



The Ubiquitous Internet, ICT Productivity and Household Economic Welfare

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A quick overview

1. The Internet is everywhere
2. ICT productivity is hard to measure
3. The effect on household welfare depends upon income, demographics ... and opportunity costs not currently well measured

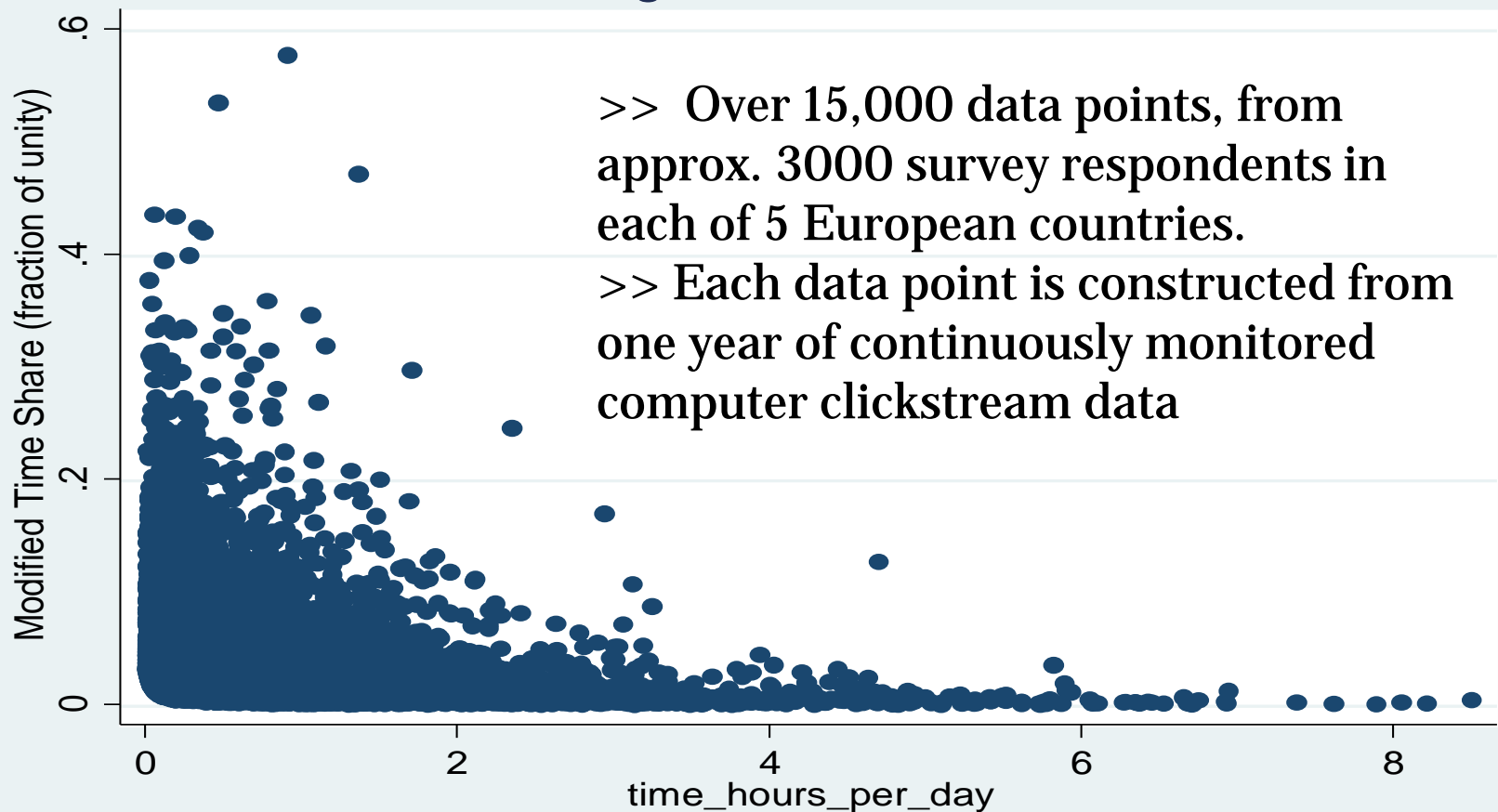
Guess the R-squared competition

How well would a regression curve fit these data?

Guess the shape competition

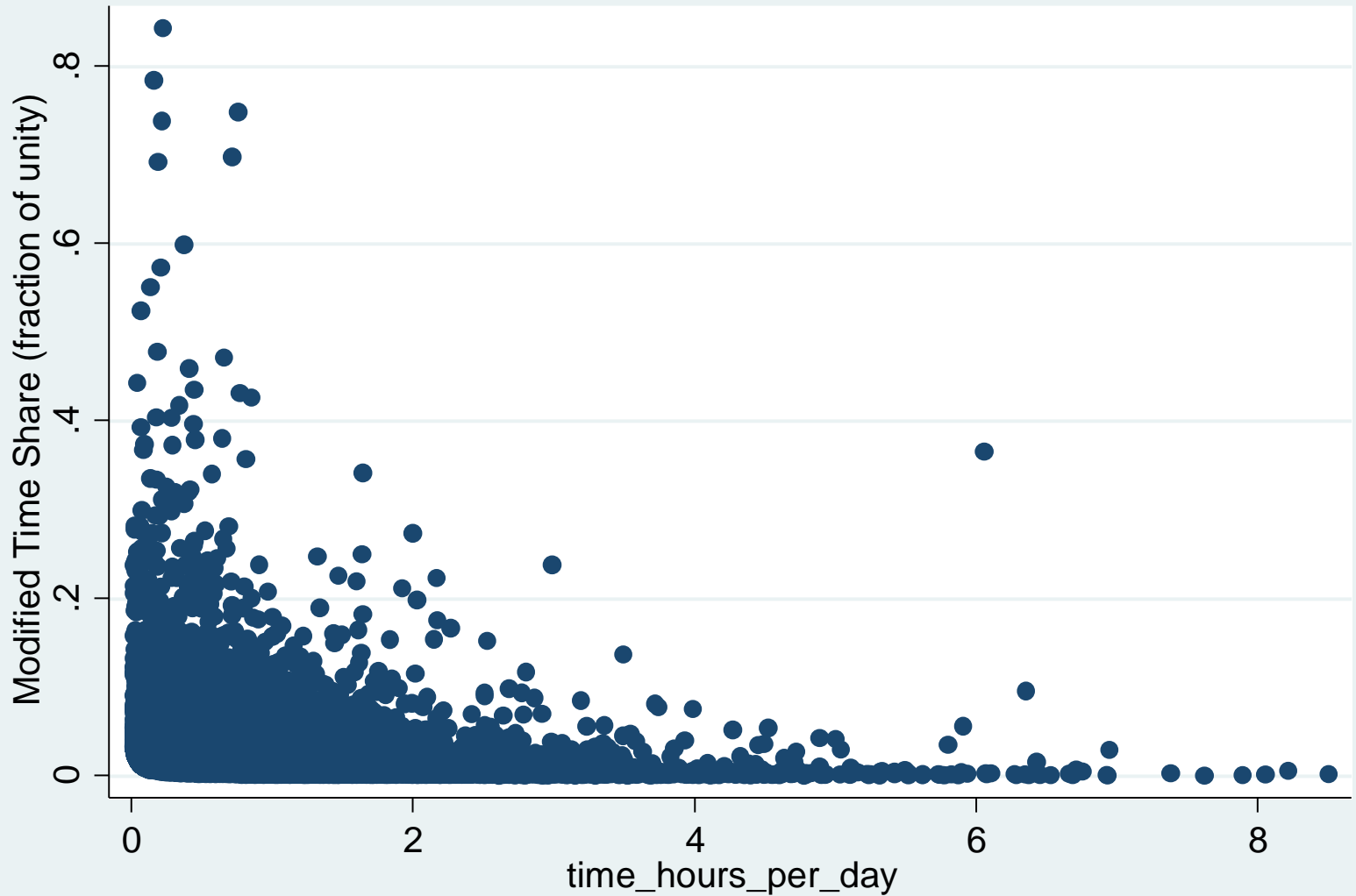
Is this 'product' a (time)-necessity or luxury?

'Engel' Curve: Travel



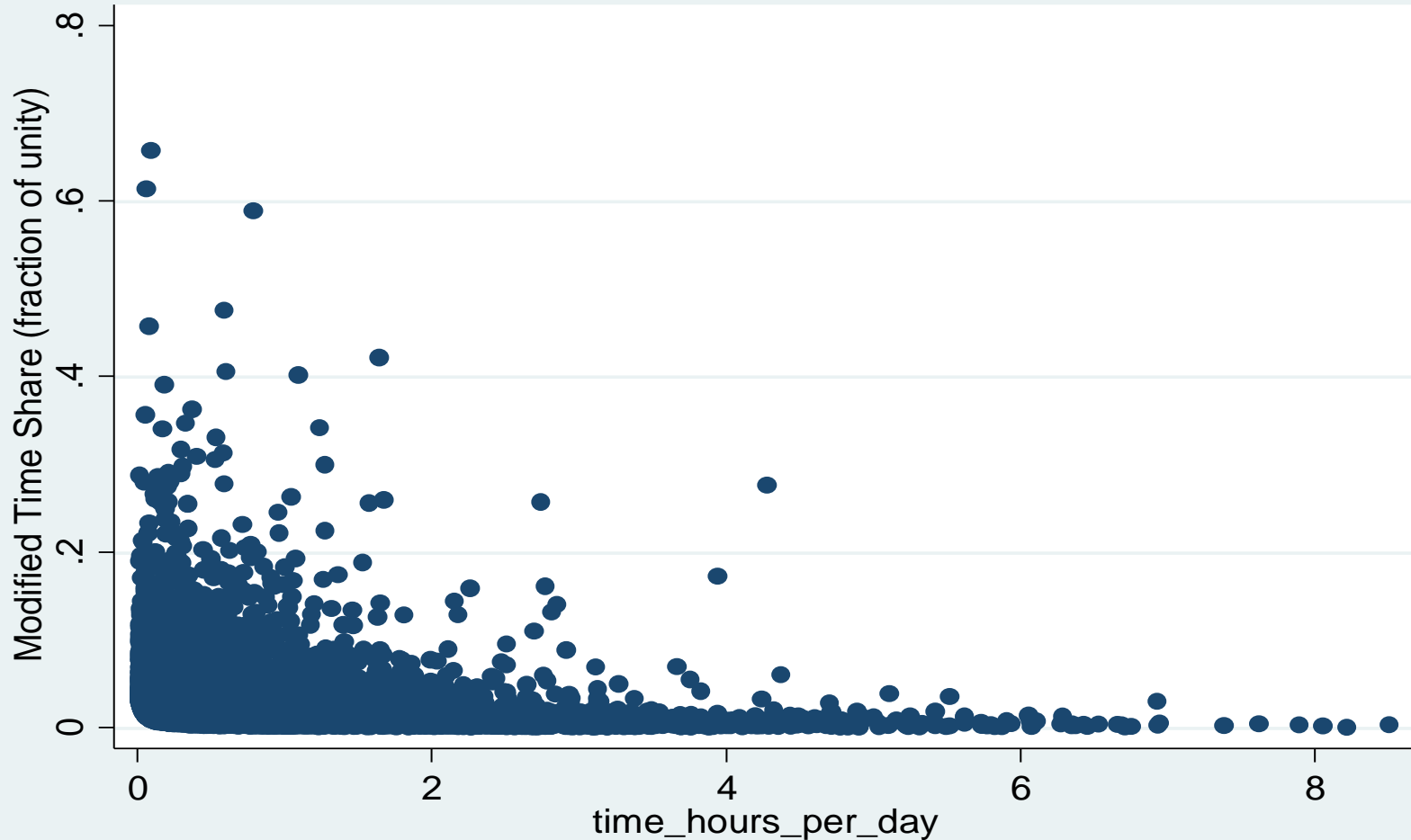
Data fit? Necessity or luxury?

