UNIVERSITÀ DEGLI STUDI FIRENZE

Aging and transport-related energy use: do generations matter?

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Outline

- Energy demand, aging population and energy culture
- Preference for car in Italy
- Empirical analysis: a double hurdle model with a decomposition of age and cohort effects
- Concluding remarks

Research questions

Do age and generations matter in transport mode choices ?

Are there cultural factors interplaying with aging in shaping a transport culture transition?

Is population structure harming energy and climate related policies?

Population aging is a long-term trend which began several decades ago in Europe. In Italy, the proportion of population aged 65 and over (22.1% in 2016) is the highest among European countries.

Economic literature almost universally predicts that aging population leads to an aggregate increase in residential energy consumption and to a decrease in transport demand.

However, we also observe a rise of life expectancy in «good health». The share of people aged 75 and over still driving a car is sharply increasing (Coughlin, 2009)

Is population structure harming energy and climate related policies?

Okada (2012) estimates the effect of aging population on CO2 travel emissions. The author finds a sort of Kuznetz curve between per capita CO2 emissions from road transportation and the share of elderly.

However, aging population also means a growing number of "new" elderly people with a more active lifestyle and smaller household size. This population has additional mobility demand.

On the other side, generational culture can interplay with aging. **Fuel Institute (2014)** finds evidence that US elderly people are driving more than in the past and Millennials are driving less, with lower driver-licensing rates.

Chancel (2014) finds a clear cohort effect for residential and transport energy use in France, with the 1930-1955 cohort consuming more than other cohorts.

Generations and *energy culture*

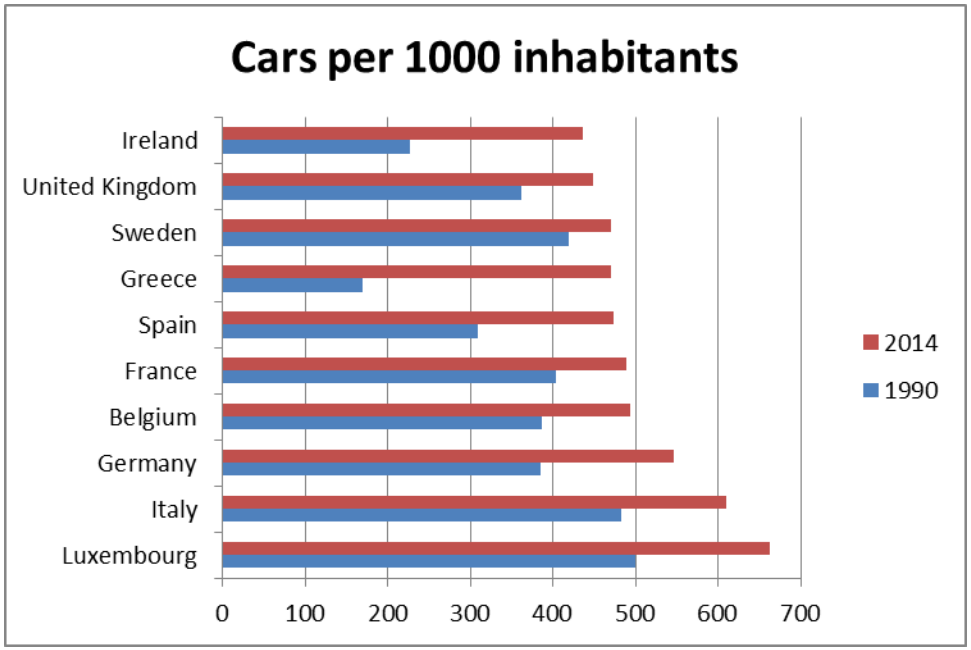
Different **social norms**, including individual **expectations** and **aspirations**, interplay with **material culture** and **energy practices** in shaping individual behaviour, subject to the external influences that form the context where transport cultures develop. (Sarrica et al., 2016, Stephenson et al. 2014)

A transport culture transition?

