The socioeconomic gradient in diet

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Motivation

- There is a well established relationship between health outcomes and socioeconomic status
  - Those from lower socioeconomic groups tend to have poorer health outcomes
  - Many of these health outcomes are related to diet

▸ SE diet gradient

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  - Those from lower socioeconomic groups tend to have poorer health outcomes
  - Many of these health outcomes are related to diet

▸ SE diet gradient

- SE group/diet correlation could be driven by
  - Income differences, if "healthy" foods are luxuries
  - Preference heterogeneity
  - Or differences in prices faced by households from different SE groups
- Establishing the causal mechanism driving this relationship is crucial for policy

Contribution

- Paper estimates the impact of a measure of household income on diet quality
  - Using a demand system defined over food groups
  - Exploiting detailed panel data that allows us to capture household specific preferences and differences in prices faced by different households
- Provides evidence of the importance of a household specific component to preferences on shape of food Engel curves

Separable food demand

- Assume preferences are defined over foods - diet quality is consequence of food consumption
- Assume demand for food is weakly separable from non-food (but not from leisure)
- And food demand is weakly intertemporally separable across months
- Model decision of household h in period t over how to allocate total monthly food expenditure, x_{ht}, over food groups indexed $j \in \{1, ..., J\}$

Form of preferences

- Assume preferences take form leading to Quadratic Almost Ideal Demand System (QUAIDS)
- Leads to budget share demands linear in log prices, log expenditure and the square of log expenditure
- Allows Engel curves to take relatively flexible form in context of a parametric and integrable demand system
  - Important for conducting counterfactual and welfare analysis
- We augment standard framework with household specific preferences

Demand equations

- w_{hjt} denotes the share of its period t food expenditure, x_{ht}, household h devotes to food type j when faced with prices $p_{ht} = (p_{h1t}, \ldots, p_{hJt})$

$$w_{hjt} = \alpha_{hjt} + \sum_k \gamma_{jk} \ln p_{hkt} + \beta_j \ln \left(\frac{x_{ht}}{\Gamma(p_{ht})} \right) + \frac{\lambda_j}{\Pi(p_{ht})} \left[\ln \left(\frac{x_{ht}}{\Gamma(p_{ht})} \right) \right]^2 + \epsilon_{hjt}$$

where

$$\ln \Gamma(p_{ht}) = \alpha_0 + \sum_j \alpha_{hjt} \ln p_{hjt} + \frac{1}{2} \sum_j \sum_k \gamma_{jk} \ln p_{hjt} \ln p_{hkt}$$

$$\ln \Pi(p_{ht}) = \sum_j \beta_j \ln p_{hjt}$$

Consumer theory restrictions

- Adding up and homogeneity imply

$$\sum_j \alpha_{hjt} = 1 \qquad \sum_j \gamma_{jk} = 0 \qquad \sum_k \gamma_{jk} = 0 \qquad \sum_j \beta_j = 0 \qquad \sum_j \lambda_j = 0.$$

- Slutsky symmetry implies

$$\gamma_{jk} = \gamma_{kj} \ \forall \ (j,k).$$

Non separabilities and preference heterogeneity

- The intercept of the share demand equation is given by:

$$\alpha_{hjt} = \alpha_{1j} + \alpha_{2j}\tau_t + \alpha_{3j}r_{ht} + \mu_{hj}$$

where

- τ_t are time and seasonal dummies
- r_{ht} measures labour supply of main shopper and household head
  - Capturing non-separability between household supply and food demand
- μ_{hj} are household fixed effects capturing household specific factors which impact on food demand
  - Capturing all household specific factors influencing level of (budget share) demand

Prices

- Measure period t price for household h of food type j as weighted average of disaggregate prices of products $i_j \in \{1, ..., I\}$ that comprise j:

$$p_{hjt} = \sum_{i_j} \omega_{hi_jt} p_{hi_jt}$$

- Household variation in:
  - p_{hi_jt} reflects differences in prices faced by different households
  - ω_{hi_jt} reflects differences in choices made among disaggregate products within a food type
- We assume preferences over products within food groups are weakly homothetically separable

