Consumption Quality: A New Perspective on the Welfare Implications of Business Cycle Fluctuations

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December 16, 2019

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Overview

Two Long-standing Questions in Household Finance and Macroeconomics

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2. What are the welfare costs?

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2. What are the welfare costs?

State of Literature

- Examine effects on total consumption expenditures.
- Lucas calculation
  - Welfare gain of eliminating spending volatility $\approx 0.05\%$ of spending.
  - Incorporating additional features (incomplete markets, income insurance) yields $\approx 0.1\%$ of spending.

New Perspective

Instead of total consumption expenditures, we zoom into consumption bundles and composition:

- Households smooth consumption at both the **quality** and **quantity** margin when facing income shocks.
- Quality v. quantity margin of consumption reallocation has important welfare implications.

Motivation

"Consumers choose the *quality* of their purchases, and unit values reflect this choice. Moreover, quality choice may itself reflect the influence of prices as consumers respond to price changes by altering both quantity and quality."

— Angus Deaton (1988)

"The analysis of quality is an important topic in economics"

— Angus Deaton and John Muellbauer (1980)

Research Questions

1. To what extent do households exploit quantity versus *quality* margins of adjustments in their consumption decision?
2. How does this quantity-quality choice affect welfare implications of economic shocks?

This Paper

- Empirical:
  - Quantify *quality* margin adjustment as a consumption smoothing mechanism, using granular panel data on household consumption.
    - Given negative income shock, 2/3 of expenditure reduction is due to adjustment at the quality margin.
  - Show considerable heterogeneity across income groups in their access to this consumption smoothing channel.
    - The low income groups are *"quality constrained"*.

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  - Quantify *quality* margin adjustment as a consumption smoothing mechanism, using granular panel data on household consumption.
    - Given negative income shock, 2/3 of expenditure reduction is due to adjustment at the quality margin.
  - Show considerable heterogeneity across income groups in their access to this consumption smoothing channel.
    - The low income groups are *"quality constrained"*.
- Theory:
  - Non-homothetic preferences.
    - Households value both the quality and quantity margins of household consumption.
  - Estimate welfare costs of income fluctuations for the full income distribution.
    - The low income groups bear a a disproportionately greater share of the cost of business cycle fluctuations.

Outline

1. **Data and Quality Measures**
2. Empirical Analysis
3. Empirics $\Rightarrow$ Theoretical Framework
4. Theory and Welfare Analysis

I. Data

- Nielsen household panel dataset (2004-2013)
  - Transaction data: 4 million household purchase transactions
    - Scanned Universal Product Code (UPC) level data—
      (Trip specific:) Date, store, quantity, price, deals;
      (Product specific:) Brand, type, volume, packaging.
  - Product data
    - Food departments: dairy, deli, dry grocery, fresh produce, frozen food, packaged meat;
    - Non-food departments: alcohol, general merchandise, health, non-food grocery.
  - Demographic data: 98,547 households.
    - Yearly self-reported household-level data: income, age, sex, race, education, occupation, region of residency, employment status, family composition and household size.

- Nielsen Retailer Scanner Data (2006-2013)
  - Weekly point-of-sale information from 35,000 stores.
  - UPC level data—total sales in revenue and quantity

I. Data Dimensions on Product Groups

- Departments
  - Ex.: "Dairy"
- Product Modules
  - Ex.: "Dairy-Milk-Refrigerated"
- UPCs
  - Ex.: "Berkeley Farmers Organic 2% Milk"

I. Defining Quality

Fundamental Assumptions

- When buying a product (fresh milk) households choose
  - *How much* milk to buy
  - *What quality* of milk to buy
- Extract quantity directly from the data
- Need measure for quality, reflecting
  - Perceived quality value

I. Defining Quality (cont')

Price contains information about quality

1. Demand theory
   - Revealed preferences

     If $A \succ B$ and $P_A \geq P_B$ then quality of A is higher than B.

2. Supply theory
   - Marginal costs

     If MC is increasing in quality $\Rightarrow$ Price is increasing in quality.

I. Quality Measures

Set 1: Baseline

- Average Price

Set 2: Quality Ranking

- UPC Price Ranking
- UPC Relative Price Ranking

Set 3: Quality Ladder

- Within-Store Quality Ladder
- Cross-Store Quality Ladder
- Overall Quality Ladder

*All measures are constructed within product module-size unit.

