



# **An empirical analysis of disability and household expenditure allocations**

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## Introduction

- Disability may influence household expenditure allocations in several dimensions
  - Eg loss of earnings potential, constraints on time inputs
  
- This study is based on an Engel curve analysis
  - Focus on current expenditure allocation across non-durable goods
  - Model to be estimated is static & covers market goods
  - Empirical applications have been rare
  
- Jones and O'Donnell (J. Pub Econ, '95) :
  - Compares Engel curves of childless couples w/ disability vs couples w/o disability in a unitary setting



## Introduction

- Extend Jones & O'Donnell's analysis with benefit from recent advance in demand analysis
  - A collective model due to Lewbel & Pendakur ('08)
  
- In a childless couple household, how does disability of one spouse affect :
  - Intra-household resource allocation between spouses &
  - the extent to which goods are jointly consumed,
  - after taking into account individual-level preference changes due to disability?
  
- Very little is known about these issues



## Overview

- Primary data source:
  - Canadian Survey of Household Spending '04-'07
- Major findings
  - Individual Engel curve estimates show expected responses to disability eg. spend less on clothing, more on hhld ops.
  - Sharing rule is more precisely estimated than economies of scale
    - Variations in total expenditures help identify both
    - But sharing rule has other sources of variations too
  - Own disability reduces woman's share of resources by 3~6 % pts while spousal disability increases it by 4~9% pts.
  - Some estimates suggest that disability reduces benefits from joint consumption but too imprecise to warrant firm conclusions



## Literature

- Recent interest in the impact of disability on household consumption from the policy literature
  - Tibble ('05) and Stapleton et al. ('08) for extensive reviews
  
- Objective is to analyse extra costs of living associated with disability instead of earnings losses
  - Intended to inform disability allowance programs
  
- “The standard of living approach” is gaining popularity
  - Similar concept as equivalence scales in microeconomic demand analysis



## Literature

- Disability recognised as an area of application in theoretical contributions eg Lewbel ('85) and Blackorby & Donaldson ('92)
- Empirical applications have been rare
  - Most household expenditure surveys collect no info on disability
- The only exception?: Jones and O'Donnell (J.Pub Eco, '95)
  - Uses a one-off supplement to UK Family Expenditure Survey
  - Focuses on equivalence scales which can be estimated from a single equation regression over a single cross section
  - Compares Engel curves of childless couples w/o disability vs childless couples w/ disability



## Literature

- Jones & O'Donnell ('95) – ctd.
  - Under certain restrictions on preferences, conclude that a disabled couple needs to spend at least 40~70% more to be as well off as a non-disabled couple
  - A possible interpretation: disability affects the extent to which goods can be jointly consumed within the household
  
- The present analysis extends Jones & O'Donnell's analysis by incorporating recent advance in demand analysis
  - Estimate a collective Engel curve system previously applied to '90-'92 Canadian data (Lewbel & Pendakur, '08) and '05 Irish data (Bargain et al., '10) (These papers did not incorporate health or disability in the analysis)



## Motivation

- Consider person A who may marry a disabled person B or a non-disabled person C
- What may explain differences in spending patterns of couple {A, B} and couple {A,C} ?
- One simple answer: B's preferences are different from C's
- Another: structural components of interest
  - Disability may affect jointness of consumption goods
  - and how household resources are shared between spouses





## Motivation

- Can we disentangle preference differences from the structural components at least to some extent?
- Evidence on the economies of scale changes over and above preference changes may provide a strong economic justification for policy intervention
- Information on changes in resource shares may be relevant for poverty & inequality analysis



## Modelling framework

- A collective household demand model of Browning, Chiappori & Lewbel (unpublished; '09)
  
- Key features :
  - Intrahousehold resource allocation is Pareto efficient
  - Total consumption of husband & wife  $>$  expenditure on goods
    - Due to jointness of consumption
    - Incorporated into the model using “Barten-Gorman” technology
  - Assume that preferences remain stable before & after marriage
    - ie relevant preference changes can be parametrised independently
  - Combine data on singles and couples to recover sharing rule & economies of scale