'Engel' Curve: Education and Careers



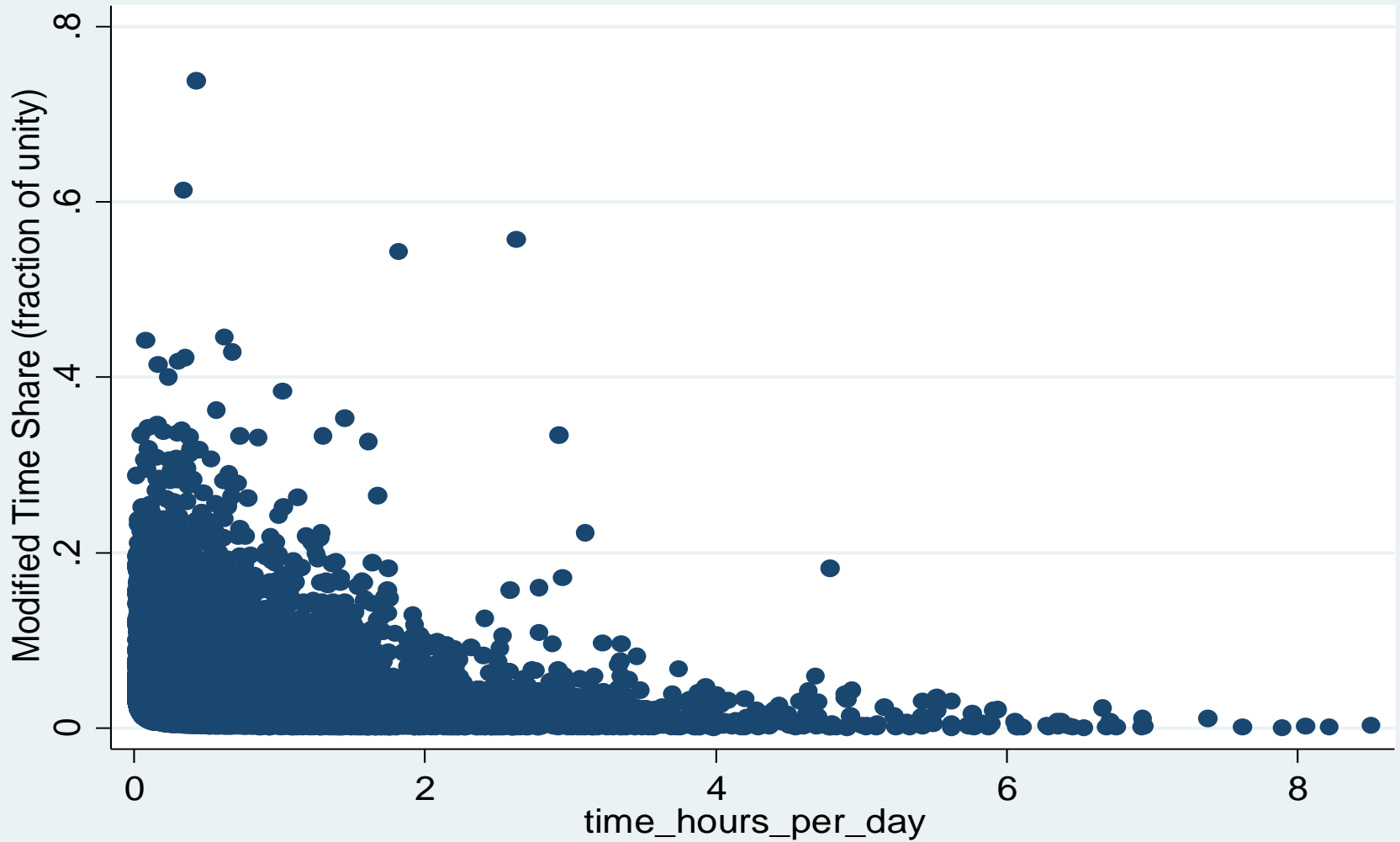
Data fit? Necessity or luxury?

'Engel' Curve: Computers and Consumer Electronics



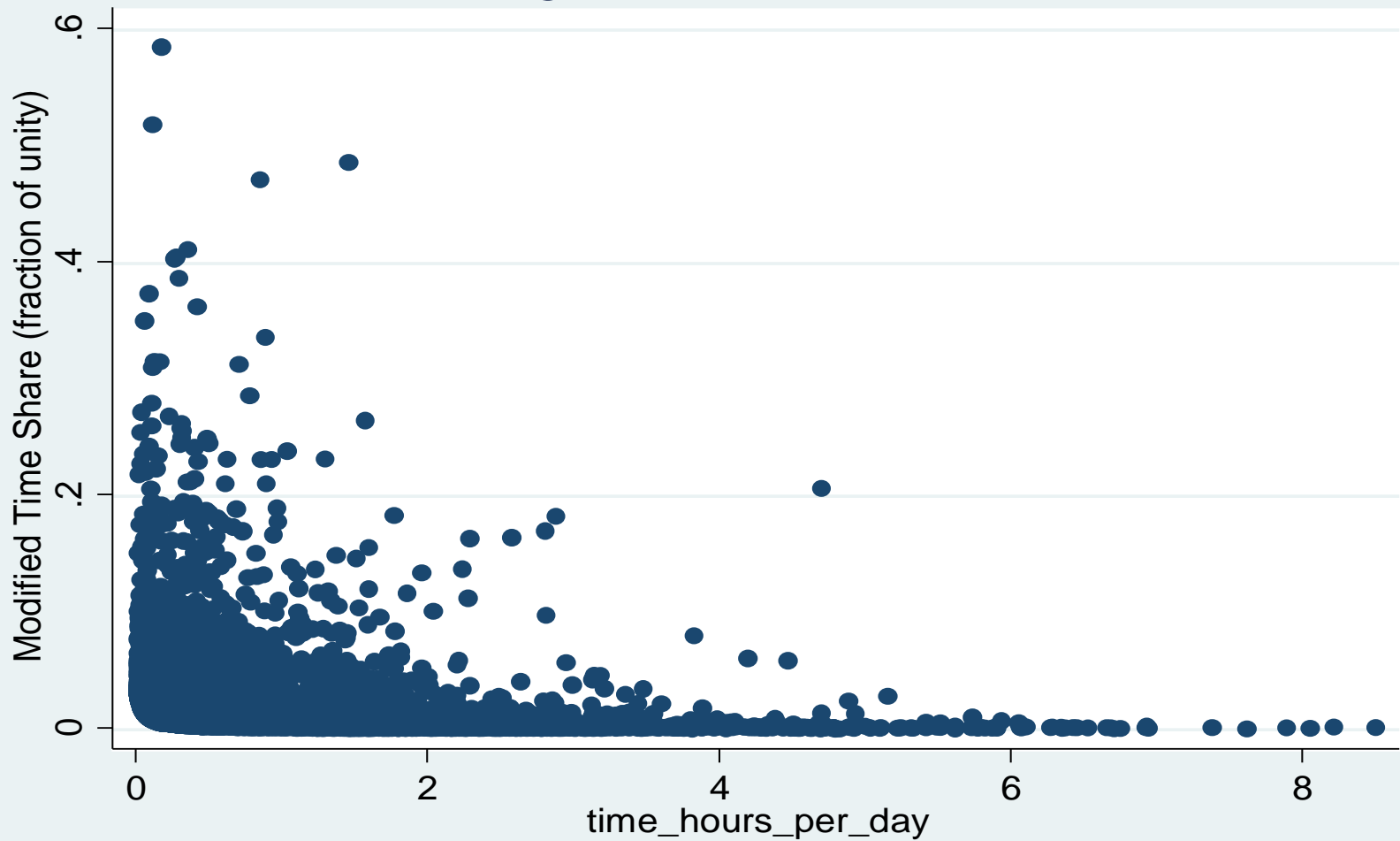
Data fit? Necessity or luxury?