I. Quality Measure Set 1 – Average Price

Average Price

$$P_{hgt} = \frac{X_{hgt}}{\sum_u c_{hut}} \tag{1}$$

- X_{hgt} = Total expenditure in product-module g by household h in month t: $\sum_u c_{hut} \cdot p_{hut}$
- c_{hut} : Volumes purchased of UPC u
- p_{hut} : *Unit* price of UPC u

I. Quality Measure Set 2 – UPC Price Ranking

Average UPC ranking of household purchases

$$R_{hgt} = \sum_u s_{hut} \cdot R_u \tag{2}$$

- s_{hut} : UPC budget share
- R_u proxies for a *quality index* : higher R_u means better quality
  - $R_u = \frac{\tilde{R}_u}{\tilde{R}^{max}+1} \in (0,1)$
    - $\tilde{R}_u = \omega_u \cdot rank\left(p_u | p_1, p_2, \ldots, p_N\right)$
    - p_u : Yearly *unit* price
    - ω_u : UPC Scantrack marketshare
    - $\tilde{R}^{max} \equiv \max \tilde{R}_u$

I. Quality Measure Set 2 – Relative UPC Price

Alternative UPC ranking of household purchases

$$R'_{hgt} = \sum_{u} s_{hut} \cdot \log\left(p_{ut}/p_{ut}^{med}\right). \qquad (2')$$

- s_{hut} : UPC Budget share
- p_{ut} : *Unit* price
- p_{ut}^{med} : Median *unit* price

I. Quality Measure Set 3 – Quality Ladders

Within-Store Quality Ladder

$$x^{UPC}_{hc,g,t} = x_{hc,g,t} - \sum_{w \in t} \sum_{s} \sum_{u} c_{hw,u} \cdot \min_{u}\{p_{hw,s,u}\} \quad (3)$$

Cross-Store Quality Ladder

$$x^{Store}_{hc,g,t} = x_{hc,g,t} - \sum_{w \in t} \sum_{u} c_{hw,u} \cdot \min_{s}\{p_{hw,s,u}\} \quad (3')$$

Overall Quality Ladder

$$x^{Extreme}_{hc,g,t} = x_{hc,g,t} - \sum_{w \in t} \sum_{u} c_{hw,u} \cdot \min_{s,u}\{p_{hw,s,u}\} \quad (3'')$$

- w : Week
- s : Store
- c : Number of Items $\Rightarrow$ p : *Actual* price
  or Volume $\Rightarrow$ p : *Unit* price

Outline

Regression Model

$$Y_{hc,g,t} = \beta_1 UE_{ct} + \beta_2 UE_{ct} \times I_{h,l.t} + \theta^{'} X_{h,t} + \zeta_{h,g} + \eta_t + \varepsilon_{hc,g,t} \quad (4)$$

- $Y_{hc,g,t}$: Consumption expenditure, quantity and quality for household h in county c of product module g at month t.
- UE_{ct} : Monthly county-level unemployment rate.
- $I_{h,l.t}$: Lagged (year) income quintile.
- X_{it} : Controls: (yearly) employment status, lagged (monthly) shopping trips, lagged (monthly) unique stores visited.
- $\zeta_{h,g}$: Household-Product-Module fixed-effect.
- η_t : Time dummies.
- Standard errors clustered at the county level.

II. Summary Statistics – Demographics

Variable	Income Quintile 1st	2nd	3rd	4th	5th	All
			Yearly Averages			
Income, $1,000	15.28	33.88	53.11	78.56	133.04	65.23
Age	50.5	48.4	47.3	48.1	48.6	48.5
HH size	2.1	2.4	2.8	2.8	2.9	2.6
All Adults Not Employed	0.4	0.1	0.1	0.1	0	0.1
One Not Employed	0.6	0.4	0.4	0.3	0.3	0.4
Monthly Unempl. (Sea. Adj.), %	8.49	8.25	8.12	7.99	7.88	8.13
No. Observations	7,939	8,360	8,817	8,852	9,555	43,523

