The potential for segmentation of the retail market for electricity in Ireland

Marie Hyland (ESRI and TCD)
Eimear Leahy
Richard S. J. Tol

21st March 2013

Motivation

- Many benefits of smart meters
  - Enable demand-side management
  - Help integrate micro-generation and micro-storage
  - Help integrate hybrid and electric vehicles
- They will also yield unprecedented amounts of information about consumer behaviour
- In other markets similar revolutions in data availability have led to market segmentation
  - Can be benign, e.g. targeted promotions
  - Can also result in exclusion, e.g. health insurance

Motivation

- Businesses want to identify and target their most profitable customers
- Particularly important in Irish electricity market where increased competition has led to switching
- By identifying gross margin across different groups of consumers, electricity companies can more efficiently target and retain their most profitable customers

Previous research

- Very limited
- Joskow & Tirole (2006) outline how competitive screening and adverse selection by electricity suppliers can arise
- Rothschild & Stiglitz (1976) discuss issues of adverse selection arising in the insurance market
- Our study is the first (to our knowledge) to determine which household characteristics are statistically significant in explaining profitability of an electricity customer

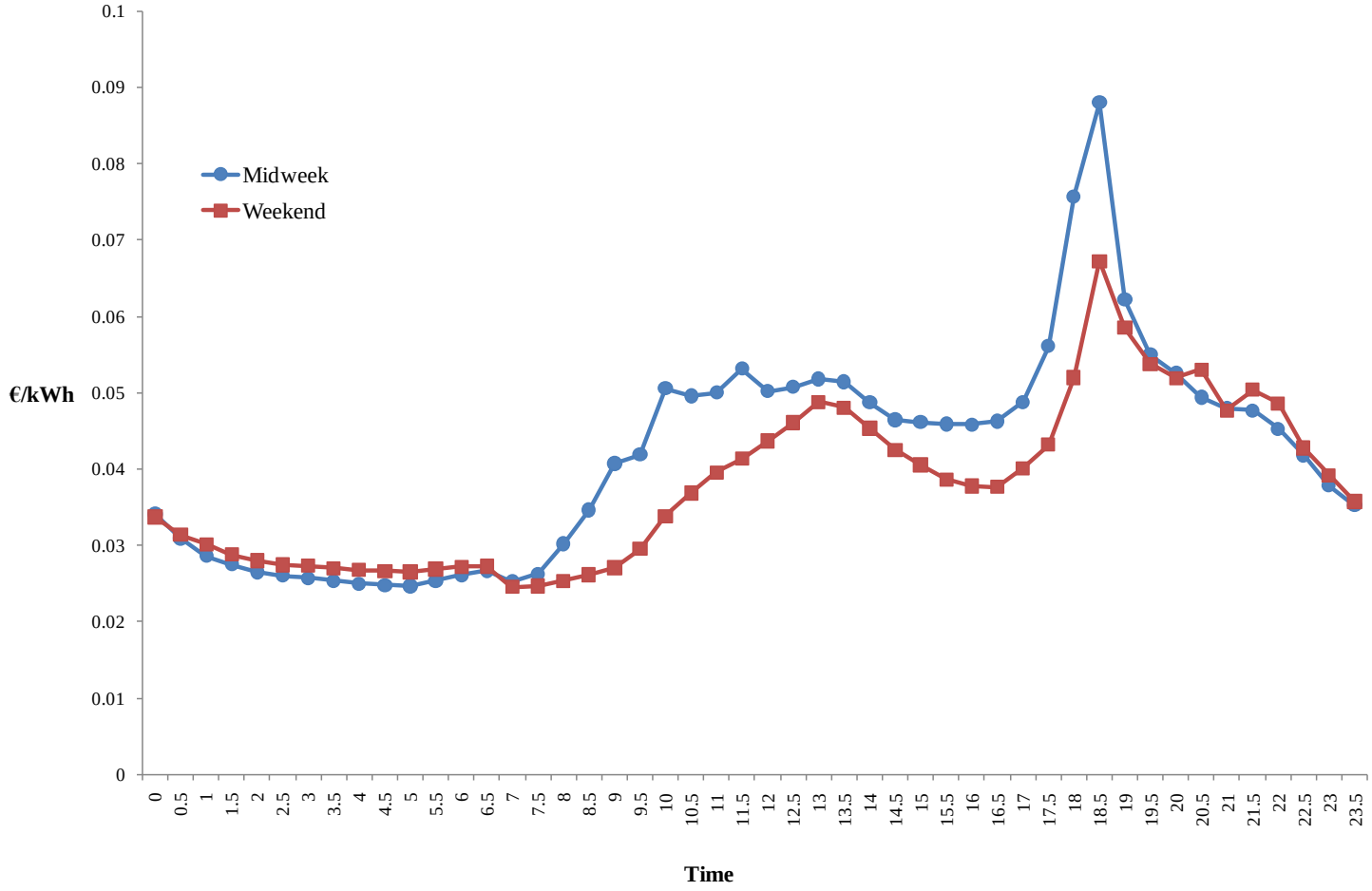
Smart metering - CBT

- In 2009-10, the Irish Commission for Energy Regulation co-ordinated an RCT in the Irish residential electricity market
- Smart meters introduced in approximately 5,000 households
- Participants divided into treatment and control groups; treatment groups exposed to a variety of tariffs and stimuli (DiCosmo et al., 2012)
- Control (pre-trial) period: July – December 2009

Data

- Use electricity demand data for 4,232 households for every half hour 14th Jul to 31st December 2009
- Retail price of electricity: ESB, Customer Supply
  - 14.6c/KWh May-Sep 2009
  - 14.1c/kWh Oct-Dec 2009
- All-island market (SEM): mandatory pool
  - Wholesale price of electricity: SMP
  - Other costs: DUoS, TuoS, capacity payments, imperfection charges
  - loss adjustment factor

Data – average SMP by time of day



Data – household characteristics