## Empirical specification

- Given the short span of data, estimate a collective Engel curve system instead of a demand system with price variations
  - Lewbel and Pendakur (J.Econometrics; '08) develops relevant restrictions on preferences
  - Structural in the sense that the sharing rule and the economies of scale parameters are separately identified
  
- Model specification consists of three building blocks summarised below



## Empirical specification

- Step 1: Specify individual Engel curves incorporating preference changes due to disability (& other demographic controls)
  - These are estimated from data on singles (and couples)
  
- Step 2: Construct household Engel curves by combining individual Engel curves according to the theoretical structure
  - Economies of scale and sharing rule functions are introduced into the system
  
- Step 3: Parameterise economies of scale & sharing rule
  - The new parameters are estimated from data on couples



## Step 1: Specifying individual Engel curves

- First, specify an individual Engel curve system which incorporates preference differences b/w person B and C
- A parsimonious specification:
  - Introduce demographics including disability into a quadratic Engel curve system using Shape Invariance transformation

$$\begin{aligned}w_i^k &= a_i^{k0} + a_i^k ' z_i + b_i^k (\ln y - e_i ' z_i) + c_i^k (\ln y - e_i ' z_i)^2 + \varepsilon_i^k \\ &= w_i^k (y, z_i) + \varepsilon_i^k\end{aligned}$$

- $k = 1, 2, \dots, K$  goods                      -  $i =$  male, female
- $z_i =$  vector of demographic characteristics **including disability**
- $\ln y =$  log of expenditure budget



## Step 2 : Combine individual Engel curves

- Second, specify a household Engel curve system incorporating the effects of joint consumption and sharing rule :

$$w_h^k = \eta(Z) w_f^k \left( \frac{\eta(Z) y}{\delta_f(z_f)}, z_f \right) + [1 - \eta(Z)] w_m^k \left( \frac{[1 - \eta(Z)] y}{\delta_m(z_m)}, z_m \right)$$

$$\eta(Z) \frac{\partial \ln \delta_f(z_f)}{\partial \ln p_k} + [1 - \eta(Z)] \frac{\partial \ln \delta_m(z_m)}{\partial \ln p_k} + \varepsilon_h^k$$

- $Z = z_f, z_m$  and distribution factors
- $0 < \eta(z) < 1$  : female spouse's share of household resources,  $y$
- $0.5 < \delta_i(z_i) < 1$  : spouse  $i$ 's benefit from joint consumption
- $p_k$  : price of good  $k$



## Step 3: Parameterise economies of scale & sharing rule

- To minimise non-linearities, sharing rule and economies of scale functions are specified to be linear in demographics :

$$\eta(Z) = r_0 + r'Z$$

$$\ln \delta_i(z_i) = d_{0i} + d_i' z_i$$

$$\frac{\partial \ln \delta_i(z_i)}{\partial \ln p_k} = n_i^{k0} + n_i' z_i$$

- In simple, economies of scale is introduced by taking additional Shape Invariance transformation



## Empirical specification : An example

- Given the functional forms, wife's contribution to the household budget share of good k is :

$$\begin{aligned} & (r_0 + r'Z)[a_f^{k0} + a_f^k z_f + n_f^{k0} + n_f z_f + \\ & b_f^k (\ln y - e_f z_f + \ln(r_0 + r'Z) - d_{0f} - d_f z_f) + \\ & c_f^k (\ln y - e_f z_f + \ln(r_0 + r'Z) - d_{0f} - d_f z_f)^2] \end{aligned}$$

- Black : Cross equation restrictions b/w single women & married women
- Red : Extra terms due to sharing rule & economies of scale





## Empirical specification

- The key identifying assumption of this model is that single and married individuals share the same Engel curve parameters in  $w_m^k(y, z_m)$  &  $w_f^k(y, z_f)$
- Thus joint estimation of singles' and couples' Engel curve systems allows recovery of the structural components
  - Below, estimation is done by FGNLS on TSP 5.1
- Fairly restrictive if singles' preferences are fundamentally different from those who choose to marry
  - For robustness checks, restrict the sample of singles to those who have been previously married