II. Summary Statistics – Monthly Shopping

	Income Quintile					
Variable	1st	2nd	3rd	4th	5th	All
			Monthly Averages			
Monthly Expenditures, $	286.89	324.06	355	371.62	402.87	350.53
No. Unique PMs Bought	39.41	43.46	46.07	46.72	45.51	44.36
No. UPCs Bought	100.98	109.02	115.14	114.53	112.15	110.6
Avg. Price per UPC, $	3.14	3.25	3.44	3.59	3.99	3.5
Quality						
UPC Rank, %	19.3	20.27	20.91	21.46	22.08	20.86
Relative UPC price, %	-3.85	-2.01	-0.4	1.89	5.33	0.39
UPC Arbitrage (Actual Price), $	49.68	60.34	67.8	72.01	85.67	67.85
Store Arbitrage (Actual Price), $	85.31	101.57	117.63	129.54	155.74	119.45
Extreme (Actual Price), $	216.21	249.16	279.86	301.5	339.41	279.84

II. Reduced Form Results – Monthly Expenditures

	Dependent Variables (Estimates Multiplied by 100)		
Variable	(1) Log Expenditure	(2) Log Volume	(3) Log Average Price
Local Unemployment, β_1	**-0.674*** **	**-0.204*** **	**-0.468*** **
(Seasonally Adj.)	**(0.125)**	**(0.061)**	**(0.0686)**
Income Quintile × Unemployment			
1st	0.568***	-0.0462	0.462***
	(0.201)	(0.0798)	(0.115)
2nd	0.0344	-0.102	0.0562
	(0.161)	(0.0699)	(0.0975)
3rd		—Base Level—	
4th	0.0306	0.0781	-0.0243
	(0.125)	(0.0673)	(0.0791)
5th	-0.035	0.126*	-0.0786
	(0.134)	(0.0756)	(0.0771)
Controls	Yes	Yes	Yes
HH-Product Module FE	Yes	Yes	Yes
Time dummies	Yes	Yes	Yes
Million Observations	61.95	62.23	61.95
Thousand Clusters	77.2	77.2	77.2

II. Reduced Form Results – Interpretation

- A one percentage point increase in the local unemployment level is associated with 0.6 percent reduction in monthly expenditures on average.
  - 2/3 of the this reduction comes from the quality margin, and 1/3 from the quantity margin.

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II. Reduced Form Results – Interpretation

- A one percentage point increase in the local unemployment level is correlated with 0.6 percent reduction in monthly expenditures on average.
  - 2/3 of the this reduction comes from the quality margin, and 1/3 from the quantity margin.
- When facing negative income shock, low income households do not appear to lower consumption quality.

II. Reduced Form Results – UPC Ranking

	Dependent Variables (Estimates Multiplied by 100)	
Variable	(1) UPC Rank	(2) Rel. UPC Price
Local unemployment	-0.034**	-0.153***
(Seasonally Adj.)	(0.0159)	(0.0317)
Income Quintile × Unemployment		
1st	**0.0573*** **	**0.198*** **
	(0.0192)	**(0.04)**
2nd	0.0263	0.0725**
	(0.0166)	(0.0349)
3rd	—Base Level—	
4th	-0.0368**	-0.0428
	(0.0183)	(0.0369)
5th	-0.0643***	-0.0397
	(0.0202)	(0.0386)
Controls	Yes	Yes
HH-Product Module FE	Yes	Yes
Time Dummies	Yes	Yes
Million Observations	61.4	61.4
Thousand Clusters	77.4	77.4

II. Reduced Form Results – Unexploited “Arbitrage”

	Dependent Variables, Actual Price (Estimates Multiplied by 100)		
Variable	(1) UPC	(2) Store	(3) Extreme Shopping
Local Unemployment	-0.866***	-3.1***	-5.28***
(Seasonally Adj.)	(0.236)	(0.576)	(0.743)
Income Quintile × Unemployment			
1st	**0.886*****	**1.49***	**2.7*****
	(0.289)	**(0.766)**	**(0.955)**
2nd	0.403	0.838	0.931
	(0.254)	(0.612)	(0.814)
3rd		—Base Level—	
4th	0.164	0.711	-0.671
	(0.221)	(0.664)	(0.801)
5th	-0.0764	1.55*	0.491
	(0.255)	(0.846)	(0.886)
Controls	Yes	Yes	Yes
HH-Product Module Fixed-Effects	Yes	Yes	Yes
Time dummies	Yes	Yes	Yes
Million Observations	62.23	62.23	62.23
Thousand Clusters	77.2	77.2	77.2