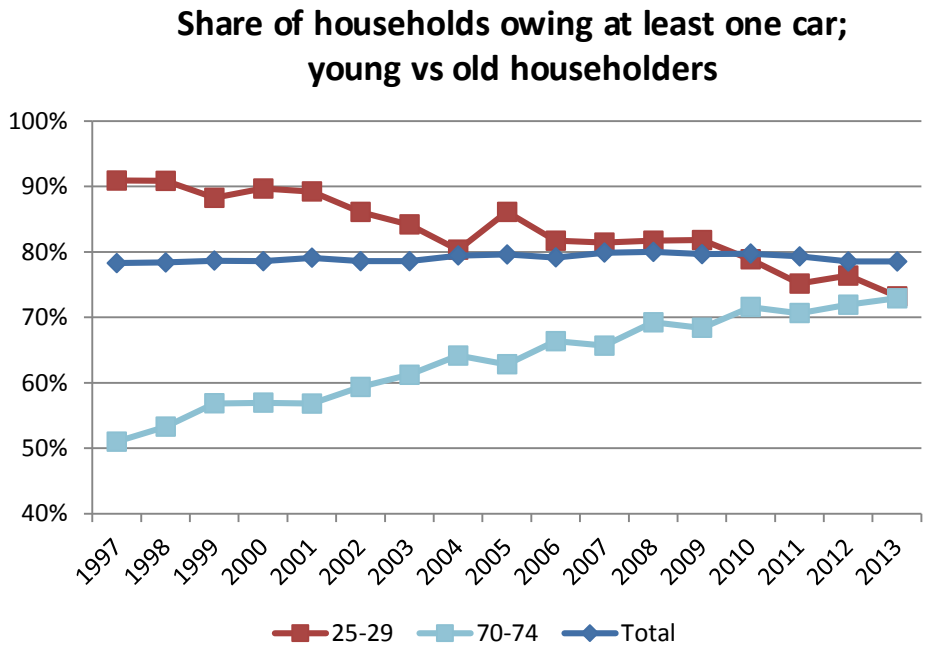
Baby boom generation	
Material culture/ Public Policies	Automobile-dominated infrastructure
Norms	Car as a status symbol
Practices	Big cars, Home purchasing choices and commuting practices
Millennials	
Material culture/Public Policies	Public transport infrastructure; Limited Traffic Zones; Emission/Consumption limits
Norms	New source of prestige; Environmental concern
Practices	IT innovation widely used to improve transport efficiency and share transport costs; IT technology limits learning/work commuting

Italians love cars!!

The link among aging population, generational cultures and transport choice is particularly important in Italy, where cars are still very important to build a status.
Indeed Italy has one of the highest ratio of vehicles over population.



Hints of different behaviour of generations can be found by looking at the share of young and old householders owing at least one car.



However, this graph cannot distinguish between an age and a generation effect. We need specific techniques.

Age effects and cohort effects in Italy

To identify whether “transport culture” changes over time we need to distinguish between **age** (life-cycle) and **cohort** (generational) effects in fuel consumption profiles. Two research strategies can be employed

1) Building a pseudo-panel, as in Bardazzi and Pazienza (En.Eco., 2017) for residential energy use analysis;

2) Cragg’s Double Hurdle model, including age and cohort effects.

We employ both methodologies and we found very similar results. Here only a Double Hurdle model is presented.

Cragg's Double Hurdle (Cragg 1971)

This model, also used by **Aristei et al (2008)** for alcohol and **Eakins (2016)** for fuels, considers two different steps:

A **participation** decision: i.e. the decision for private mobility

An **expenditure decision**: travel intensity, that is relevant only for those with a positive participation decision.

$y_{i1}^* = w_i\alpha + u_i$ Participation

$y_{i2}^* = x_i\beta + v_i$ Expenditure

$y_i = x_i\beta + v_i \quad if \quad y_{i1}^* > 0 \; and \; y_{i2}^* > 0$

$y_i = 0 \quad otherwise$

As the focus of our analysis is cohort and age effects, we identify householder age and date of birth in each wave of the survey. **Cohorts** are built by date of birth of the household head, considering a five years span.

Following **Aristei et al (2008),** we consider the age and cohort effects within the Double Hurdle model, by adding age (D_a) cohort (D_c) and time (D_t) dummies. Therefore the estimated equation for household fuel consumption (per adult) is

$$\ln (hh\ fuel\ exp)_i = F(x_i, w_i) + \gamma D_a + \delta D_c + \theta D_t + \epsilon_i$$

We must drop one column from each of the three matrices of dummies, to avoid singularity and add an additional constraint.

Evidence for Italian households (1)