Respondent characteristics	Household characteristics	
Age	Type of accommodation	# Electrical appliances
Employment status	# Bedrooms	Type of cooker
Gender	# Household members	Year accom. built
Social class	# Household members at home during the day	Household income (1,946 responses)
Education level of CES		Energy saving features: •Attic insulation •External wall insulation •Lagging jacket •Concern for environment

Methodology (1)

- Gross margin from supplying customer *i,* in a particular day is calculated as:

$$G_i = \sum_{h=1}^{48} (P - LAF_h * (W_h + DUoS + TUoS_h + CapCharge_h + ImperCharge)) * D_{i,h}$$

- DUoS: 2.998c/kWh up to end Sept 2009 and 3.621c/kWh after
- TUoS
  - Network capacity charge: €4.3337/MWh (day only)
  - Network transfer charge: €1.9959/MWh
  - System services charge: €2.3301/MWh
  - Demand side management charge: €0.2061/MWh

Methodology (2)

- Transmission and distribution loss adjustment factor (LAF)
  - 1.12 at peak times
  - 1.11 during day hours
  - 1.09 during night hours
- Find the total gross margin earned for each of these 4,232 customers in the second half of 2009
- Compare margin across household characteristics
- Run an OLS regression to see which characteristics are statistically significant in explaining margin

$$y_i = x_i\beta + \varepsilon_i$$

Descriptives - Total Gross Margin (1)

(Min and max per category)	Mean (€)	Std. Dev (€)	Min (€)	Max (€)	Gross Margin/ Demand (€/kWh)	#
Age of respondent						
Aged 46-55	70	34	4	344	0.0302	1031
Aged over 65	54	30	-1	306	0.0297	953
Household income						
< €15,000	48	28	6	184	0.0304	185
> €75,000	74	34	6	224	0.0300	372
Employment Status						
Self-employed with employees	84	47	13	344	0.0304	232
Retired	54	28	2	306	0.0298	1285
Education level of CES						
Primary education	53	31	6	306	0.0298	475
Third level	67	34	3	344	0.0301	1580
Social Status						
AB: Managerial, admin., professional	72	38	7	344	0.0301	642
DE: Semi and unskilled manual	56	29	5	306	0.0298	1593

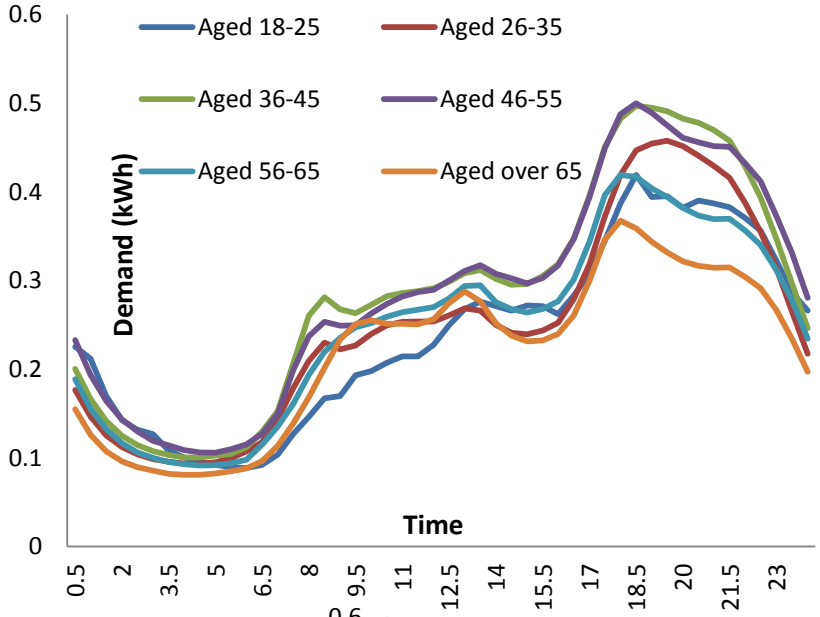
- The relationship between gross margin and age is inverse-U-shaped
- Gross margin highest for richest households
- Self-employed generate highest gross margin
- Education positively correlated with margin – more educated own more appliances. Could also be age-related
- Social status closely linked with income