## Empirical specification

- To sum up, the Engel curve system looks like:

$$w_f^k = w_f^k(y, z_f) + \varepsilon_f^k$$

$$w_m^k = w_m^k(y, z_m) + \varepsilon_m^k$$

$$w_h^k = \eta(Z)w_f^k\left(\frac{\eta(y)y}{\delta_f(z_f)}, z_f\right) + [1 - \eta(Z)]w_m^k\left(\frac{[1 - \eta(y)]y}{\delta_m(z_m)}, z_m\right) + n_h^k(Z) + \varepsilon_h^k$$

$$z_i = (\text{age}_i, \text{educ}_i, \text{work}_i, \text{disability}_i)$$

$$Z = z_f, z_m, \text{woman's share of household income}$$



## Data : an overview

- Canadian Survey of Household Spending, '04-'07
  - Cross sectional recall data on household spending
  - Provides an individual-level disability indicator for the reference person and his/her spouse
  - Defined as presence of physical, mental or health conditions which induce activity limitations
  - Severity index is not provided
    - Key limitation of these data
    - In Jones and O'Donnell's ('95) UK study, severity or type of condition not found to be significant
    - Some informal sensitivity checks have been done using percentiles of total OOP health expenditure



## Data : sampling choices

- Basic sampling criteria follow Lewbel and Pendakur ('08) :
  - To facilitate comparison with the previous study
  - Childless singles and couples
  - reside in large urban areas (minimise effects on home production)
  - aged 26-59 (minimise labour market entry & exit effects)
  - Live on rented dwellings (rent not observed for home owners)
- Choice of pooling cross sections time periods
  - Engel curve analysis assumes constant prices
  - Pooling cross sections increase sample size
    - Particularly important as a small fraction of the sample is disabled
  - This presentation focuses on '04-'05 and '04-'07 results



## Data : sampling choices

- Total expenditure budget has been deflated by CPI from Statistics Canada
  - An alternative may be to construct a Stone index or use provincial deflators
  - Inflation rate between '04 and '07 has been 6% nationwide
    - 2% b/w '04 and '05
  - Relative price changes yet to be checked



## Data : expenditure classification

- The most disaggregated system to be estimated include 11 categories :
  1. Food at home
  2. Restaurant meals
  3. Recreation goods (eg DVDs, video games)
  4. Leisure (eg movie tickets, sports fees)
  5. Personal care
  6. Household operations
  7. Transport
  8. Alcohol
  9. Clothing
  10. Household furnishings & equipment
  11. Housing (Rent + energy)



## Data – key features

### ■ '04-'05 data

- 2,051 households in total : 1,522 singles + 529 couples
- 667 single women in total : 135 disabled (21%)
- 845 single men in total : 163 disabled (19%)
- 529 couples in total: 63 disabled men (12%) & 59 women (11%)

### ■ '04-'07 data

- 3,971 households in total : 2,966 singles + 1,008 couples
- 1,308 single women in total : 292 disabled (22%)
- 1,658 single men in total : 313 disabled (19%)
- 1,008 couples in total : 116 disabled men (12%) & 115 women (11%)



## Data – key features

- It is likely that disabled singles face less severe restrictions than their counterparts in couples on average
  - Given the model specification, the impact on the economies of scale may be contaminated by the impact of severity increase
  
- Raw data on budget shares show that spending pattern differences exist between disabled & non-disabled singles though
  - Eg budget share of food at home (restaurant meals) is 0.02 higher (lower) for disabled singles





## Data – mean budget share, singles '04-'07

	man_no	man_dis	fem_no	fem_dis
food in	0.163	0.187	0.158	0.178
food out	0.075	0.047	0.050	0.029
recreation	0.034	0.024	0.029	0.024
leisure	0.015	0.006	0.016	0.006
ops	0.076	0.069	0.085	0.093
pcare	0.020	0.020	0.044	0.025
transport	0.049	0.029	0.036	0.019
alcohol	0.055	0.047	0.025	0.009
housing	0.406	0.480	0.437	0.550
clothing	0.039	0.026	0.055	0.025
furneq	0.068	0.063	0.064	0.042
# obs	1345	313	1016	292