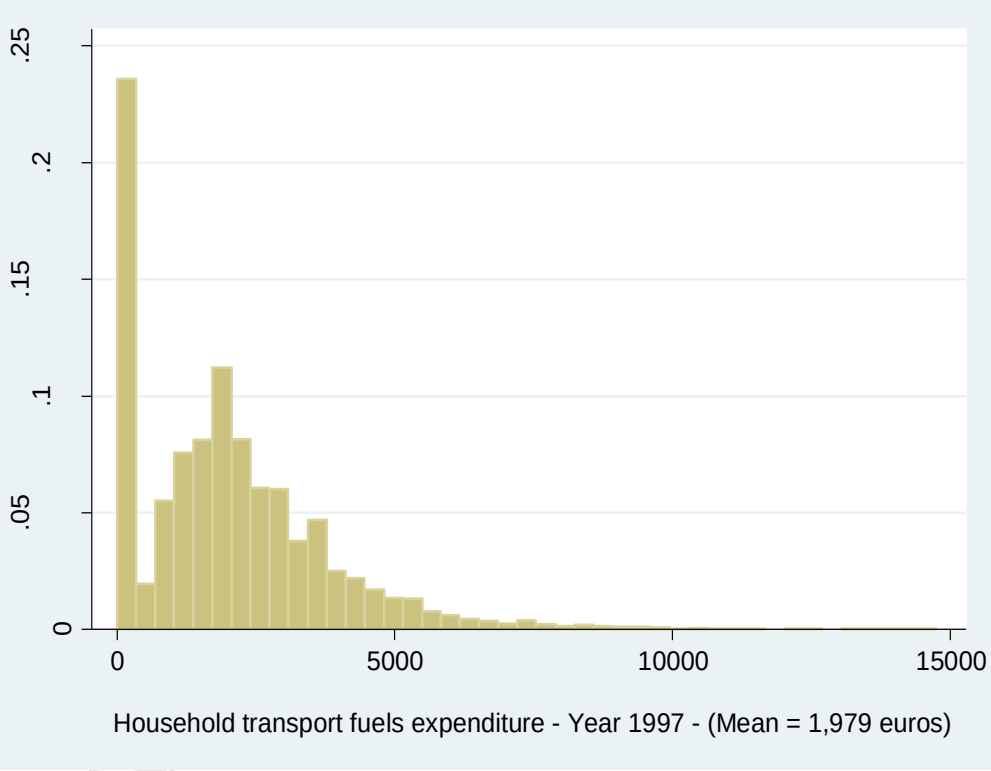
Data: Italian Household Expenditure Survey (1997-2013, ISTAT) about household energy and fuel consumption and socio-demographic characteristics (sex, age, education, family size, number of vehicles…).
Sample size: more than 20.000 households every year

	1997			2013		
Age classes	Weighted Freq.	Weighted Freq.	Househ. Size (mean)	Weighted Freq.	Weighted Freq.	Househ. Size (mean)
18-24	143,888	0.7%	2.0	78,734	0.3%	1.7
25-29	849,854	4.0%	2.2	506,697	2.0%	1.9
30-34	1,610,475	7.5%	2.7	1,166,908	4.6%	2.3
35-39	2,040,572	9.5%	3.2	2,040,740	8.0%	2.6
40-44	2,050,547	9.6%	3.3	2,459,280	9.6%	2.9
45-49	2,166,883	10.1%	3.4	2,835,754	11.1%	2.9
50-54	1,972,227	9.2%	3.3	2,743,916	10.8%	2.9
55-59	2,069,242	9.6%	2.9	2,468,415	9.7%	2.7
60-64	1,958,594	9.1%	2.5	2,153,662	8.4%	2.3
65-69	1,959,762	9.1%	2.1	2,169,403	8.5%	2.1
70-74	1,923,905	9.0%	1.8	2,084,170	8.2%	1.8
>75	2,712,880	12.6%	1.7	4,788,616	18.8%	1.6
Total	21,458,829	100.0%	2.7	25,496,295	100.0%	2.3

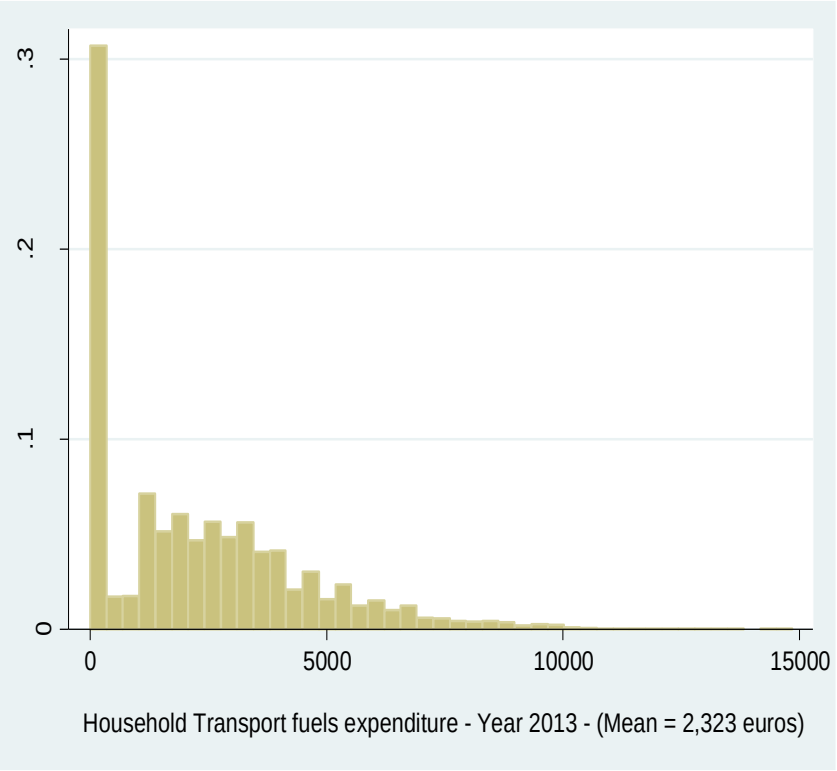
- ✓ Increased share of older hh
- ✓ increased household numbers
- ✓ decrease in average family size

