	924.48	1,002.57
	—	(346.91)	(352.71)	(388.56)	(409.85)	(413.93)	(456.43)	(486.23)
Hours worked$^{b}_{m}$	44.28	44.38	44.26	43.62	43.73	43.83	43.19	43.29
	(8.31)	(6.62)	(7.36)	(7.40)	(7.45)	(6.61)	(5.91)	(6.53)
Gross labor income$^{a}_{m}$	3,578.63	3,693.23	3,936.23	4,122.32	4,247.84	4,434.63	4,623.92	4,884.37
	(1,170.48)	(1,254.28)	(1,526.49)	(1,632.20)	(1,622.73)	(1,621.31)	(1,712.98)	(1,927.18)
Hours worked$^{b}_{f}$	30.40	27.45	28.21	28.44	27.91	27.73	26.99	25.90
	(14.29)	(12.81)	(13.41)	(11.61)	(13.21)	(13.11)	(13.29)	(12.89)

NOTE: Standard errors are given in parentheses.
[a] Measured on a monthly basis in DM.
[b] Measured on a weekly basis in DM.
$_m$ Variable refers to male.
$_f$ Variable refers to female.

Table 2. Descriptive Statistics for the PSID Subsample

	Year: 1980	1981	1982	1983	1984	1985	1986	1987	1988
Household size	3.98	3.92	3.87	3.82	3.84	3.83	3.78	3.83	3.82
	(1.65)	(1.60)	(1.52)	(1.40)	(1.42)	(1.42)	(1.26)	(1.25)	(1.23)
Number of children under 16	1.57	1.55	1.54	1.53	1.58	1.63	1.64	1.65	1.65
	(1.34)	(1.33)	(1.28)	(1.24)	(1.25)	(1.24)	(1.20)	(1.19)	(1.17)
Number of rooms	5.40	5.42	5.56	5.52	5.59	5.61	5.59	5.69	5.91
	(1.53)	(1.54)	(1.49)	(1.45)	(1.53)	(1.51)	(1.53)	(1.64)	(1.71)
Rent[a]	221.03	241.85	266.84	273.22	301.70	322.37	334.87	—	—
	(110.76)	(126.11)	(139.86)	(127.97)	(147.72)	(161.70)	(166.73)	—	—
Hours worked$^{b}_{m}$	42.76	41.48	40.57	41.97	42.85	42.86	43.33	43.96	43.72
	(12.10)	(12.15)	(12.00)	(12.13)	(11.70)	(11.37)	(11.86)	(11.58)	(11.88)
Gross labor income$^{a}_{m}$	1,425.05	1,550.87	1,605.56	1,733.35	1,886.44	1,957.76	2,052.69	2,234.64	2,334.64
	(838.74)	(946.49)	(1,007.32)	(1,072.58)	(1,337.93)	(1,198.64)	(1,247.06)	(1,456.30)	(1,391.11)
Hours worked$^{b}_{f}$	26.52	25.66	26.07	26.17	27.73	27.59	28.34	28.87	29.07
	(14.67)	(13.78)	(14.51)	(14.46)	(14.76)	(14.23)	(12.99)	(13.37)	(13.14)

NOTE: Standard errors are given in parentheses.
[a] Measured on a monthly basis in U.S. dollars.
[b] Measured on a weekly basis in U.S. dollars.
$_m$ Variable refers to male.
$_f$ Variable refers to female.

- The following notation applies to household n at time t:
  - l_{0nt} female leisure
  - l_{1nt} male leisure
  - h_{nt} housing services
  - x_{nt} observed demographics
  - $(\epsilon_{0nt}, \ldots, \epsilon_{3nt})$ unobserved disturbance *iid* over n
- Current utility takes the form:

$$\begin{aligned} u\left(l_{0nt}, l_{1nt}, h_{nt}, , x_{nt}\right) \quad \equiv \quad & \alpha_0^{-1} \exp\left(x_{nt} B_0 + \epsilon_{0nt}\right) h_{nt}^{\alpha_0} l_{0nt}^{\alpha_2} \\ & + \alpha_1^{-1} \exp\left(x_{nt} B_1 + \epsilon_{1nt}\right) l_{1nt}^{\alpha_1} l_{0nt}^{\alpha_3} + \ldots \end{aligned}$$

- The wage rate is the value of the marginal product for a standard labor unit times the efficiency rating of n:

$$w_{nt} \equiv w_t \exp\left(x_{nt} B_2 + \epsilon_{2nt}\right)$$

- Similarly:

$$r_{nt} \equiv r_t \exp\left(x_{nt} B_3 + \epsilon_{3nt}\right)$$

An International Comparison

Estimates of the marginal rate of substitution functions

Table 3. Estimation of the MRS Functions

Parameters of utility function	*Variable*	*I* SOEP	*I* PSID	*II* SOEP	*II* PSID	*III* SOEP	*III* PSID	*IV* SOEP	*IV* PSID
$\alpha_0 - 1$		−2.02	−2.08	−4.58	−2.32	−4.19	−1.91	−3.17	−.91
		(.22)	(1.13)	(.24)	(.59)	(.26)	(.38)	(1.46)	(1.00)
$\alpha_1 - 1$		−1.87	−2.15	−2.46	−2.53	−3.88	−1.95	−3.76	−1.83
		(.93)	(2.81)	(1.07)	(1.68)	(.73)	(1.22)	(1.51)	(1.97)
$\alpha_2 - \alpha_3$		−.92	−1.23	−.83	−1.74	—	—	—	—
		(.89)	(2.81)	(1.04)	(1.67)				
α_2		—	—	—	—	−.31	−.66	−.29	−.61
						(.84)	(2.14)	(3.00)	(4.20)
α_3		—	—	—	—	2.09	.47	2.29	.56
						(.39)	(2.11)	(2.19)	(2.58)
ΔB	Household size	−.21	−.16	−.46	.50	—	—	—	—
		(.20)	(.26)	(.21)	(.36)				
	Number of children	.07	.10	.29	−.15	—	—	—	—
		(.22)	(.30)	(.12)	(.29)				
B_0	Household size	—	—	—	—	.33	.39	.40	.15
						(.26)	(.48)	(.58)	(1.01)
	Number of children	—	—	—	—	−.09	−.11	−.23	−.05
						(.20)	(.53)	(.81)	(.96)
B_1	Household size	—	—	—	—	.02	.13	.13	.11
						(.21)	(.31)	(.51)	(.44)
	Number of children	—	—	—	—	.22	−.15	−.13	−.12
						(.17)	(.46)	(.64)	(.42)
B_3	Size of housing unit	.28	.19	.47	.27	.48	.37	.41	.27
		(.03)	(.08)	(.02)	(.06)	(.02)	(.06)	(.11)	(.16)
	City indicator	.76	.52	−.11	.63	.94	.55	1.37	.54
		(.05)	(.24)	(.04)	(.15)	(.05)	(.02)	(.39)	(.23)
	J value	197.74		333.48		331.46		242.42	
	Degrees of freedom	207		319		321		209	

NOTE: Standard errors are given in parentheses. To calculate *t* tests, divide coefficients by estimated standard errors and multiply result by $N^{1/2}$. Only five instruments were used in IV.

- The column key is:
  1. MRS between housing and male leisure plus housing rental function
  2. Adds wage equation
  3. Adds intertemporal MRS for male leisure over consecutive periods and subtracts rent equation
  4. Both MRS conditions plus wage and rent equations
- The number of observations is about 400 so $\sqrt{N}$ is about 20.
- J is asymptotically χ_d where $d = \#$ overidentifying restrictions.
- None of the specifications is rejected, all the coefficients are significant and are signed according to economic intuition.
- Contingent claims prices (inversely) track aggregate consumption quite well.

An International Comparison

Aggregate consumption (solid line) and estimated contingent prices (dotted) for Germany and the U.S.

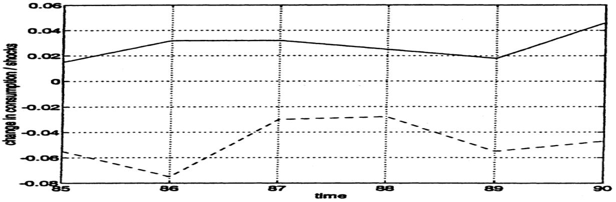

Figure 1. Aggregate Consumption and Shocks in Germany: ———, Change of Aggregate Real Consumer Expenditures; – –, Estimated Change of Price Realizations for Contingent Claims.

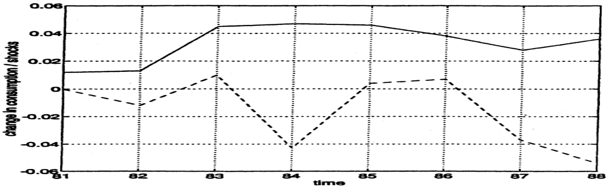

Figure 2. Aggregate Consumption and Shocks in the United States: ———, Change of Aggregate Real Consumer Expenditures; – –, Estimated Change of Price Realizations for Contingent Claims.

An International Comparison

Testing equality of prices, preferences and efficiency ratings

- We reject the null hypotheses that:
  - contingent claims prices between Germany and US are equal
  - contingent claims prices between different regions in the US are equal at the 0.05 but not at the 0.1 level
  - preferences between the two countries are the same
- With respect to purchasing power parity we:
  - do not reject the null that the value of marginal product of labor is equalized across both countries
  - reject the null that the premium to education is the same.

Summary

Has work in this area stalled?

- Aggregate data on consumption:
  - reject the representative consumer model with standard assumptions.
  - has lead to relaxing the expected utility assumption
  - prompted empirical work on hyperbolic discounting.
- Cross sectional and panel data on consumption and labor supply:
  - averages across individuals (or households), not time.
  - useful for predictive purposes in a steady state economy.
  - can be adapted to dynamic economies (Altug and Miller, 1998).
  - does not invariably reject complete markets (Altug and Miller, 1990).
  - used to estimate dynamic models where financial markets don't exist.
- Moving forwards there seems scope for:
  - estimating and testing models of integration across political jurisdictions and geographical regions.
  - estimating models with data on individual financial portfolio choices with consumption (French and Jones, 2011).
  - focusing on trading mechanisms and contractual arrangements.