'Engel' Curve: Home and fashion



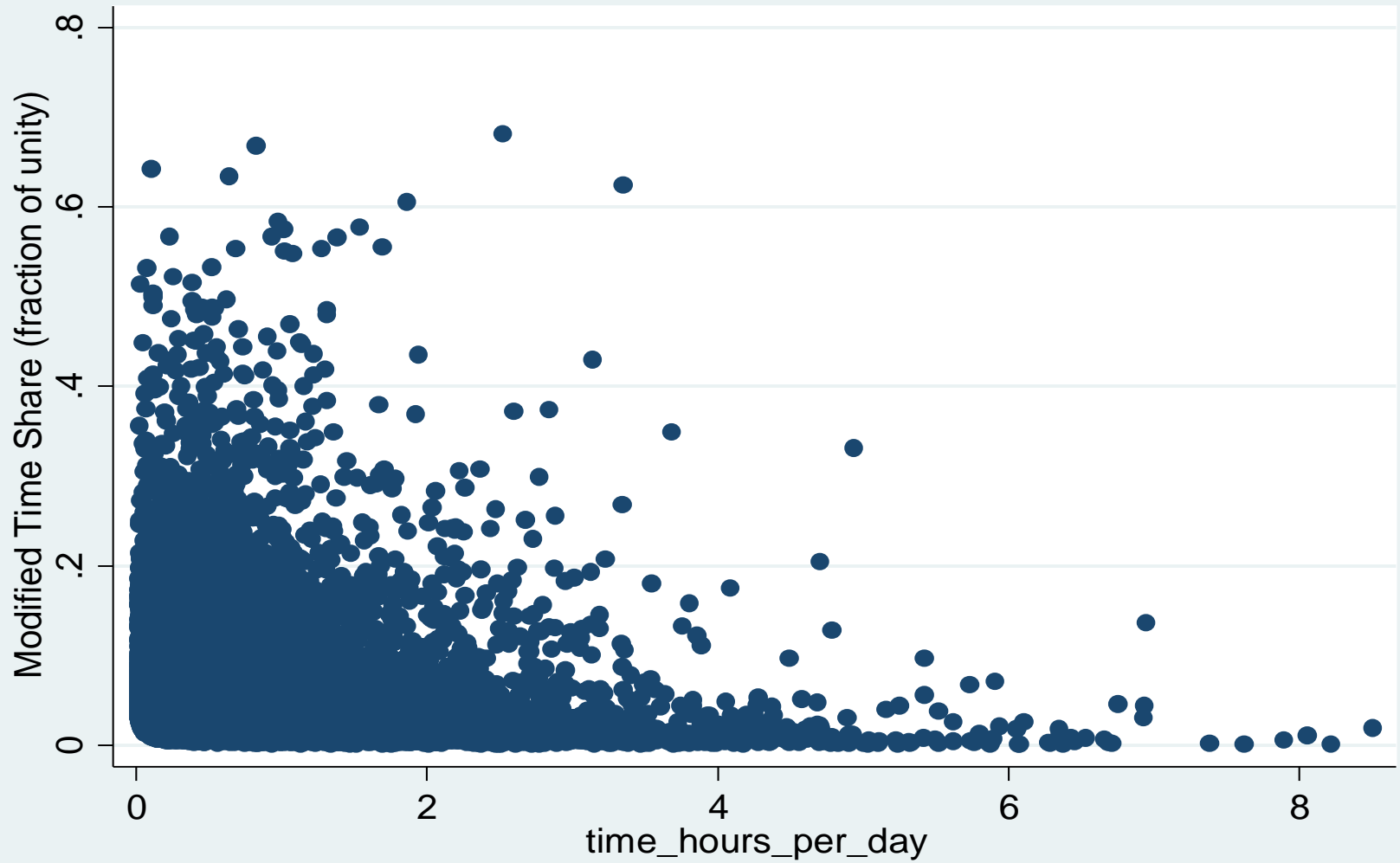
Data fit? Necessity or luxury?

'Engel' Curve: Automotive



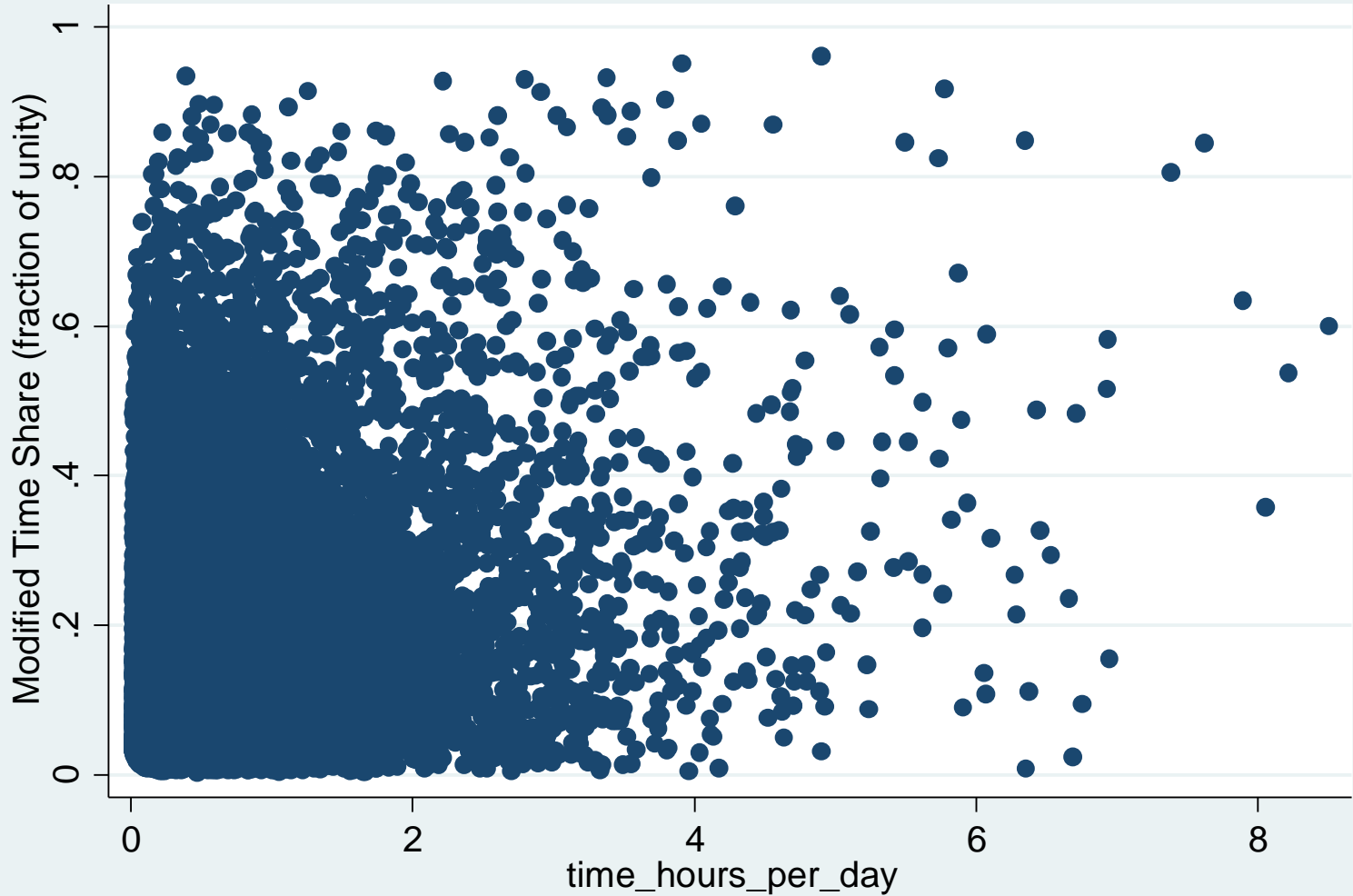
Data fit? Necessity or luxury?

'Engel' Curve: News and Information



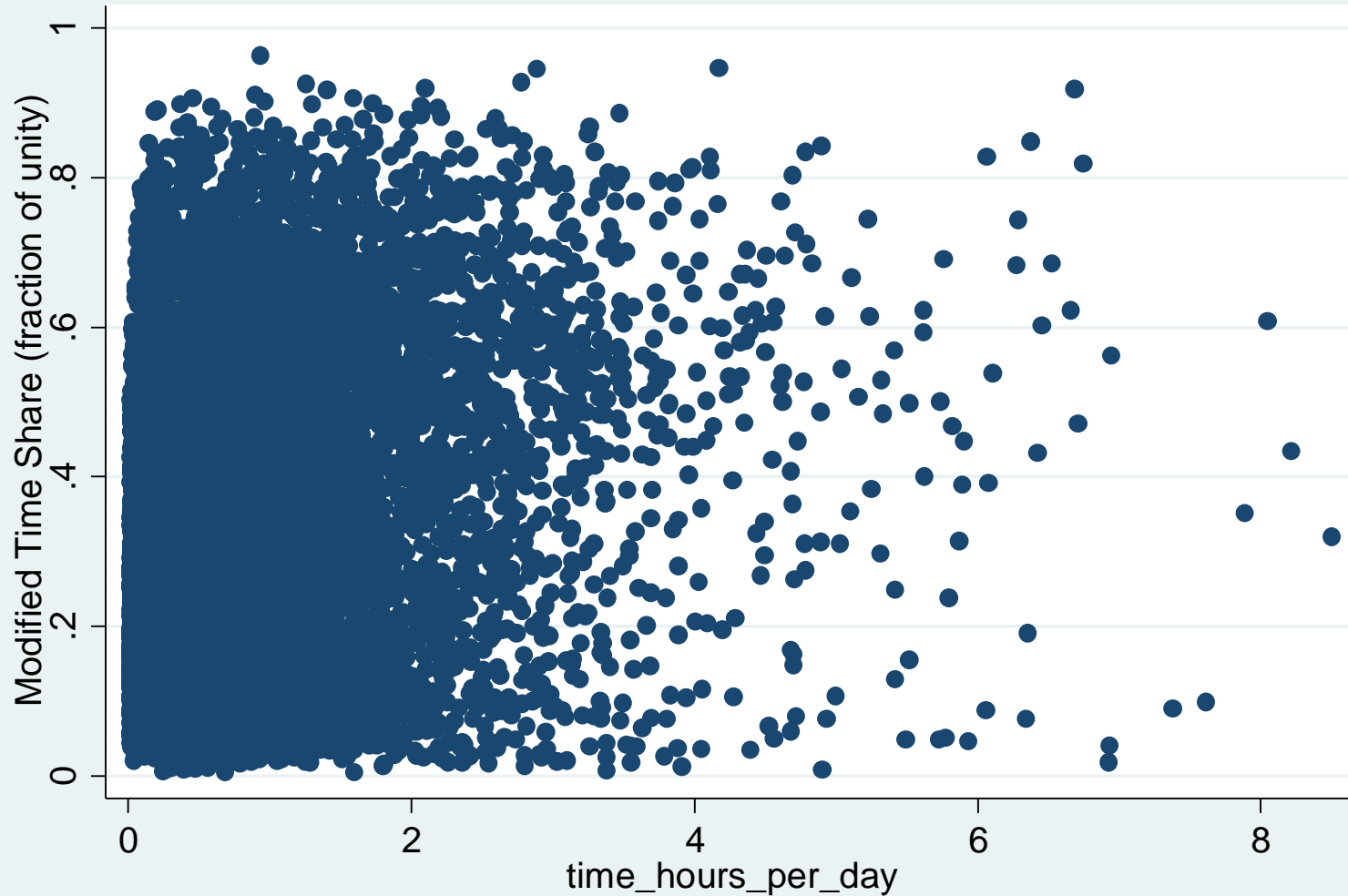
Data fit? Necessity or luxury?