Evidence for Italian households (2)
Incidence of zeros

Year 1997 – 23 per cent



Year 2013 - 31 per cent



Estimation results (Not all coefficients shown)

	Selection step		Expenditure step		Marginal Effects	
	Coef.	P>z	Coef.	P>z	dy/dx	P>z
Gender	0.467	0.00	0.084	0.00	1.011	0.00
Marital status	0.373	0.00	-0.353	0.00	0.493	0.00
Children	0.028	0.01	0.086	0.00	0.113	0.00
Education	0.073	0.00	-0.001	0.78	0.133	0.00
Employee/Pensioner	0.284	0.00	0.072	0.00	0.655	0.00
Self employment	0.006	0.54	0.015	0.00	0.022	0.26
Area						
Italy- Centre	0.175	0.00	-0.034	0.00	0.295	0.00
Italy- South	0.062	0.00	-0.055	0.00	0.078	0.00
Urban sprawl	0.163	0.00	0.065	0.00	0.349	0.00
Total consumption	-	-	0.596	0.00	0.420	0.00
Motorbike	-	-	-0.136	0.00	-0.096	0.00
Bicycle	-	-	-0.028	0.00	-0.020	0.00
Public Transport Expenditure	-	-	-0.033	0.00	-0.023	0.00

Estimation results (socio-demographic variables)

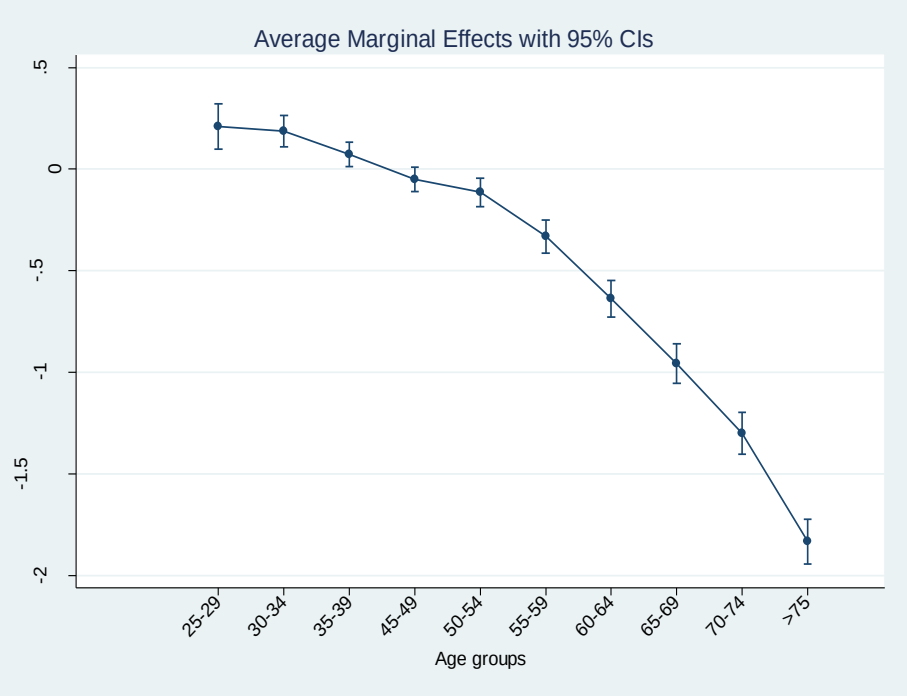
Per adult household fuel expenditure increases when:

- ✓ household head is male
- ✓ the family has children
- ✓ household head has high education level and an occupation linked to a monthly check
- ✓ the total household consumption is higher (proxy for disposable income)
- ✓ household leaves in central-south Italy, far from urban areas