II. Reduced Form Results – Yearly Income

(Estimates Multiplied by 100)	Income		HH-PM-FE	Mio.	1,000
Dependent Variable	Estimate	Std.Err	& Controls	Obs.	Clusters
Log Expenditure	17.1***	(2.11)	Yes	28.6	76.1
Log UPCs Bought	13.5***	(2.05)	Yes	28.7	76.1
Log Avg. Price	3.53***	(0.891)	Yes	28.6	76.1
Quality					
UPC Rank	0.494**	(0.252)	Yes	28.7	76.1
Relative UPC price	2.5***	(0.713)	Yes	28.7	76.1
UPC (Actual Price), $	6.26**	(2.56)	Yes	28.8	76.1
Store (Actual Price), $	38.9***	(7.83)	Yes	28.8	76.1
Extreme (Actual Price), $	69.9***	(9.27)	Yes	28.8	76.1

II. Reduced Form Results – -Product Module Substitution

Estimated Partial Effects of Local Unemployment Rate Shock, by Department

	(–All Estimates Multiplied by 100–)					
	Log Expenditures		Log Products Bought		Log Avg. Price Paid	
Department	Avg.	1st Quantile	Avg.	1st Quantile	Avg.	1st Quantile
Alcoholic Beverages	1.4	7.17***	1.44	2.81*	−0.354	1.87*
	(1.3)	(1.3155)	(1.05)	(1.4956)	(0.692)	(1.0694)
Dairy	−1.15***	−1.02***	−0.0974	0.05	−1.23***	−1.18***
	(0.164)	(0.276)	(0.15)	(0.2754)	(0.0786)	(0.1398)
Deli	−0.925**	0.15	−0.769**	−0.01	−0.615**	−0.2
	(0.383)	(0.7336)	(0.324)	(0.6486)	(0.242)	(0.4827)
Dry Grocery	−0.604***	0.05	−0.223*	−0.02	−0.238***	0.22*
	(0.123)	(0.2237)	(0.116)	(0.1935)	(0.0727)	(0.1293)
Fresh Produce	0.135	0.88	0.126	0.33	−0.314	0.23
	(0.302)	(0.5762)	(0.226)	(0.4159)	(0.205)	(0.4675)
Frozen Foods	−0.168	0.23	0.447**	0.7**	−0.157	0.6**
	(0.231)	(0.3797)	(0.221)	(0.3527)	(0.148)	(0.2625)
General Merchandise	−0.264	2.66**	0.0662	2.27**	−0.189	1.71
	(0.902)	(1.3175)	(0.609)	(0.9646)	(1)	(1.4269)
Health & Beauty Care	−0.649	−0.3	−0.229	−0.24	−0.498	−0.15
	(0.402)	(0.6387)	(0.271)	(0.4943)	(0.36)	(0.5889)
Non-food Grocery	−0.371	−0.45	−0.0854	−0.33	−0.281*	−0.38
	(0.234)	(0.619)	(0.193)	(0.3996)	(0.165)	(0.2991)
Packaged Meat	−0.268	−0.12	−0.145	−0.16	−0.619***	−0.1
	(0.294)	(0.4736)	(0.254)	(0.4526)	(0.229)	(0.3491)

II. Stylized Facts

1. When facing negative income shock, households lower their monthly consumption expenditure by reducing both the *quality* and *quantity* of the products purchased.
   - Households engage in both intra-product module switching and inter-product module switching.
2. Low-income households *do not* downgrade the quality of the products purchased, while they still reduce their consumption quantities.
   - They face *quality constraints*.

II. Stylized Facts ⇒ Theoretical Framework – Key Features

1. Non-homotheticities of quality and quantity.
   - Allow substitution *between* UPCs within product module.
   - Allow substitution *across* product modules.
2. Quality constraints.