'Engel' Curve: Entertainment



Data fit? Necessity or luxury?

'Engel' Curve: Search Engines Portals and Communities



Some Relevant Background Literature

- Goolsbee, A., and Klenow, P.J. (2006) Valuing Consumer Products by the Time Spent Using Them: An Application to the Internet. *National Bureau of Economic Research Working Paper Series No. 11995.*
- Goldfarb A. and J. Prince (2007) 'Internet adoption and usage patterns are different: Implications for the digital divide', *Information Economics and Policy*, Elsevier, vol.20, pages 2-15.
- SQW (2013) 'UK Broadband Impact Study', Literature Review (February), Impact Report (November).

Summary of some of our relevant recent work:

(1) Differential Impact of the Internet among Australian Households

(2) The Digital Divide across Age and Household Size Differentiated Australian Demographic Groups: What the CPI does not reveal

(3) Network Divides: What Australian Household Expenditure Survey Data Reveals about the Special Nature of Social Networks

(4) Demographic Productivity Differentials – A Household Perspective

#1

Differential Impact of the Internet among Australian Households Modelling Details

Utility
function:
(indirect)

$$V = \left(\frac{M}{P_B} \right)^\eta \ln \left(\frac{M}{P_A} \right) \quad , \text{ where: } \quad P_A = p_N^\alpha p_L^{1-\alpha}$$

$$P_B = p_N^\beta p_L^{1-\beta}$$

and $p_N q_N + p_L q_L = M$

Roy's
identity

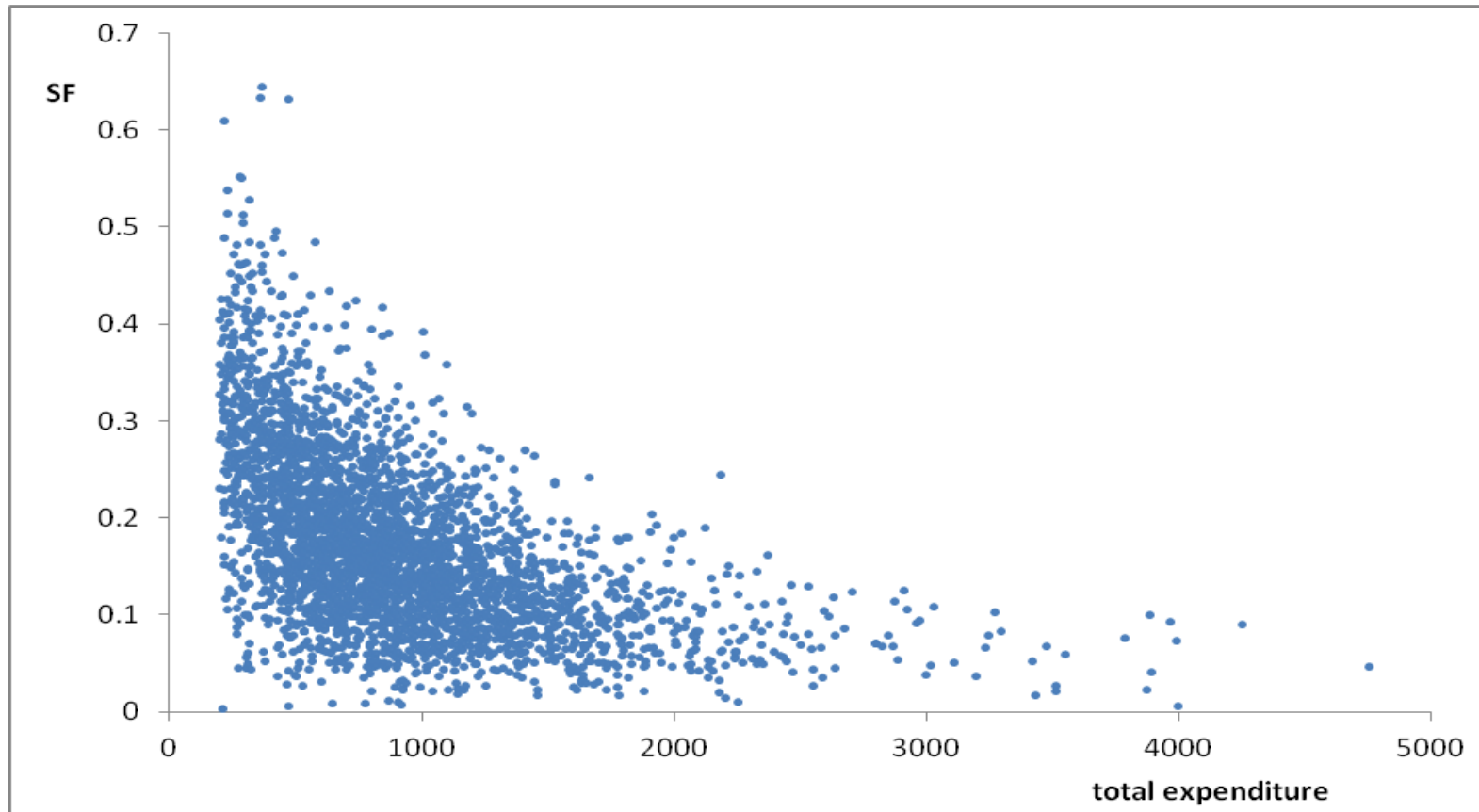


Share
demand:

$$s_N = \frac{p_N q_N}{M} = \frac{\alpha + \beta \eta \ln \left(\frac{M}{P_A} \right)}{1 + \eta \ln \left(\frac{M}{P_A} \right)}$$

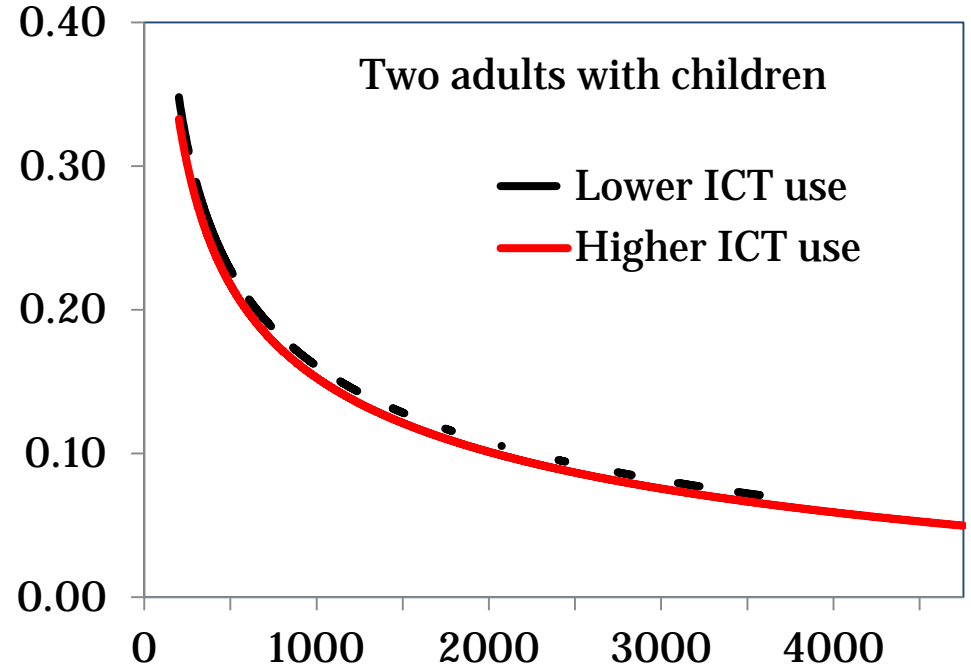
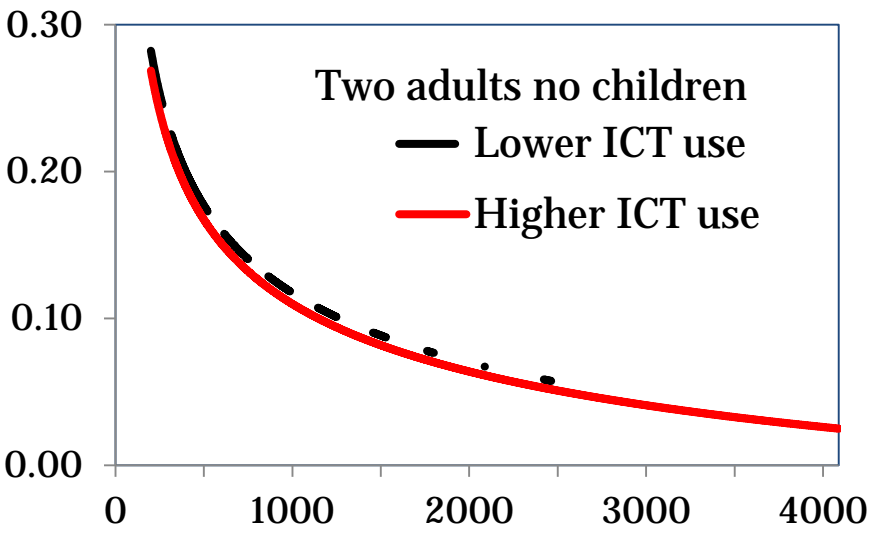
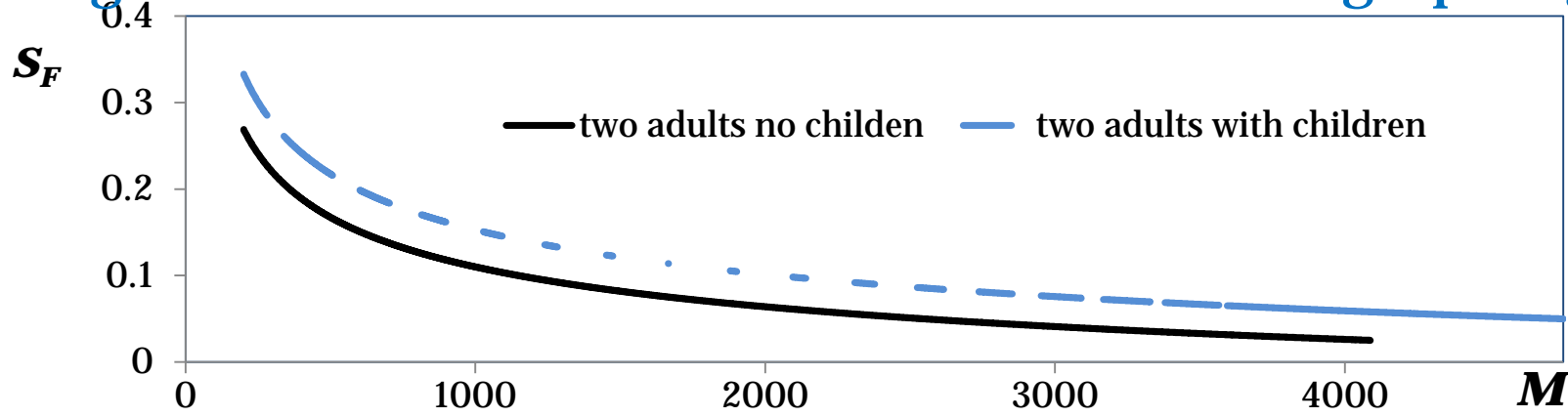
Differential Impact of the Internet among Australian Households