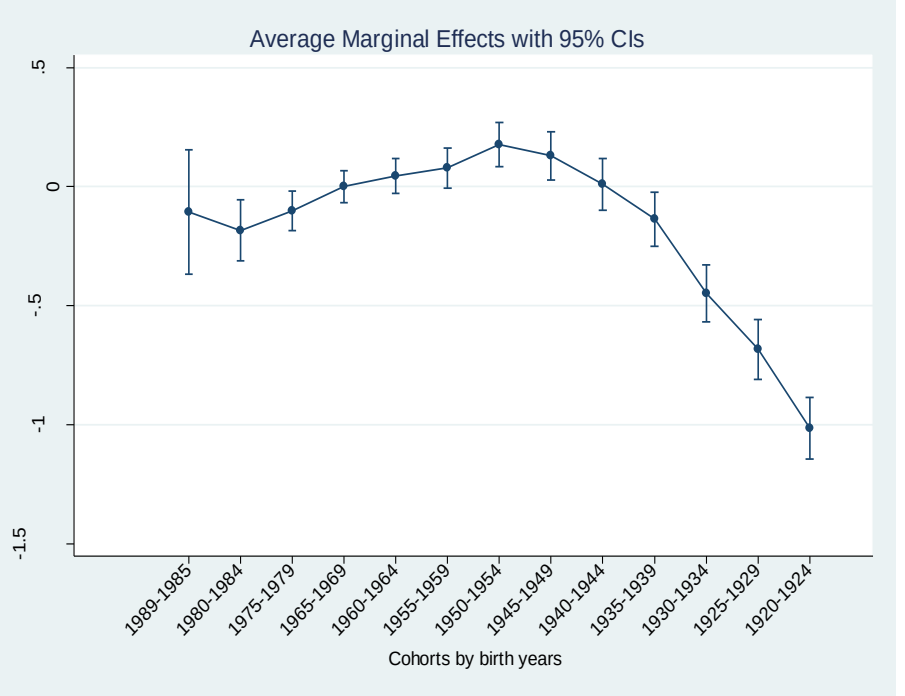
Alternative transport modes (bike, motorbike, public transport) have a negative impact.

Our main result: generations matter

Age effects



Cohort effects

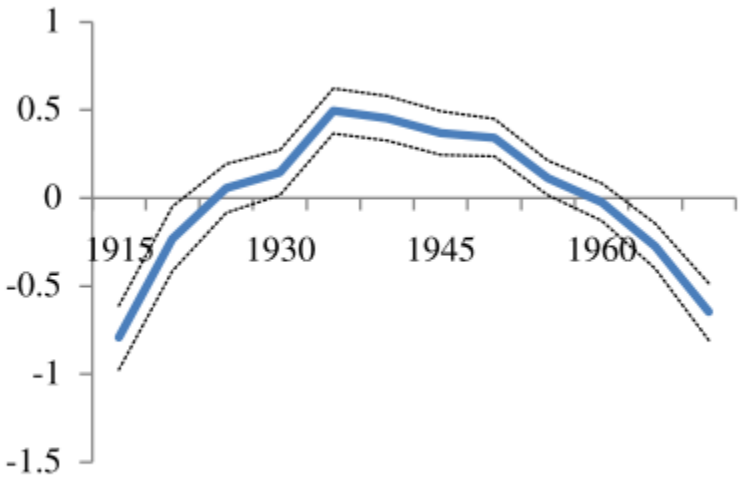


Age and cohort effects

- Getting older means a lower per adult fuel expenditure

- Cohort effects are non-linear: generations born after WWII (between 1949 and 1959) exhibit the highest transport fuel expenditure while younger generations show lower marginal effects

Cohort effect for private transport in France (Chancel 2014)



Private transport

With a different model and estimation technique, Chancel finds similar results on private transport-related CO2 emissions for France

Conclusions

Travel modal choices influence energy demand and CO2 emissions. From aging population literature expects lower (private) travel demand; however, "longer" private mobility related consumption, with many people still driving above 80 years old, is observed.

The changing age structure of population is interplaying with different transport cultures:

- for baby boom generations cars still give status and bb hh drive more and more;
- Millennials show a higher environmental attitude and use new technology to share and mix transport means.

This means that, beyond population aging, new generations may contribute to reduction of fuel use and emissions.