II. Theoretical Framework – Limitations in Existing Literature

- Standard framework assumes UPC choice is binary choice:
  1. Quality-quantity choice is *homothetic*
     - No substitution *between* UPCs within Product Module: agent picks (one and only) $u^* = \arg_u \max\{Q_u \cdot M/p_u\}$
     - From above: u^* is *independent* of M
     - Budget shares across Product Module are constant wrt income.
  2. No constraints on quality

- Common approach: Assume preference for quality changes with income. (Handbury 2015; Redding and Weinstein 2016, Faber and Fally 2016)

  $\Rightarrow$ Agent picks $u^* = \arg_u \max\{Q_u(I) \cdot M/p_u\}$
  - UPC choice now varies with income (and budget).
  - Challenge: Cannot address welfare costs of income fluctuations since stable preference over time and across income groups is required.

Outline

IV. Theory – Standard Utility Aggregation

Utility Function: Agent maximizes utility by choosing the consumption bundle of quantity, C_j, and quality, Q_j, across all product modules, j.

$$U(\mathbb{C}, \mathbb{Q}) = \Big(\sum_j \upsilon_j u_j(C_j, Q_j)^{\frac{\sigma-1}{\sigma}} \Big)^{\frac{\sigma}{\sigma-1}}, \quad \upsilon_j \geq 0, \tag{5}$$

- υ_j: product module share.
- $\sigma(> 1)$: elasticity of substitution between product modules.

Budget Constraint

$$\sum_j C_j \cdot P(Q_j) \leq M. \tag{6}$$

- M: total expenditure/budget .

IV. Theory – Power-Log Sub Utility

$$u_j(C_j, Q_j) = \ln(C_j)^{\alpha_j} + \ln(Q_j)^{\beta_j}. \quad (7)$$

- α: preference for quantity of pm j.
- β: preference for quality of pm j.
- *Non-homothetic* for (almost) all values of $\alpha \neq \beta$.
- With non-homothetic utility and if the elasticity of the price is non-unit value, $\varepsilon_{P|Q} \neq 1$, then the demand for quality (and quantity) is a non-linear function of income.

IV. Theory – Price

Price Relation

$$P(Q) = \eta Q^{\gamma_j}. \tag{8}$$

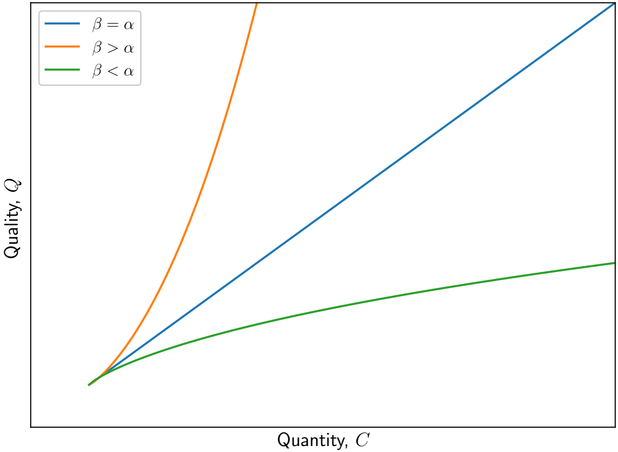
- η: normalizing factor
- γ_j: Price Elasticity wrt. Quality $= \varepsilon_{P|Q} \equiv \frac{P(Q)}{Q} \frac{\partial P(Q)}{\partial Q}$

IV. Theory – Optimal Relation between Quantity and Quality

$$\ln(Q_j)^{1-\beta_j} = \frac{\beta_j}{\alpha_j \gamma_j} \ln(C_j)^{1-\alpha_j}. \qquad (9)$$

- For $\alpha \neq \beta$ and $\gamma \neq 1$ then the optimal relationship between quantity, C, and quality, Q, is non-linear
- For $\beta > \alpha$: Quality increase *faster* than quantity
- For $\beta = \alpha$ and $\gamma < 1$: Quality increase *faster* than quantity
- For $\beta = \alpha$ and $\gamma > 1$: Quality increase *slower* than quantity

IV. Theory – Quantity Quality Trade Off



Relationship between optimal choice of quantity and quality for hypothetical preferences and $\gamma = 1$, based on the optimality condition (9).