Scatter diagram – food share vs ‘income’



Differential Impact of the Internet among Australian Households

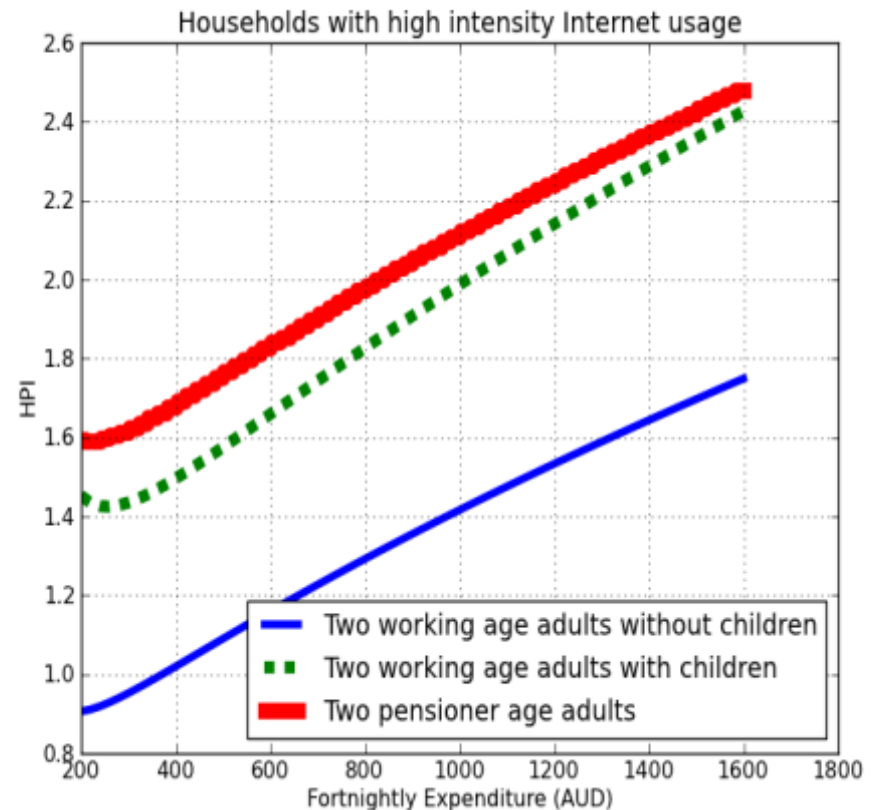
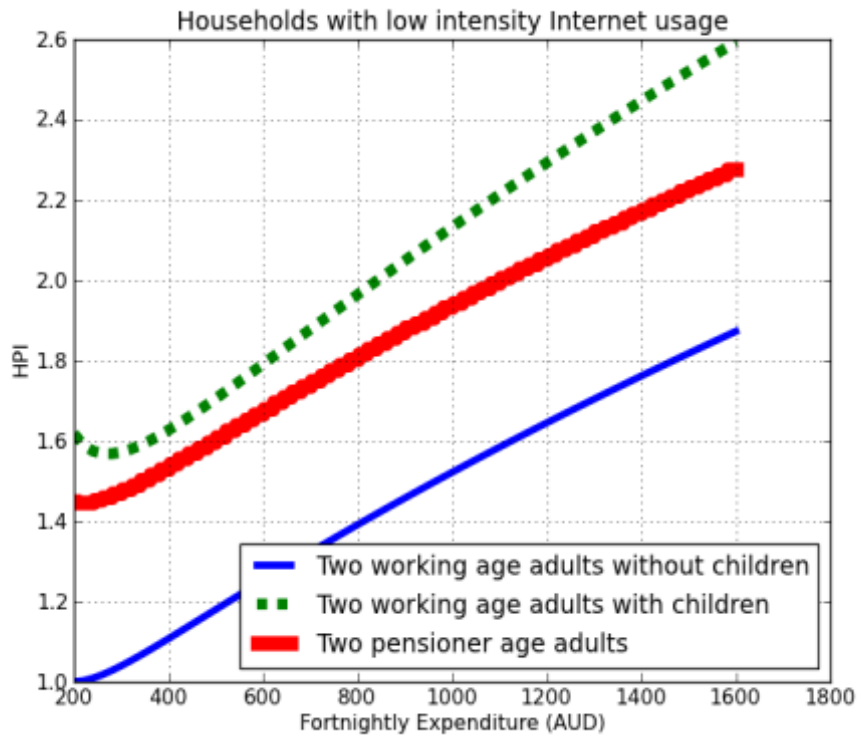
Engel Curve differences between the main demographic groups



#2

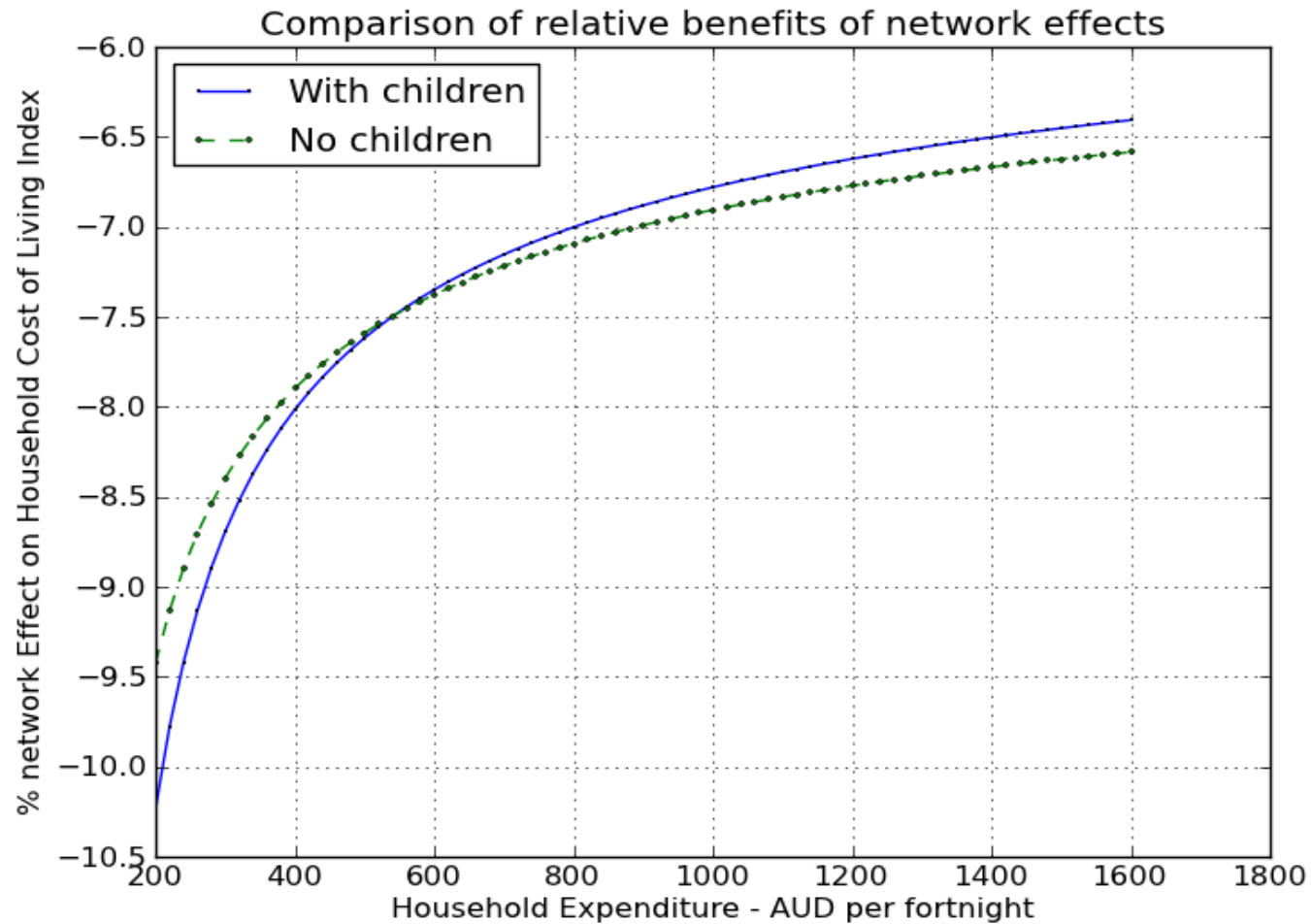
The Digital Divide across Age and Household Size Differentiated Australian Demographic Groups: What the CPI does not reveal

$$PQ = M \text{ and } Q \equiv \text{Utility} \Rightarrow P_{H,d,k} = \frac{M}{1 + \left(M / P_{B,d,k} \right)^{\eta_d} \ln \left(M / P_{A,d,k} \right)} = \frac{\text{Money}}{\text{Indirect Utility Function}}$$