Thank you for your attention

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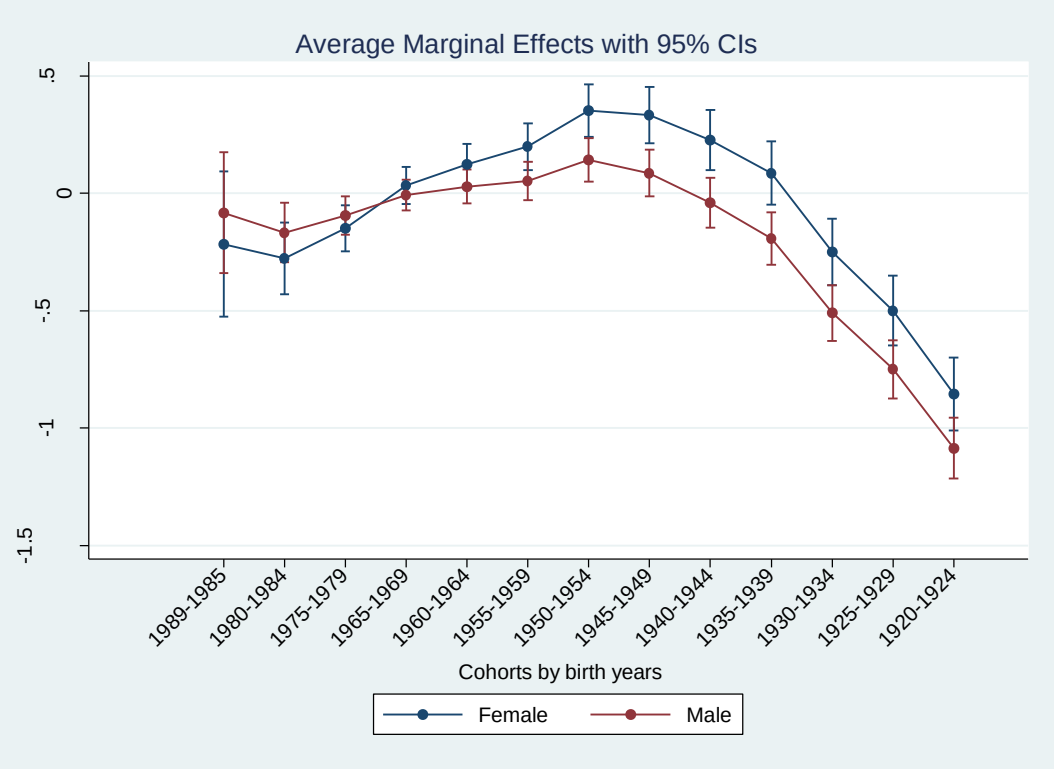
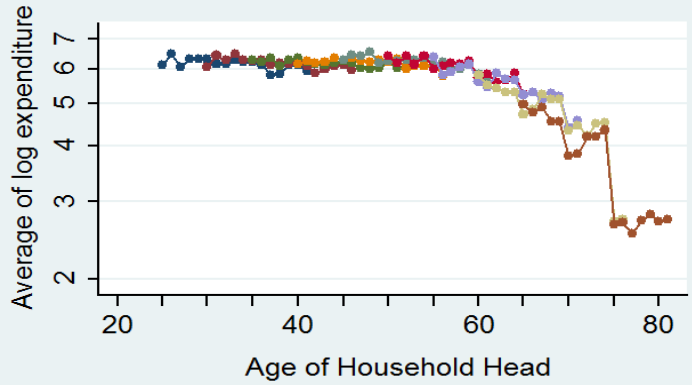
Cohort effects by gender

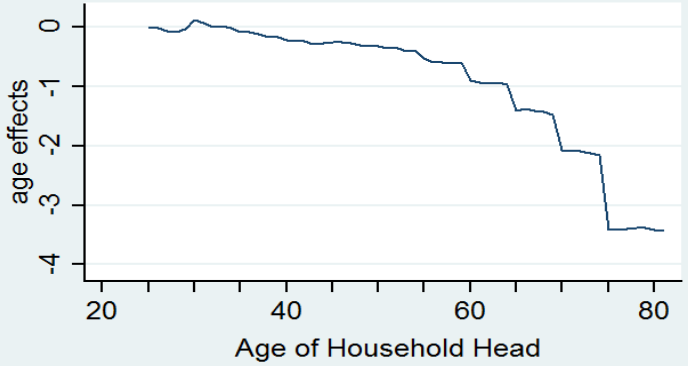


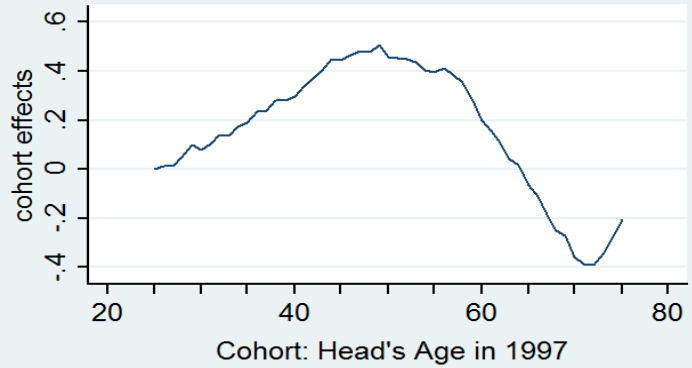
Cohort effect is more marked in case of female hh: female labour force participation emerged in the Sixties