Identification I

- Use within household time series variation in x_{ht} to pin down impact of total food expenditure on food demands
- Shock to demand for good j could induce correlation between ϵ_{hjt} and x_{ht}
- We instrument for x_{ht} with total non-food fast moving consumer good expenditure

Identification II

- Household specific price p_{hjt} partly reflects choice
- A shock to demand for a disaggregate product (e.g. strawberries) could induce correlation between food type's (e.g. fruit) price and ϵ_{hjt}
- Instrument for a household's monthly weighted mean transaction price using price computed using household's long run average purchase weights

Identification III

- We allow for changes in labour supply to directly affect demand for different foods
- In principle monthly shocks to food demand could also cause changes in labour supply
- We assume that this does not happen

Data

- Data include all purchases of fast-moving consumer goods that are brought into the home by a representative sample of UK households
  - Household records all purchases using handheld scanner
  - Including expenditure and transaction level prices on disaggregate products (at barcode level)
- Information on 10,841 households over the period 2006-2009
- Data are longitudinal
  - Average length of time in the panel is 41 (of 48) months
- Data include details of nutritional content of each individual food product

Food types

Table: *Mean expenditure and calorie shares, by food type*

Food type and main items	Calories per 100g	Share of total expenditure	Share of total calories
Fruit: fruit, including fruit juices	56.3	8.8%	5.1%
Vegetables: fresh, canned or frozen vegetables	53.7	11.0%	6.7%
Grains: flour, cerals, pasta, rice, breads	260.5	8.7%	19.8%
Dairy: milk, cream, yogurt	64.7	8.8%	8.9%
Cheese: cheese, oils, butter, margarine	478.9	5.8%	10.1%
Red meat: beef, lamb, pork, nuts, eggs	238.4	11.2%	8.8%
Poultry and fish: poultry, seafood	151.8	7.5%	3.6%
Drinks: fizzy drinks, tea, coffee, water	19.5	5.2%	1.9%
Prepared (sweet): ice cream, cakes, cookies etc.	297.0	11.1%	17.7%
Prepared (savoury): ready meals, soups, snacks	177.8	22.0%	17.5%

Healthy Eating Index (HEI)

- We translate predictions about food purchasing behaviour into implied diet quality
- Diet has many components, we use an index measure developed by the USDA
- Based on Dietary Guidelines for Americans (DGA); many of the USDA's food-assistance programs must be in compliance with the DGA.
- Medical literature suggest HEI is a significant predictor of medical outcomes

Healthy Eating Index (HEI): construction

Table: *Components of the HEI*

		Value range	
Component	Max score.	Low value	High value
Total fruit	5	0	120g per 1000 kcals
Whole fruit	5	0	60g per 1000 kcals
Total vegetable	5	0	165g per 1000 kcals
Dark green/orange veg	5	0	60g per 1000 kcals
Total grains	5	0	75g per 1000 kcals
Whole grains	5	0	32.5g per 1000 kcals
Total grains	5	0	75g per 1000 kcals
Milk	10	0	260g per 1000 kcals
Meat	10	0	70g per 1000 kcals
Oils	10	0	12g per 1000 kcals
Saturated fat	10	>15% of energy	<7% of energy
Sodium	10	>2g per 1000cals	<0.7g per 1000 kcals
Calories from SoFAS	20	>50% of energy	<20% of energy
Total	100		

Contrast with "standard" approach

- Existing literature:
  - Uses cross-sectional variation in expenditures to identify shape of Engel curves
  - Replaces household specific term in α_{hjt} with a vector of observable household characteristics
  - Typically has much less precise measures of prices