#3

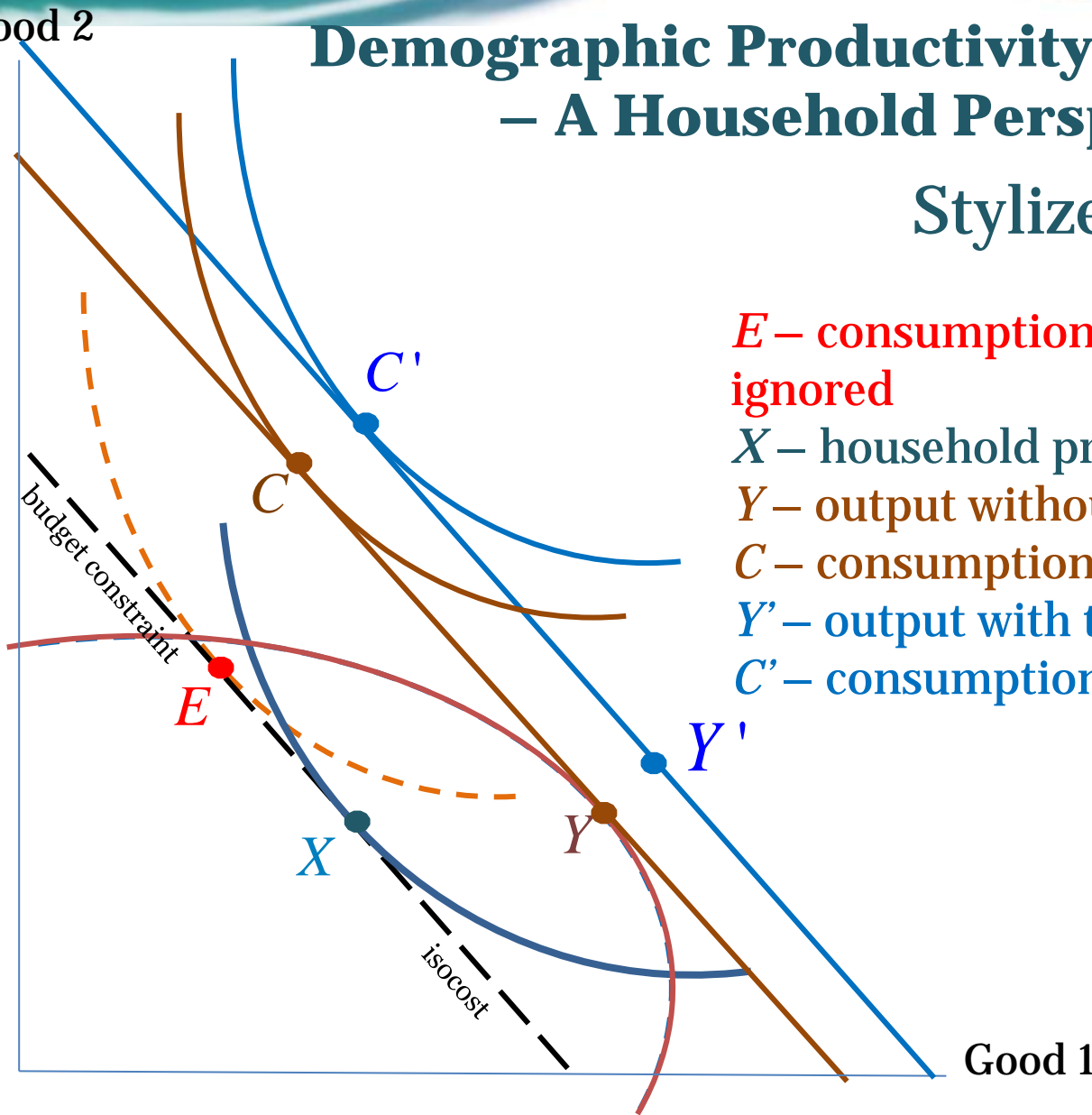
Network Divides: What Australian Household Expenditure Survey Data Reveals about the Special Nature of Social Networks



#4

Demographic Productivity Differentials – A Household Perspective

Stylized model



E – consumption with h/h production ignored

X – household production

Y – output without the Internet use

C – consumption without the Internet use

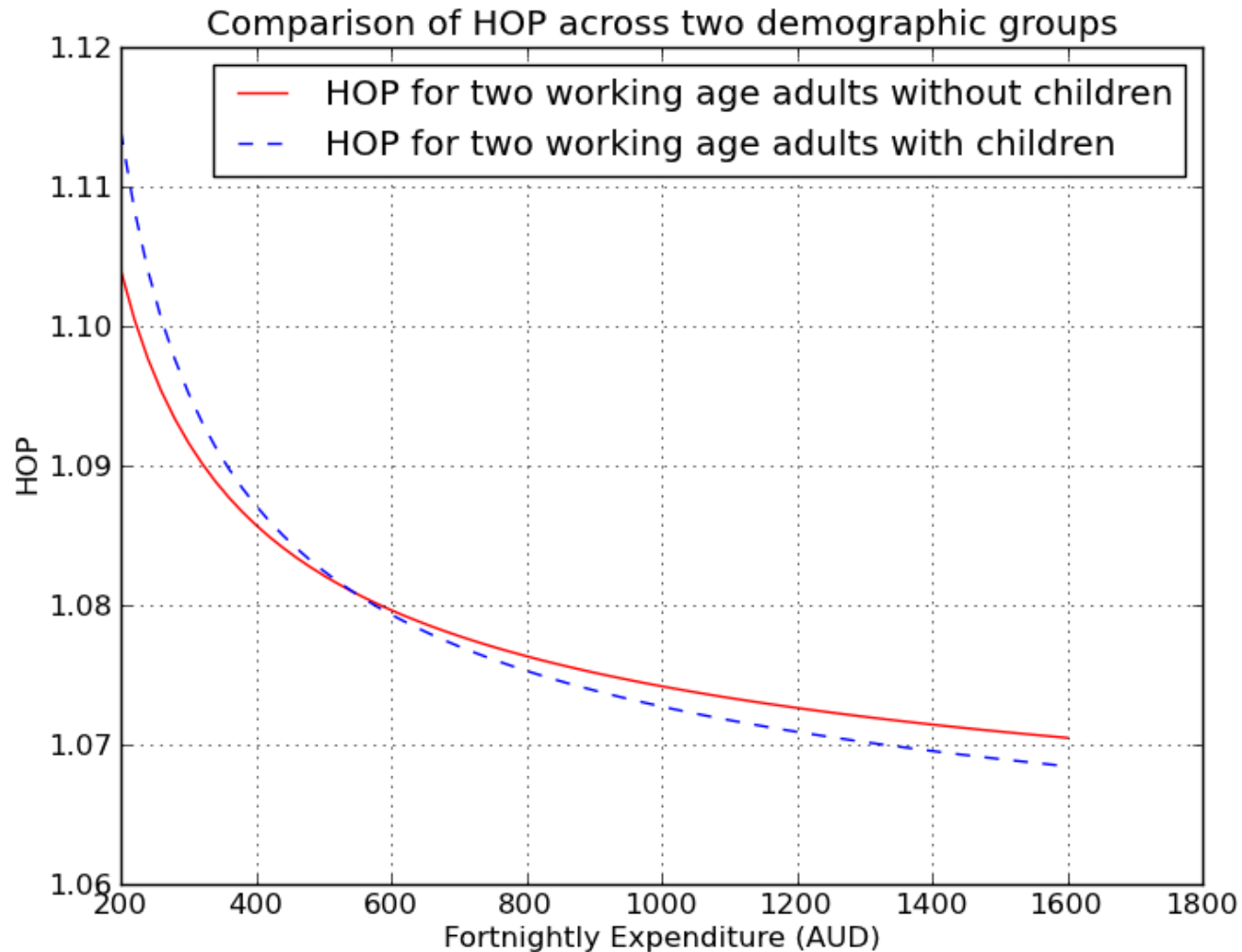
Y' – output with the Internet use

C' – consumption with the Internet use

$$P_C C = P_{C'} C'$$

$$HOP = \frac{P_C}{P_{C'}}$$

HOP across the two demographic groups





Our preliminary conclusions from research so far

The 'ICT revolution' has impacted not only on the market economy, but also increased productivity of 'household production'.

The household productivity impact differs for households of different demographics.

The productivity impacts are very progressive with larger beneficial impacts at lower income levels.

The size of the benefits at low income levels tend to favour households with children, but at higher income levels the ranking of beneficial impacts is reversed.