Estimating Utility Parameters

$$\ln \tilde{Q}_j = \theta_0^j + \theta_1^j \ln \tilde{C}_j + \varepsilon_j. \tag{10}$$

where $\tilde{Q}_j = \ln Q_j$ and $\tilde{C}_j = \ln C_j$.

Estimating Price Parameters

$$\ln P(Q_j) = \ln \eta_j + \ln \eta_t + \gamma_j \ln Q_j + \epsilon_j. \tag{11}$$

Dealing With Endogeneity

- Instrumenting Q_j with lagged total expenditure and lagged income.
- Household fixed-effects.
- Interior solution: Use only HHs with income $>$ median.

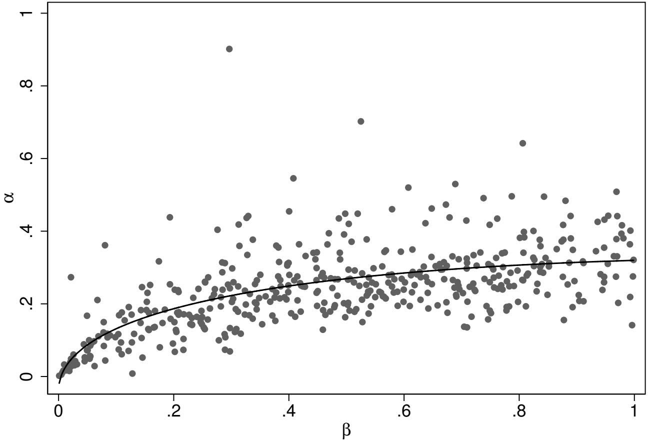
Estimating Preference Parameters

1. Obtain estimates for θ_0, θ_1 and γ from regression models (10) and (11) above.
2. Then solve for α and β in the equation system below.
3. In general, there can be multiple solutions, we pick the solutions obeying fundamental utility assumptions.

$$\hat{\theta}_0 = \frac{1}{1-\beta}\left(\ln(\beta/\alpha) - \ln(\hat{\gamma}) \right), \tag{12}$$

$$\hat{\theta}_1 = \frac{1-\alpha}{1-\beta}. \tag{13}$$

IV. Theory – Plotting Utility Parameters



Note: Solid line shows polynomial fit.

Scatter of Estimated Quantity Parameters, α, and Quality Parameters, β.

IV. Theory – Optimal Quality and Expenditure

$$
\begin{aligned}
\ln(X) &= \ln(C) + \ln(P(Q)) \\
&= \left(\frac{\alpha\gamma}{\beta}\right)^{\frac{1}{1-\alpha}} \left(\ln(Q) \right)^{\frac{1-\beta}{1-\alpha}} + \eta + \gamma \cdot \ln(Q) \qquad (14)
\end{aligned}
$$

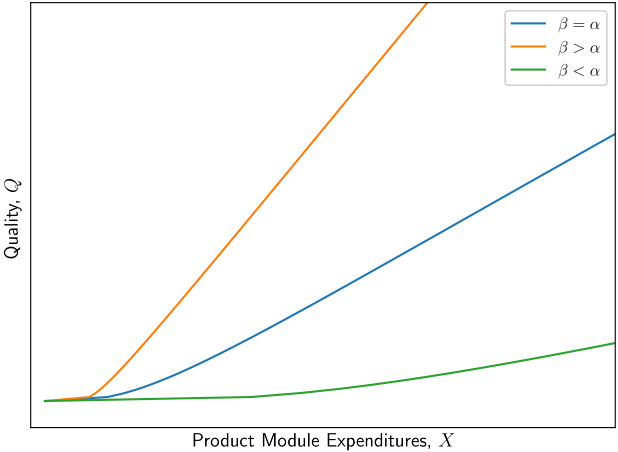
- Non-linear relationship between quality, Q, and PM expenditure, X.
- No closed form solution; perform numerical search.

Optimal Quality as a Function of PM Expenditures

$$\ln(Q) = \Gamma(X), \qquad (15)$$

where $\Gamma(\cdot)$ represents the solution to $\ln(Q)$ in (14).

IV. Theory – Optimal Quality and Expenditure (cont.)



Relationship between optimal choice of quality as a function of product module expenditures, based on equation (14).