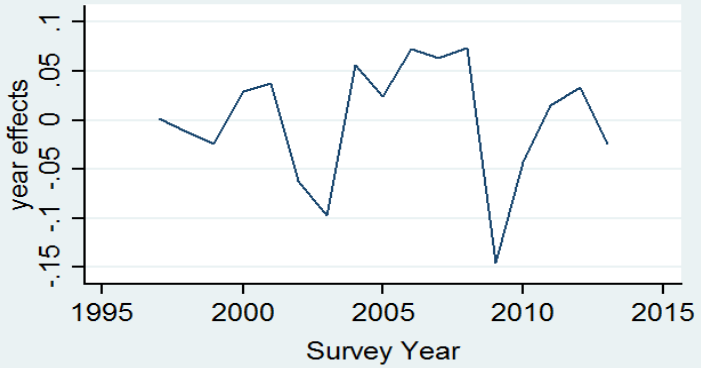
Fuels

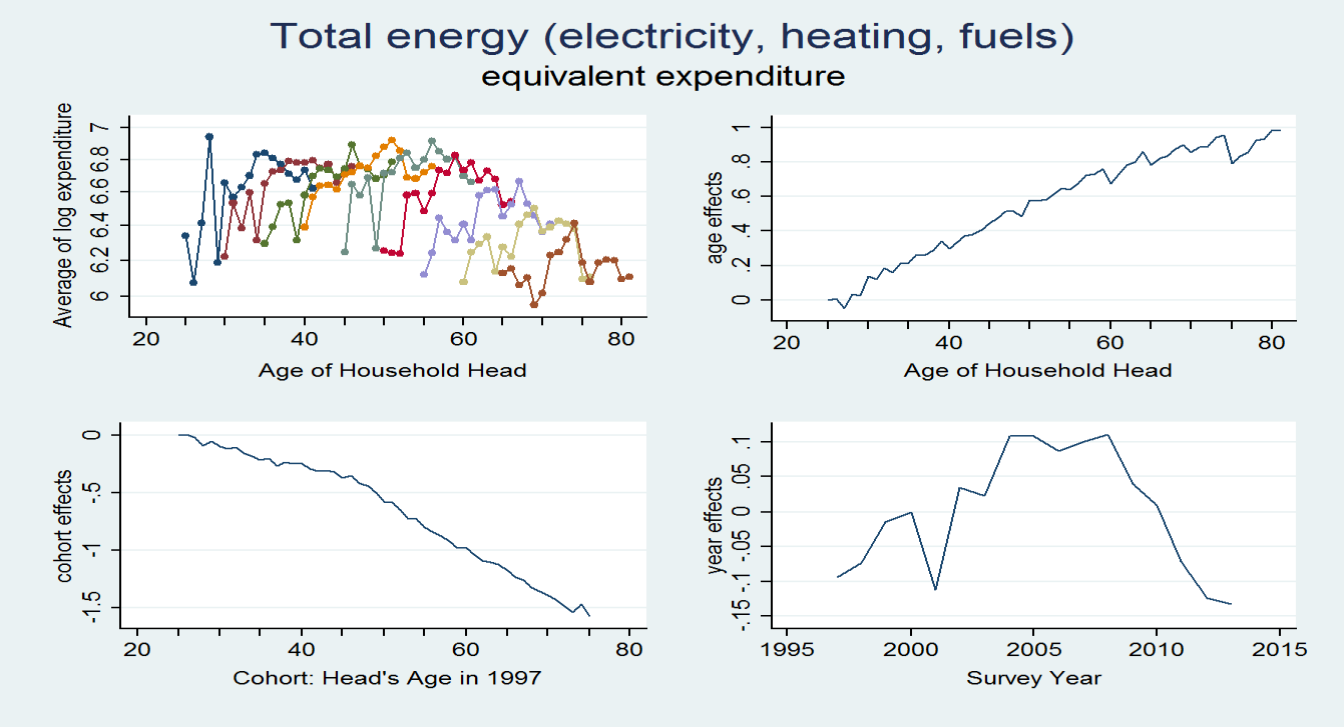
equivalent expenditure





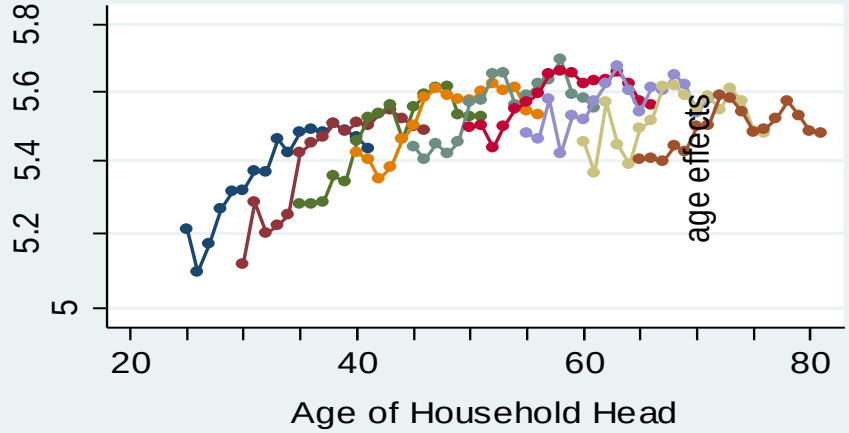


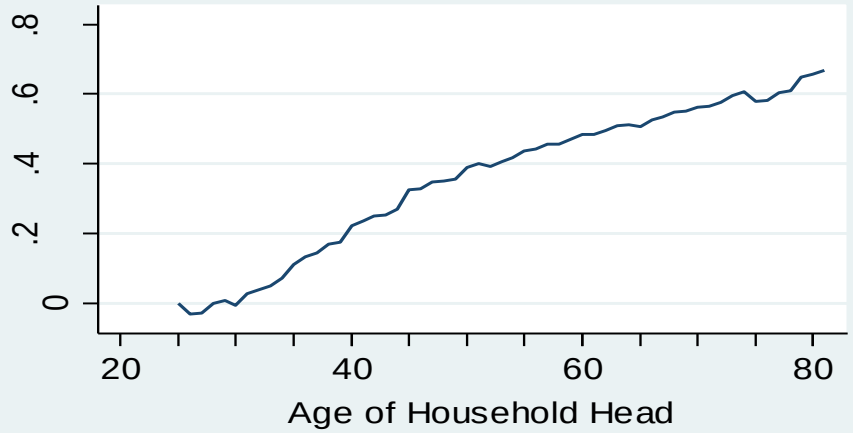


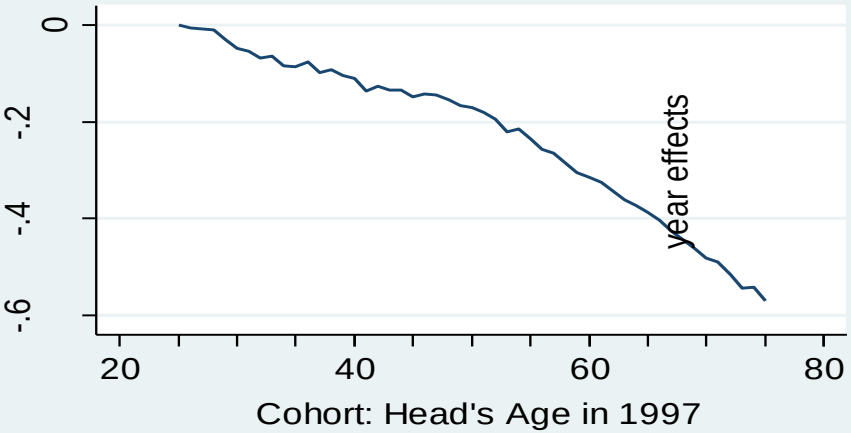

Total energy (electricity, heating, fuels)
equivalent expenditure
Average of log expenditure
6 6.2 6.4 6.6 6.8 7
20 40 60 80
Age of Household Head
age effects
0 .2 .4 .6 .8 1
20 40 60 80
Age of Household Head
cohort effects
-1.5 -1 -.5 0
20 40 60 80
Cohort: Head's Age in 1997
year effects
-.15 -.1 -.05 0 .05 .1
1995 2000 2005 2010 2015
Survey Year

Electricity

equivalent expenditure







Age, cohort and time shock effects

We decompose the three sets of effects according to this model (Deaton and Paxson, 1994):

$$y = \beta + A\alpha + C\gamma + T\psi + u$$

where y is the energy consumption, A is a matrix of age dummies, C a matrix of cohort dummies, and T a matrix of year dummies.

We must drop one column from each of the three matrices of dummies, to avoid singularity.

Moreover, it is still impossible to estimate this regression because of an additional linear relationship across age, cohort and year (age is the sum of cohort and time).
One of the most common solution is to impose the constraint that year dummies coefficients are orthogonal to a time-trend and sum to zero (Deaton and Paxson, 1994.) This means that time in itself does not have a persistent effect but it gives exogenous shocks which sum to zero in the long run.