Back to the future

'Engel' Curve: Entertainment

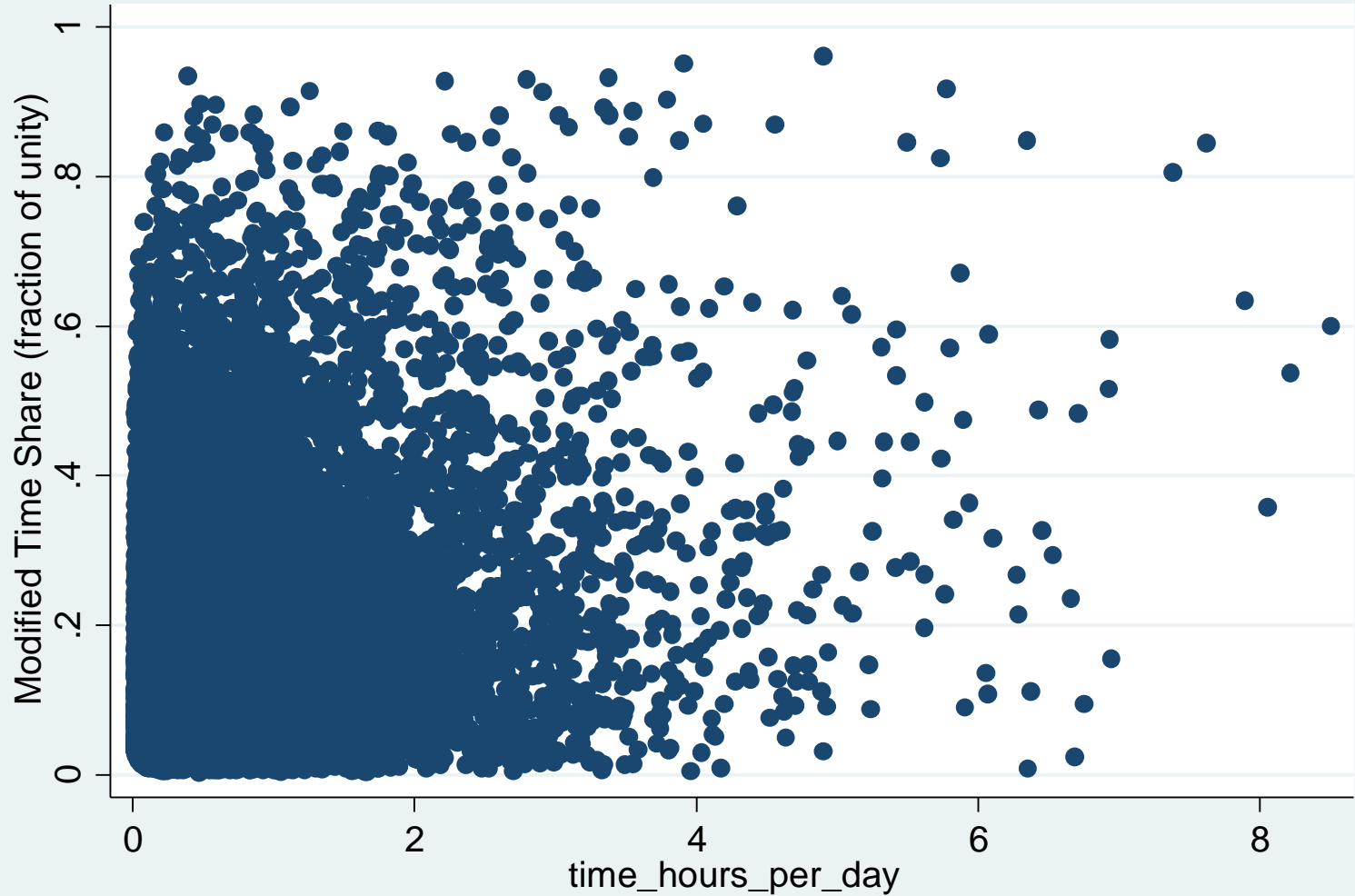


Figure 14: Internet time share of category 5 'Entertainment' as a function of Real Income for males with 'Clerical/Administrative' occupations

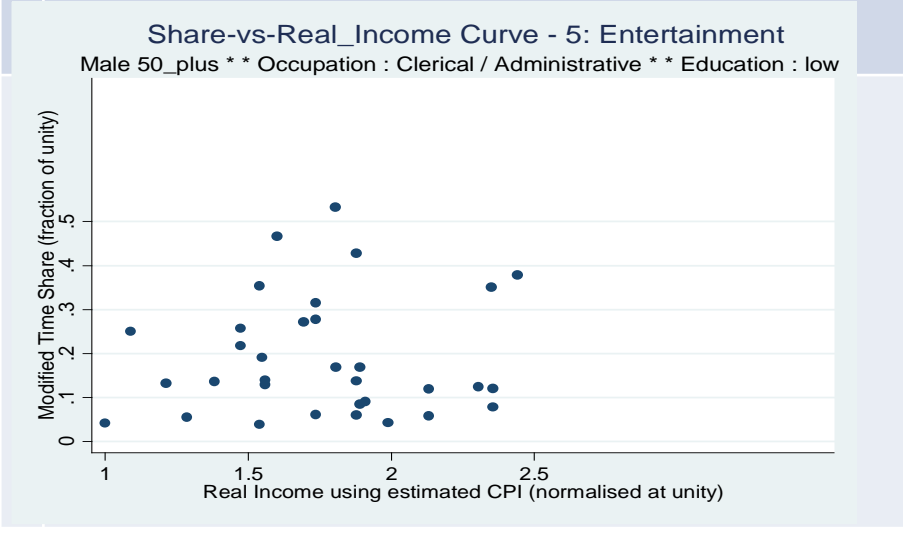
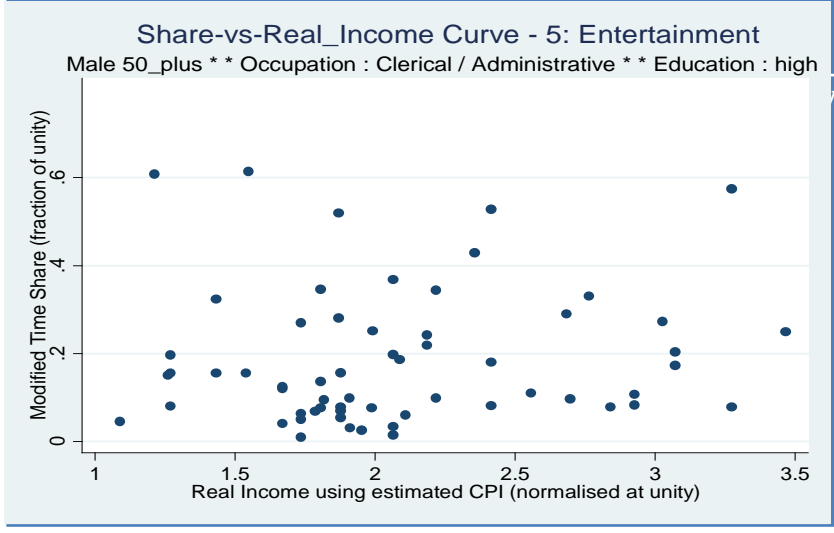
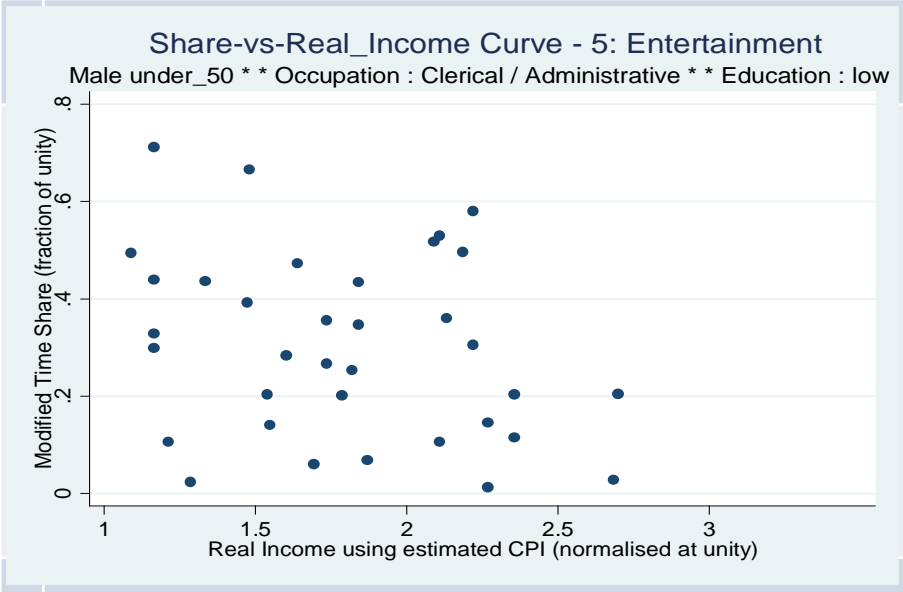
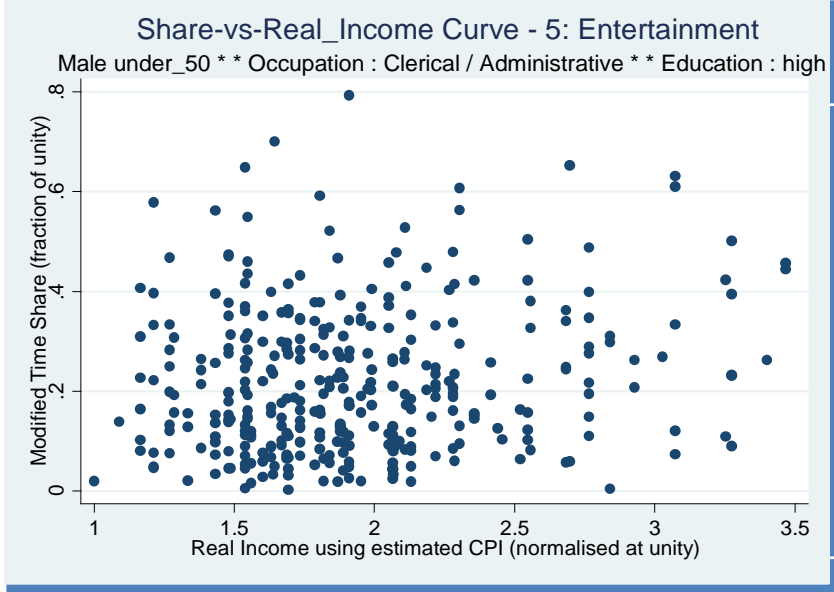