Sub-Utility as a Function of PM expenditures, X

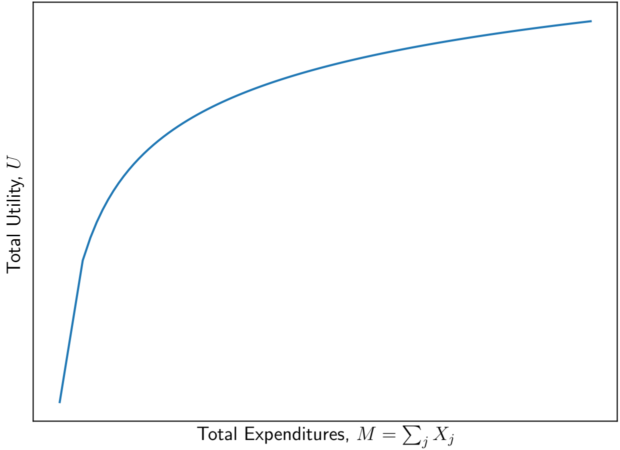
$$
\begin{aligned}
u(X) &= \left(\frac{\alpha\gamma}{\beta}\right)^{\frac{\alpha}{1-\alpha}} \ln(Q(X))^{\alpha\frac{1-\beta}{1-\alpha}} + \ln(Q(X))^{\beta} \\
&= \Omega\Gamma(X)^{\psi} + \Gamma(X)^{\beta}.
\end{aligned} \tag{16}
$$

- Applying the standard sub-utility aggregation approach shows the well-known *super*-utility as a direct function of total expenditures, $M = \sum_j X_j$.

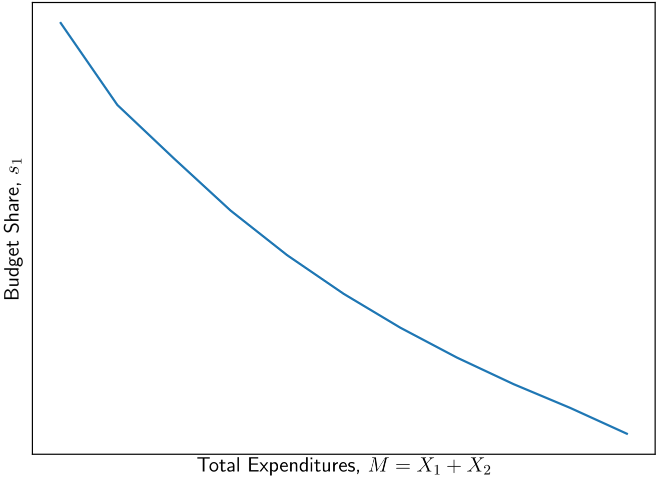
$$\tilde{U}(M) = \Big(\sum_j \tilde{v}_j u(X_j)^{\frac{\sigma-1}{\sigma}} \Big)^{\frac{\sigma}{\sigma-1}}. \tag{17}$$

- Utility is a *concave* function of total expenditures.
- Recall that, for almost any α_j and β_j, this utility function is non-homothetic in its inputs, C and Q, and therefore in total expenditures M.
- Thus, budget shares are *non-linear*, leading to non-linear Engel curves.

IV. Theory – Graphing the Utility Function



Relationship between utility and total budget based on equation (17).

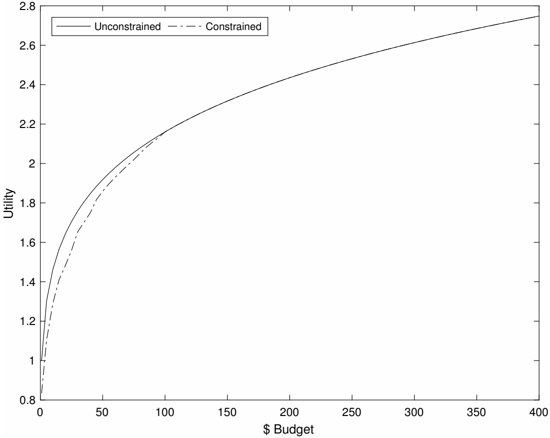


Budget share, s_1 calculated as X_1/M, where $\alpha_1 < \alpha_2$, $\beta_1 < \beta_2$, and all other parameters are identical.