## Data – mean budget shares, couples '04-'07

	no_dis	man_dis	fem_dis	both_dis
food in	0.181	0.185	0.215	0.208
food out	0.059	0.046	0.036	0.033
recreation	0.033	0.029	0.026	0.037
leisure	0.017	0.008	0.004	0.004
ops	0.079	0.093	0.108	0.077
pcare	0.036	0.034	0.030	0.022
transport	0.062	0.048	0.050	0.049
alcohol	0.033	0.036	0.035	0.034
housing	0.354	0.416	0.387	0.418
clothing	0.070	0.043	0.038	0.039
furneq	0.076	0.061	0.070	0.079
# obs	826	67	66	49



## Estimation strategy

- 1. Choose the level of disaggregation
  - Here I summarise the results from 11, 9 and 7 category systems
  - To reduce the number of parameters to be estimated
  - Check for robustness to expenditure classifications
  
- 2. Start with a full set of demographic characteristics (age, college education, employment & disability). Drop the employment dummy. Drop the education dummy.
  
- 3. Check for parametric restrictions which may improve statistical precision of economies of scale estimates
  - Eg restricting slope coefficients across genders



## Main results – woman's resource share

- The sharing rule is far more precisely estimated than the economies of scale
  - The economies of scale enters the model only as the budget multiplier
  - The sharing rule multiplies the budget AND controls how similar the household Engel curve is to the single woman's Engel curve
  
- The magnitude of woman's resource share is closer to Bargain et al. ('10)'s study of Irish couples in 2005 than Lewbel and Pendakur's ('08) study of Canadian couples from in 1990-92
  - Bargain et al : Woman's share is somewhere around 0.55
  - Lewbel and Pendakur: Woman's share is around 0.40
  - \*Browning et al. : Woman's share is over 0.60



## Main results – woman's resource share

- The reference couple :
  - Both spouses aged 40
  - Both without college education
  - Both without disability
  - (Both outside full-time employment)
  - Wife contributes 40% of the couple's pre-tax income
  
- In '04-'05 sample, the reference wife's resource share estimate is a bit above 0.50 in general with t ratios well in excess of 4
  - Some variations depending on demographic controls
  - 0.52 in 11-goods, 0.50~0.53 in 9-goods and 0.50~0.56 in 7-goods
  - Similar to '04-'07 sample, though there the resource share is a bit below 0.50



## Main results – woman's resource share

- Wife's resource share increases in her gross income share
  - Precisely estimated at 5% level across all specifications & samples
  - The coefficient estimate is around 0.075 when employment dummies are controlled, and 0.095 when excluded
    - Eg for someone otherwise identical to the reference case, changing her income share from 0 to 1 changes her resource share from 0.462 to 0.557
  - Similar in magnitude to findings in Lewbel & Pendakur ('08)



## Main results – woman's resource share

- Wife's resource share decreases in own disability and increase in spousal disability
  - In '04 and '05 sample, own disability reduces her resource share by 0.05~0.06 and spousal disability increases it by 0.07~0.09
  - The point estimates tend to be marginally in/significant at 10% level
  - In '04 and '07 sample, both own (-0.04~-0.05) and spousal disability (0.04~0.06) effects somewhat smaller in magnitude, though they are usually significant at 10% level and occasionally at 5% level
  
- Other demographic variations in resource share do not exhibit robust patterns



## '04-'05 Woman's resource share, 11 goods

	Specification 1		Specification 2		Specification 3	
	Est	S.E.	Est	S.E.	Est	S.E.
intercept	0.5234**	0.1019	0.5213**	0.0820	0.435**	0.0783
fem_shr	0.0779**	0.0364	0.0936**	0.0294	0.095**	0.0284
fem_age	-0.0002	0.0020	-0.0006	0.0020	-0.0017	0.0021
man_age	-0.0003	0.0016	-0.0005	0.0016	-0.0008	0.0015
fem_work	-0.0026	0.0248				
man_work	-0.0345	0.0210				
fem_educ	-0.0335	0.0236	-0.0337	0.0243		
man_educ	0.0080	0.0263	0.0936**	0.0294		
fem_dis	-0.0589*	0.0350	-0.0509	0.0356	-0.0492*	0.0292
man_dis	0.076*	0.0456	0.085*	0.0455	0.0690	0.0475
# parameters	259		213		167	
# obs.	2051		2051		2051	