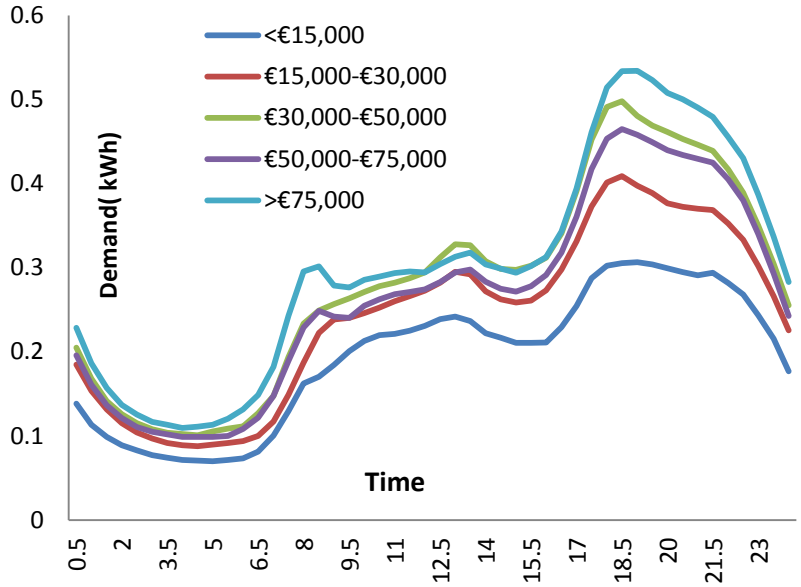
Descriptives - Total Gross Margin (2)

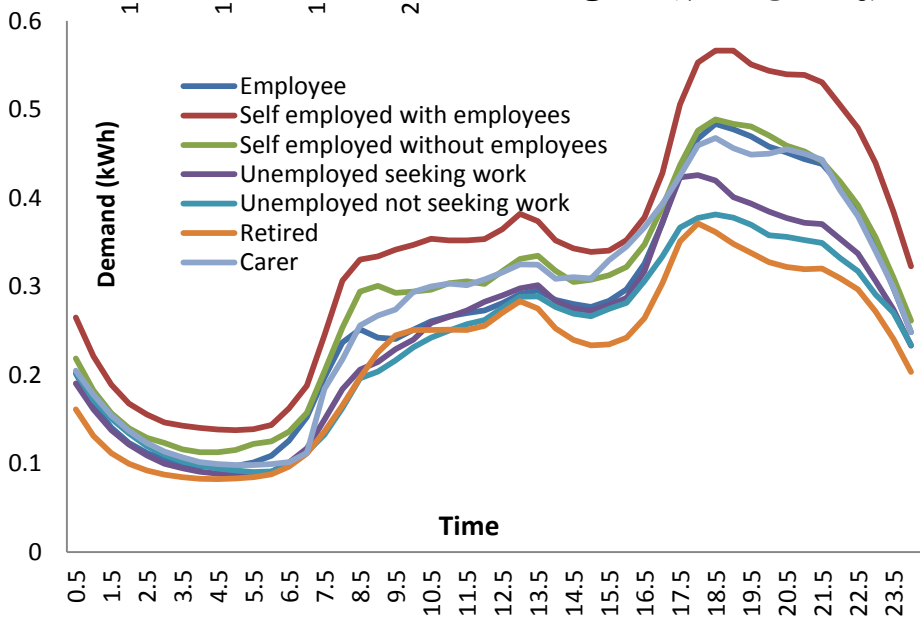
	Mean (€)	Std. Dev (€)	Min (€)	Max (€)	Gross Margin/ Demand (€/kWh)	#
Gender of respondent						
Male	64	33	2	306	0.0300	2127
Female	61	31	-1	344	0.0297	2105
Household Size						
1 person household	53	29	14	181	0.0306	51
10 person household	129	.	129	129	0.0294	1
Accommodation Type						
Apartment	34	18	5	95	0.0306	72
Detached	72	36	4	344	0.0299	1121
Tenure						
Renting Privately	49	28	9	129	0.0310	71
Mortgage holder	68	34	3	344	0.0296	1706
Number of bedrooms						
1 bedroom	41	44	8	294	0.0316	46
At least 5 bedrooms	87	40	8	344	0.0301	465