Table 3 Reduced Sample: Respondents x Occupation x Country

	Number of respondents (after culling)					
Occupations (after culling)	Country					
	Spain	Italy	France	UK	Germany	Total
2 Clerical/Administrative	580	875	592	440	614	3101
5 Executive/managerial	157	94	878	466	168	1763
6 Full time student	443	458	244	284	207	1636
7 Homemaker	212	255	168	346	254	1235
10 Operator/labourer	200	292	183	255	306	1236
13 Retired	137	251	581	532	439	1940
15 Self-employed	358	577	131	422	358	1846
17 Technical	378	140	333	160	140	1151
18 Unemployed	496	317	238	271	402	1724
Totals	2961	3259	3348	3176	2888	15632

Internet Time Use Categories x Number of Users x Summary Time Share Statistics

Internet time use category	Users	Usage as share of total Internet time	
		Minimum share	Average share
1: Automotive	13783	2.06E-07	0.011
2: Computers and electronics	15281	6.05E-06	0.024
3: Corporate Information	14879	3.42E-06	0.012
4: Education & Careers	14380	2.47E-07	0.019
5: Entertainment	15340	9.03E-05	0.206
6: Family & Lifestyle	14993	2.59E-06	0.024
7: Finance	15090	1.09E-06	0.040
8: Government & Non-Profit	14594	1.04E-06	0.017
9: Home & Fashion	15138	7.22E-06	0.036
10: e-Commerce	15277	2.43E-05	0.083
11: News & Information	15313	2.76E-05	0.054
12: Search Engines, Portals, etc.	15352	1.72E-03	0.319
13: Special Occasions	12661	9.29E-07	0.004
14: Telecom & Internet Services	15346	1.30E-04	0.125
15: Travel	15204	2.08E-06	0.033

Internet Time Use Categories x Summary Modified Time Share Statistics for 15,352 Respondents

Internet time use category	Modified usage / modified total Internet time	
	Minimum share	Average share
1: Automotive	1.41E-04	0.014
2: Computers and electronics	3.64E-04	0.026
3: Corporate Information	1.94E-04	0.015
4: Education & Careers	1.93E-04	0.021
5: Entertainment	2.36E-03	0.198
6: Family & Lifestyle	2.74E-04	0.026
7: Finance	1.43E-04	0.041
8: Government & Non-Profit	1.42E-04	0.019
9: Home & Fashion	1.69E-04	0.037
10: e-Commerce	1.70E-04	0.081
11: News & Information	4.36E-04	0.055
12: Search Engines, Portals, etc.	4.35E-03	0.304
13: Special Occasions	1.32E-04	0.008
14: Telecom & Internet Services	6.20E-04	0.121
15: Travel	2.48E-04	0.034

Internet time share 'Engel' Curves

$$\tau_{ij} = \frac{\theta_i + \delta_i T_j + \eta_i Y_j}{1 + T_j + Y_j}$$

$$\tau_{ij} = \frac{\theta_i + \Delta\theta_{i_female} d_{gender} + \Delta\theta_{i_50+} d_{age} + \delta_i T_j + (\eta_i + \Delta\eta_{i_ed+} d_{education}) Y_j}{1 + T_j + Y_j}$$

$$IUF = \frac{V}{\Pi_B} \ln\left(\frac{V}{\Pi_A}\right) + \frac{V}{\Pi_C} \ln\left(\frac{M}{P}\right)$$

Indirect Utility Function

$$\Pi_A = \left[\sum_{i=1}^{15} \left(\gamma_i + \Delta\gamma_{i_female} d_{gender} + \Delta\gamma_{i_50+} d_{age} \right) \pi_i^{1-\rho} \right]^{1/(1-\rho)}$$

CES shadow price index

$$\pi_i = \left(M^{1-\rho} + 1 + \phi_{ik} \right)^{1/(1-\rho)}$$

Shadow pricing model:

Opportunity cost of spending

time on Internet category i

depends on wage M but also on

occupation type k

Overall fit statistics for 14 equations (excludes equation 2)

Internet time use category	R-squared
1: Automotive	0.952
2: Computers and consumer electronics	
3: Corporate Information	0.962
4: Education & Careers	0.944
5: Entertainment	0.833
6: Family & Lifestyle	0.943
7: Finance	0.924
8: Government & Non-Profit	0.955
9: Home & Fashion	0.933
10: e-Commerce	0.887
11: News & Information	0.926
12: Search Engines, Portals, & Communities	0.825
13: Special Occasions	0.971
14: Telecom & Internet Services	0.875
15: Travel	0.941

Table 10 Parameter Estimates with Comments

Parameter	Estimate	Standard Error	Z statistic	P value Prob> z	Comments
Elasticity of substitution					The elasticity of substitution is a variable. This is the value for very low income and
ρ	0.814	0.025	32.7	0.000	very little total available Internet time
Prices					
	1				CPI 1 for region 1 of Spain (Madrid)
	-0.222	0.024	-9.4	0.000	3 non-central Spanish regions all have significantly lower CPIs than Spanish region 1 (Madrid)
	-0.306	0.023	-13.4	0.000	
	-0.142	0.023	-6.2	0.000	
	0.504	0.021	23.6	0.000	CPI (London) significantly less than Madrid
	0.056	0.050	1.1	0.264	CPI for each UK non-central region not significantly different from UK region 1 (London)
	-0.032	0.044	-0.7	0.473	
	0.001	0.073	0.0	0.984	

Parameter	Estimate	Standard Error	Z statistic	P value Prob> z	Comments
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Internet time use category 5: Entertainment

Opportunity costs/Shadow prices for various occupations

Clerical/admin	-0.022	0.012	-1.9	0.058	Not significantly different to self-employed
Management	0.000	0.013	0.0	1.000	Not significantly different to self-employed
Technical	-0.044	0.015	-2.9	0.004	Significantly lower OC than self-employed
Labourer	-0.114	0.021	-5.5	0.000	Significantly lower OC than self-employed
Unemployed	-0.101	0.018	-5.5	0.000	Significantly lower OC than self-employed
Student	-0.099	0.018	-5.4	0.000	Significantly lower OC than self-employed
Homemaker	-0.078	0.017	-4.6	0.000	Significantly lower OC than self-employed
Retired	0.049	0.015	3.3	0.001	Significantly higher OC than self-employed

Entertainment preference parameters

Gamma	0.159	0.005	32.2	0.000	0.159 > 0.137 implies time share is slightly downward sloping in income. 0.428, positive, implies time share is rising proportion of total time available
Delta	0.428	0.029	14.8	0.000	
Eta	0.137	0.005	28.1	0.000	
+gamma_female	-0.087	0.004	-23.0	0.000	Females significantly less interested
+gamma_aged	-0.030	0.004	-8.4	0.000	Aged significantly less interested
+eta_educated	-0.034	0.004	-8.5	0.000	Educated significantly less interested

Parameter	Estimate	Standard Error	Z statistic	P value Prob> z	Comments
Internet time use category 6: Family and Lifestyle					
Opportunity costs/Shadow prices for various occupations					
Clerical/admin	-0.039	0.014	-2.7	0.007	Significantly lower OC than self-employed
Management	-0.050	0.017	-3.0	0.003	Significantly lower OC than self-employed
Technical	-0.027	0.017	-1.6	0.120	Not significantly different to self-employed
Labourer	-0.059	0.018	-3.2	0.001	Significantly lower OC than self-employed
Unemployed	-0.023	0.016	-1.5	0.131	Not significantly different to self-employed
Student	0.120	0.025	4.8	0.000	Significantly higher OC than self-employed
Homemaker	-0.082	0.020	-4.0	0.000	Significantly lower OC than self-employed
Retired	-0.101	0.021	-4.9	0.000	Significantly lower OC than self-employed
Family and Lifestyle preference parameters					
Gamma	0.011	0.000	23.7	0.000	0.011 < 0.013 implies time share is very slightly upward sloping in income. -0.029, negative, implies time share is falling proportion of total time available
Delta	-0.029	0.002	-14.3	0.000	
Eta	0.013	0.001	23.5	0.000	
+gamma_female	0.006	0.000	13.6	0.000	Females significantly more interested
+gamma_aged	0.001	0.000	2.5	0.011	No significant effect of age
+eta_educated	0.002	0.000	4.3	0.000	Educated significantly more interested

Parameter	Estimate	Standard Error	Z statistic	P value Prob> z	Comments
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Internet time use category 10: e-Commerce

Opportunity costs/Shadow prices for various occupations

Clerical/admin	-0.041	0.014	-2.9	0.004	Significantly lower OC than self-employed
Management	-0.051	0.017	-3.1	0.002	Significantly lower OC than self-employed
Technical	-0.085	0.020	-4.2	0.000	Significantly lower OC than self-employed
Labourer	-0.072	0.019	-3.8	0.000	Significantly lower OC than self-employed
Unemployed	0.018	0.015	1.2	0.246	Not significantly different to self-employed
Student	0.186	0.032	5.7	0.000	Significantly higher OC than self-employed
Homemaker	-0.052	0.018	-2.9	0.004	Significantly lower OC than self-employed
Retired	-0.106	0.020	-5.2	0.000	Significantly lower OC than self-employed

e-Commerce preference parameters

Gamma	0.016	0.001	11.0	0.000	0.016 < 0.072 implies time share is strongly upward sloping in income. -0.0008, effectively zero, implies time share not responsive to total time available
Delta	-0.008	0.008	-1.1	0.285	
Eta	0.072	0.003	27.4	0.000	
+gamma_female	0.014	0.001	10.8	0.000	Females significantly more interested
+gamma_aged	-0.002	0.001	-1.7	0.091	No significant effect of age
+eta_educated	0.002	0.002	1.3	0.210	No significant educational effect

Welfare evaluation

CV/EV approach?

$$IUF = \frac{V}{\Pi_B} \ln \left(\frac{V}{\Pi_A} \right) + \frac{V}{\Pi_C} \ln \left(\frac{M}{P} \right)$$

Full $M = M + V +$ Value of other leisure time

Reducing V automatically increases the available amount of other leisure time – but revealed preference shows that utility cannot increase by the full extent required to compensate for the reduction in utility due to the loss in V

There will be an amount by which M would need to be increased to compensate, but it will be overestimated if the value of the freed up time is ignored

Correct welfare evaluation is our current – and remaining – task

THANK YOU