Expenditure coefficient estimates

Fruit, vegetables, grains, dairy, cheese

VARIABLES	(1) Fruit	(2) Vegetables	(3) Grains	(4) Dairy	(5) Cheese
$\ln(x_{ht}/\Gamma(p_{ht}))$	0.02212***	-0.00788***	-0.01615***	0.04436***	-0.01620***
	(0.00277)	(0.00163)	(0.00288)	(0.00461)	(0.00308)
$\frac{1}{\Pi(p_{ht})}\ln(x_{ht}/\Gamma(p_{ht}))^2$	-0.00321***	0.00018	0.00100***	-0.00607***	0.00141***
	(0.00032)	(0.00019)	(0.00033)	(0.00052)	(0.00035)
HH fixed effects	Yes	Yes	Yes	Yes	Yes
Time effects	Yes	Yes	Yes	Yes	Yes
Observations	430238	430238	430238	430238	430238
No of households	10841	10841	10841	10841	10841

Expenditure coefficient estimates

Meat, poultry, drinks, prepared sweet, prepared savoury

VARIABLES	(6) Meat	(7) Poultry	(8) Drinks	(9) PrepSweet	(10) PrepSav
$\ln(x_{ht}/\Gamma(p_{ht}))$	-0.04993***	0.00705***	0.06087***	-0.01505***	-0.02920***
	(0.00683)	(0.00183)	(0.00776)	(0.00264)	(0.00285)
$\frac{1}{\Pi(p_{ht})}\ln(x_{ht}/\Gamma(p_{ht}))^2$	0.00591***	-0.00053**	-0.00521***	0.00322***	0.00329***
	(0.00078)	(0.00021)	(0.00088)	(0.00030)	(0.00033)
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Price elasticities

Table: *Price elasticities*

	Fruit	Vegetables	Grains	Dairy	Cheese	Meat	Poultry	Drinks	Sweet	Savoury
Fruit	**-0.669**	-0.007	-0.039	-0.036	-0.053	-0.043	-0.043	-0.082	-0.021	-0.020
Vegetables	-0.009	**-0.867**	-0.022	-0.018	-0.049	-0.063	-0.026	-0.018	0.007	0.007
Grains	-0.040	-0.018	**-0.711**	-0.024	-0.065	-0.057	-0.029	0.005	-0.008	-0.022
Dairy	-0.041	-0.018	-0.027	**-0.833**	0.002	0.006	-0.022	-0.092	0.003	-0.008
Cheese	-0.031	-0.024	-0.039	0.008	**-0.618**	-0.057	-0.025	-0.015	-0.021	-0.014
Meat	-0.041	-0.055	-0.061	0.023	-0.096	**-0.746**	-0.029	0.047	-0.005	-0.042
Poultry	-0.024	-0.010	-0.014	-0.002	-0.023	-0.022	**-0.809**	-0.031	-0.007	-0.015
Drinks	-0.021	0.010	0.026	-0.019	0.015	0.026	-0.007	**-1.066**	-0.001	0.002
Sweet	0.000	0.025	0.013	0.034	-0.011	0.002	0.007	0.010	**-1.099**	0.015
Savoury	-0.041	0.019	-0.048	-0.008	-0.046	-0.085	-0.047	-0.014	0.020	**-0.907**

Notes: Numbers reported are expenditure weighted elasticities across all households. Element (i, j) gives the change in share of food type j with respect to the price of food type i.