- Intercept represents woman's resource share in the reference household





## '04-'07 Woman's resource share – 11 goods

	Specification 1		Specification 2		Specification 3	
	Est	S.E.	Est	S.E.	Est	S.E.
intercept	0.4674**	0.0699	0.4783**	0.0671	0.4162**	0.0582
fem_shr	0.0835**	0.0250	0.0923**	0.0200	0.0996*	0.0210
fem_age	0.0005	0.0699	0.0013	0.0015	0.0003	0.0016
man_age	0.0005	0.0009	0.0007	0.0008	0.0002	0.0094
fem_work	-0.0014	0.0202				
man_work	0.0543**	0.0177				
fem_educ	0.0010	0.0236	-0.0029	0.0101		
man_educ	-0.0036	0.0115	0.0016	0.0150		
fem_dis	-0.0461**	0.0213	-0.0328*	0.0195	-0.0375	0.0341
man_dis	0.0543*	0.0317	0.0663*	0.0348	0.0396*	0.0209
# parameters	259		213		167	
# obs.	3971		3971		3971	



## Main results – economies of scale

- Economies of scale parameters have been imprecisely estimated in general
- To be consistent with underlying structural interpretation, the estimated scale must lie between 0.5 (all goods are jointly consumed) and 1 (all goods are privately consumed)
- For the reference wife, the scale estimate ranges from 0.48 to 0.67
- For the reference husband, the scale estimate ranges from 0.41 to 0.74



## Main results – economies of scale

- The range of the estimates are more similar to Bargain et al.'s than Lewbel and Pendakur's
  - The latter authors' estimates are around .7 for women and .78 for men
- Demographic variations, including those along disability, around the reference cases exhibit a fair amount of instability too
- Contrasts with individual preference deflators  $e_i' z_i$  where the effects of age and disability show up significantly



## '04-'05 log scale estimates : 11 goods

	Specification 1		Specification 2		Specification 3	
	Est	S.E.	Est	S.E.	Est	S.E.
fem_intercept	-0.7272*	0.3818	-0.4805*	0.2912	-0.9295**	0.3807
fem_age	-0.0242**	0.0124	-0.0193*	0.0114	-0.0391**	0.0140
fem_educ	-0.0613	0.2121	-0.0050	0.2016		
fem_work	0.1217	0.1949				
fem_dis	0.1214	0.2935	0.0615	0.2810	0.0735	0.3108
man_intercept	-0.5006	0.3754	-0.5485*	0.3094	-0.2363	0.2409
man_age	-0.0019	0.0124	-0.0053	0.0124	0.0022	0.0111
man_educ	-0.0655	0.2570	-0.0252	0.2513		
man_work	0.1059	0.2644				
man_dis	0.1383	0.3255	0.0317	0.3132	0.1376	0.2813
...	...	...	...	...	...	...
# parameters	259		213		167	
# obs.	2051		2051		2051	

- Intercept represent reference person's log scale economy



## '04-'07 log scale estimates : 11 goods

	Specification 1		Specification 2		Specification 3	
	Est	S.E.	Est	S.E.	Est	S.E.
fem_intercept	-0.7356**	0.3603	-0.882**	0.3934	-0.9533**	0.3195
fem_age	-0.0141	0.0101	0.0015	0.0118	-0.0113	0.0126
fem_educ	-0.0613	0.2121	-0.1285**	0.0573		
fem_work	-0.05578**	0.0247				
fem_dis	-0.1601	0.2678	-0.1019	0.3020	-0.0624	0.3166
man_intercept	-0.2912	0.2389	-0.2524	0.1977	-0.1492	0.1887
man_age	0.0145*	0.0076	0.0088	0.0080	0.0044	0.0095
man_educ	0.753**	0.2340	0.7184**	0.2381		
man_work	-0.1218	0.1634				
man_dis	-0.05178*	0.0238	0.2314	0.4325	0.04505**	0.0245
...	...	...	...	...	...	...
# parameters	259		213		167	
# obs.	3971		3971		3971	