VI. Welfare Analysis

- Quality constraints
  - Utility maximization problem is now a constrained optimization problem
    - Impose lower bound on quality, Q
  - We solve the agent's utility maximizing problem numerically
- Welfare calculations
  - Equivalent variation: $ value of difference between utility in constrained vs. unconstrained environment.
  - Compensating variation: $ compensation for not being quality constrained.

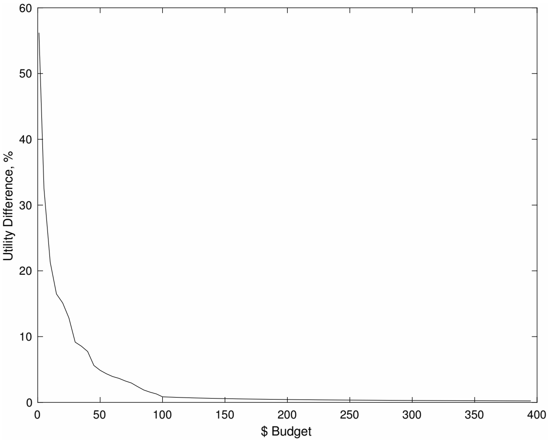
Unconstrained vs. Constrained Optimal Utility



Unconstrained versus Constrained Optimal Utility as a Function of Monthly Budget.

Notes: Let U and V be unconstrained and constrained optimal utility, respectively, then the lines plots $U(M)/U(M=1)$ *and* $V(M)/U(M=1)$.

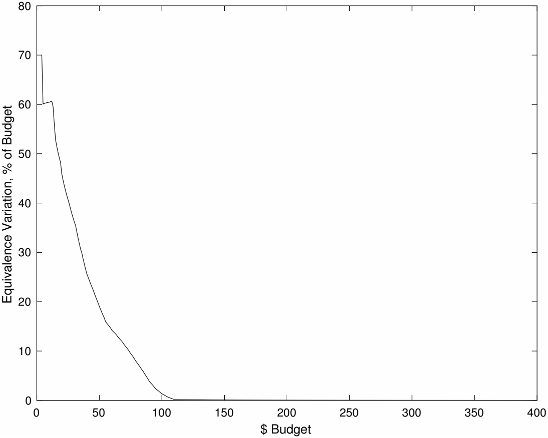
Utility Gains from Being Unconstrained



Relative Difference (%) in Unconstrained and Constrained Optimal Utility as a Function of Monthly Budget.

Notes: Let U and V be unconstrained and constrained optimal utility, respectively, then the line plots $(U - V)/V * 100$.

Equivalent Variation



% dollar compensation required to balance constrained and unconstrained optimal utility.

VI. (Lucas-style) Welfare Calculations (work in progress)

- To address welfare costs from income fluctuations, we calculate the *Lucas* welfare gain, λ^*, of eliminating consumption fluctuations

$$\lambda^* \equiv \arg_\lambda : \sum_{t=0}^{T} \beta^t E\left[\tilde{U}(\ (1+\lambda)M_t\ )\right] = \sum_{t=0}^{T} \beta^t \tilde{U}(Ae^{\mu t}), \qquad (18)$$

$$M_t = Ae^{\mu t} e^{-(1/2)\sigma^2} \varepsilon_t.$$

Where

- $\tilde{U}(M_t)$ is the period utility function from expenditures in equation (17),
- β is the (constant) inter-temporal discount factor,
- $\log(\varepsilon_t) \sim i.i.N(0, \sigma^2)$,
- $E[e^{-(1/2)\sigma^2} \varepsilon_t] = 1$,
- $E[M_t] = Ae^{\mu t}$.

Summary

- Quantified the *quality* channel for consumption smoothing in response to income shocks.
  1. Households decrease their monthly consumption expenditure by reducing both the *quantity* and *quality* of the products purchased on average.
  2. Low-income households do not downgrade the quality of the products purchased, while they still reduce their consumption quantities.

     $\Rightarrow$ Lower income households are facing *quality constraints*

- Developed a tractable model
  - Non-homotheticities of the quantity-quality choice: agents value both the quality and quantity margins of household consumption.
  - Study consequences of income shocks on household welfare through both margin of adjustments.

Thank you!