- Varies slightly by gender
- Margin increases with the number of people living in the household (note: only one 10 person HH in sample)
- Apartment dwellers demand less electricity
- Mortgage holders generate higher margin
- Larger houses positively associated with gross margin

Electricity demand profile







Pattern of demand is very similar => Almost all variation in gross margin is explained by changes in the *level* of demand

Regression results (1)

Variable	Coefficient	Standard Error
Age of respondent		
Aged 18-25	3.972	10.043
Aged 26-35	**-3.890**	**2.156***
Aged 36-45	-2.179	1.712
Aged 46-55 (ref)		
Aged 56-65	2.058	2.067
Aged over 65	**7.279**	**3.035****
Household income		
< €15,000	3.244	2.678
€15,000 - €30,000	2.517	2.021
€30,000 - €50,000	2.046	1.603
€50,000 - €75,000 (ref)		
> €75,000	1.750	1.785
Employment Status		
Employee (ref)		
Self-employed with employees	**10.224**	**2.588*****
Self-employed without employees	**6.570**	**2.407*****
Unemployed seeking work	0.117	3.952
Unemployed not seeking work	1.959	4.726
Retired	-0.451	2.807
Carer	7.490	8.156
Education level of CES		
No formal education	-1.398	6.025
Primary education	-2.135	2.696
Junior Certificate	-3.013	1.974
Leaving Certificate	-0.588	1.492
Third level (ref)		

- _n = 1,942

- Age 65+ has positive effect on margin

- Being self-employed increases gross margin

Regression results (2)

Variable	Coefficient	Standard Error
Social Status		
AB: Managerial, admin., professional	**4.677**	**2.376****
C1: Supervisory/clerical, junior managerial, administrative or professional	2.111	2.108
C2: Skilled manual workers	2.112	2.266
DE: Semi&unskilled manual workers, those in receipt of state benefits (ref)		
F: Farmers	**-8.548**	**4.281****
Accommodation Type		
Apartment	**-10.990**	**5.075****
Semi-detached (ref)		
Detached	**4.037**	**1.670****
Terraced	-2.353	2.047
Not specified	**3.504**	**1.701****
Tenure		
Renting Privately	-4.660	5.128
Renting from local authority	3.877	3.931
Owned outright (ref)		
Mortgage holder	2.204	1.494
Other tenure	22.991	26.206
Number of bedrooms		
1 bedroom	**18.483**	**6.895*****
2 bedrooms	-0.227	2.589
3 bedrooms (ref)		
4 bedrooms	**3.698**	**1.495****
At least 5 bedrooms	**13.720**	**2.246*****

- "Farmer" negatively associated with gross margin
- Accommodation type has an effect on gross margin
- Larger properties increase gross margin, but surprisingly so too do 1 bed properties

Regression results (3)

Variable	Coefficient	Standard Error
Type of Coker		
Electric Cooker (ref)		
Gas cooker	0.437	1.434
Oil fired cooker	3.062	3.933
Solid fuel cooker	0.685	4.737
Continuous Variables		
Number of electrical appliances	**2.747**	**0.231*****
Year accommodation was built	0.000	0.000
Number of household members	**6.466**	**0.491*****
Number of household members at home during the day	-0.252	0.162
Energy Conservation dummy variables		
External wall insulation	**-3.400**	**1.339****
Attic insulation	**-3.035**	**1.273****
Lagging jacket	**-3.717**	**1.663****
Concerned about the environment	-0.948	2.372
Constant	**-25.595**	**6.942*****

- Number of electric appliances and number of household members significantly increase gross margin
- Household members at home during the day is insignificant
- Energy conservation measures significantly reduce gross margin, but concern for the environment does not

Discussion

- Almost all variation in margin in explained by *level* of demand (as opposed to time used)
  - Smart meters do not give extra info on profitability
- Gross margin partly explained by
  - Number of household members
  - Number of bedrooms & accommodation type
  - Age and occupation of household members
- Energy conservation measures have a negative effect on gross margin
  - Indicates they are clearly not in supply companies interests (confirms results of Vine et al, 2003)

Conclusion

- Important that electricity provides identify the customers that generate the highest gross margin
  - Can more efficiently target & satisfy customers
- Competition is far from perfect: older & les educated (and less profitable) customers likely to stay with the incumbent
- Utilities cannot charge higher prices or refuse to connect rural customers. In the future, the Regulator may need to take action to protect other less profitable consumers
- With new technologies, and changing load patterns, half-hourly electricity-use data may become more important (to supply companies)