## Discussion

- Due to overall instability of the scale estimates, difficult to answer whether differences b/w spending patterns of couples w/ and w/o disability can be partly explained by the economies of scale
- Along with wife's income share, own and spousal disability are found to influence her share of resources significantly
  - In this study, the effect of disability has been estimated while holding income share constant
  - In practice, own disability may be accompanied by lower earnings
  - Full impact of disability on intra-household resource allocations may be bigger than what the point estimates suggest



## Extensions?

- A natural extension may be to concentrate on the issue of intra-household resource allocations instead of analysing household economies of scale at the same time
- Have been recent advance in modeling approaches which facilitate identification of sharing rules in a multi-person household
  - For example Dunbar, Lewbel and Pendakur ('10)
  - Allows to extend the scope beyond childless couples
  - Doesn't require estimation of a full Engel curve system
    - More robust estimates may be obtained



## Theoretical framework

- Due to Browning, Chiappori and Lewbel (unpublished, '09)
- Assumes that the household behaves as if solving the following program :

$$\max_{q_f, q_m} \mu U^f(q_f) + U^m(q_m)$$

$$s.t. p'x = y \text{ and } q_f + q_m = Ax$$

- $\mu = \text{Pareto weight}$
- $q_f, q_m = \text{individual consumption vectors}$
- $x = \text{vector of purchased consumption goods}$
- $A = \text{matrix of household consumption technology}$





## Theoretical framework

- Eg if  $A$  is a diagonal matrix of the same dimension as  $x$  (Barten technology),

$$q_f^k + q_m^k = A^k x^k$$

- $A^k = 1$  for pure private goods ie summation of individual consumption of good  $k$  equals what has been purchased
- $A^k = 2$  for pure public goods ie summation of individual consumption is twice what has been purchased
- $1 < A^k < 2$  in general



## Theoretical framework

- Provides decentralised duality results eg for a female spouse

$$V^f(\eta y, A^{-1}p) \Rightarrow q_f^k = A^k q_f^k(\eta y, A^{-1}p)$$

– where  $V(.,.)$  is the indirect utility function

- Thus, the household demand system is given by :

$$x^k = (A^k)^{-1} q_f^k(\eta y, A^{-1}p) + (A^k)^{-1} q_m^k([1-\eta]y, A^{-1}p)$$

- The budget share form of which is :

$$w^k = \eta w_f^k(\eta y, A^{-1}p) + [1-\eta] w_m^k([1-\eta]y, A^{-1}p)$$



## Theoretical framework

- Estimation of a full BCL demand system requires a long span of budget data and is computationally cumbersome
- Lewbel and Pendakur ('08) impose the following restriction on preferences to transform the demand system into an Engel curve system :

$$V^f(\eta y, A^{-1}p) = V^f\left(\frac{\eta y}{\delta_f}, p\right) \quad \& \quad V^m([1-\eta]y, A^{-1}p) = V^m\left(\frac{[1-\eta]y}{\delta_m}, p\right)$$

- ie there are budget deflators which can induce the same effect as price deflators



## '04-'05 log scale estimates : 7 goods

	Specification 1		Specification 2		Specification 3	
	Est	S.E.	Est	S.E.	Est	S.E.
fem_intercept	-0.6947**	0.3554	-0.3928	0.2531	-0.7642**	0.3316
fem_age	-0.0283**	0.0125	-0.0222**	0.0109	-0.0343**	0.0131
fem_educ	-0.1351	0.1950	-0.1541	0.1819		
fem_work	0.1054	0.1810				
fem_dis	0.1823	0.2829	0.0845	0.2636	0.1206	0.2965
man_intercept	-0.6125	0.3754	-0.8893**	0.3094	-0.4584	0.2860
man_age	0.0197	0.0124	0.0165	0.0146	0.0007	0.0139
man_educ	0.5122	0.3595	0.5287	0.3462		
man_work	0.3594	0.2644				
man_dis	-0.2328	0.4545	0.0736	0.4323	-0.0586	0.3563
...	...	...	...	...	...	...
# parameters	167		137		122	
# obs.	2051		2051		2051	