Expenditure elasticities

Table: *Expenditure elasticities*

	Full model	Standard model
Fruit	0.92	0.87
Vegetables	0.94	1.10
Grains	0.92	0.66
Dairy	0.87	0.67
Cheese	0.94	0.96
Red meat	1.04	1.26
Poultry and fish	1.03	1.30
Drinks	1.25	1.36
Prepared (Sweet)	1.13	0.79
Prepared (Savoury)	1.00	1.05

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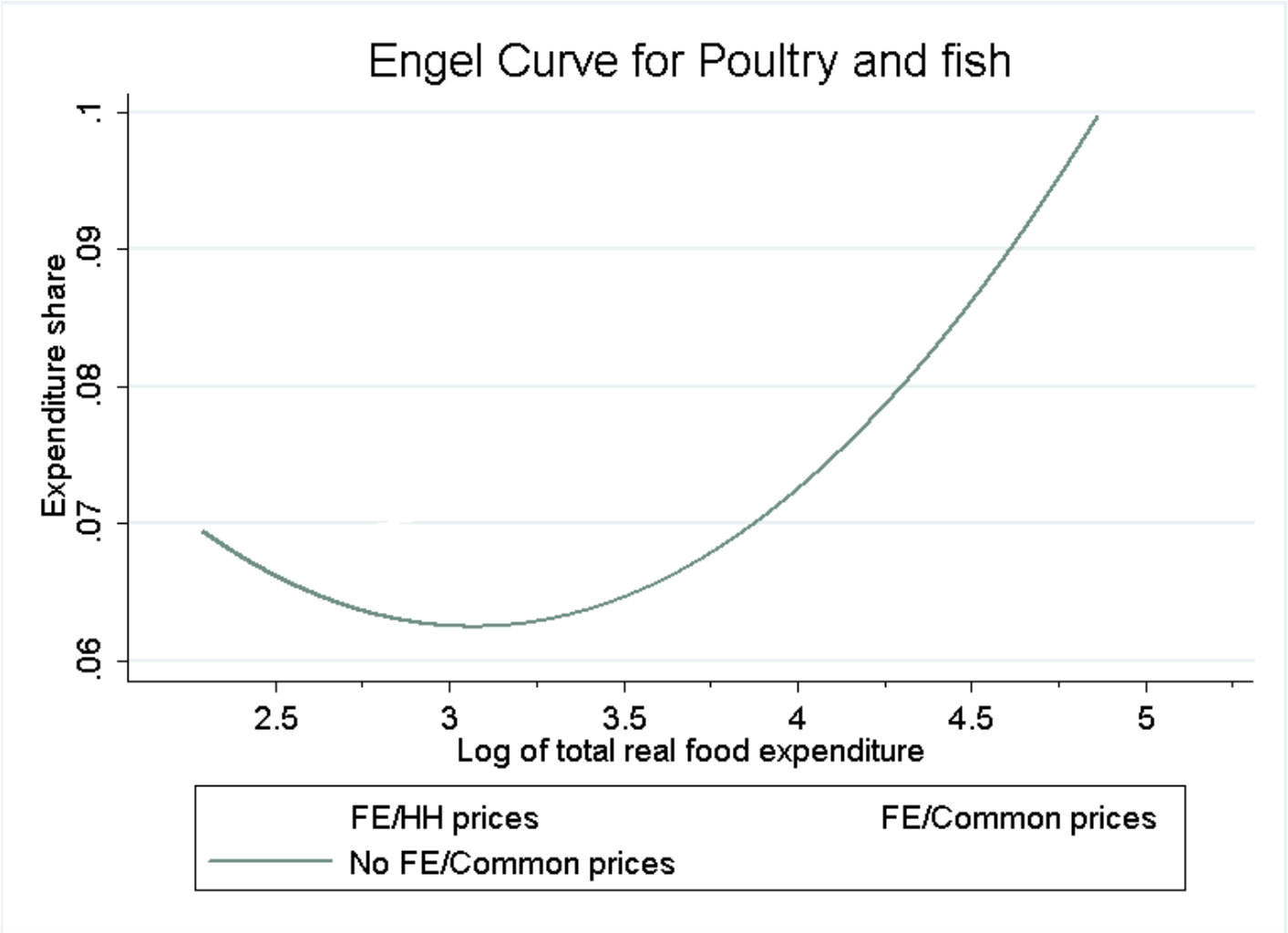
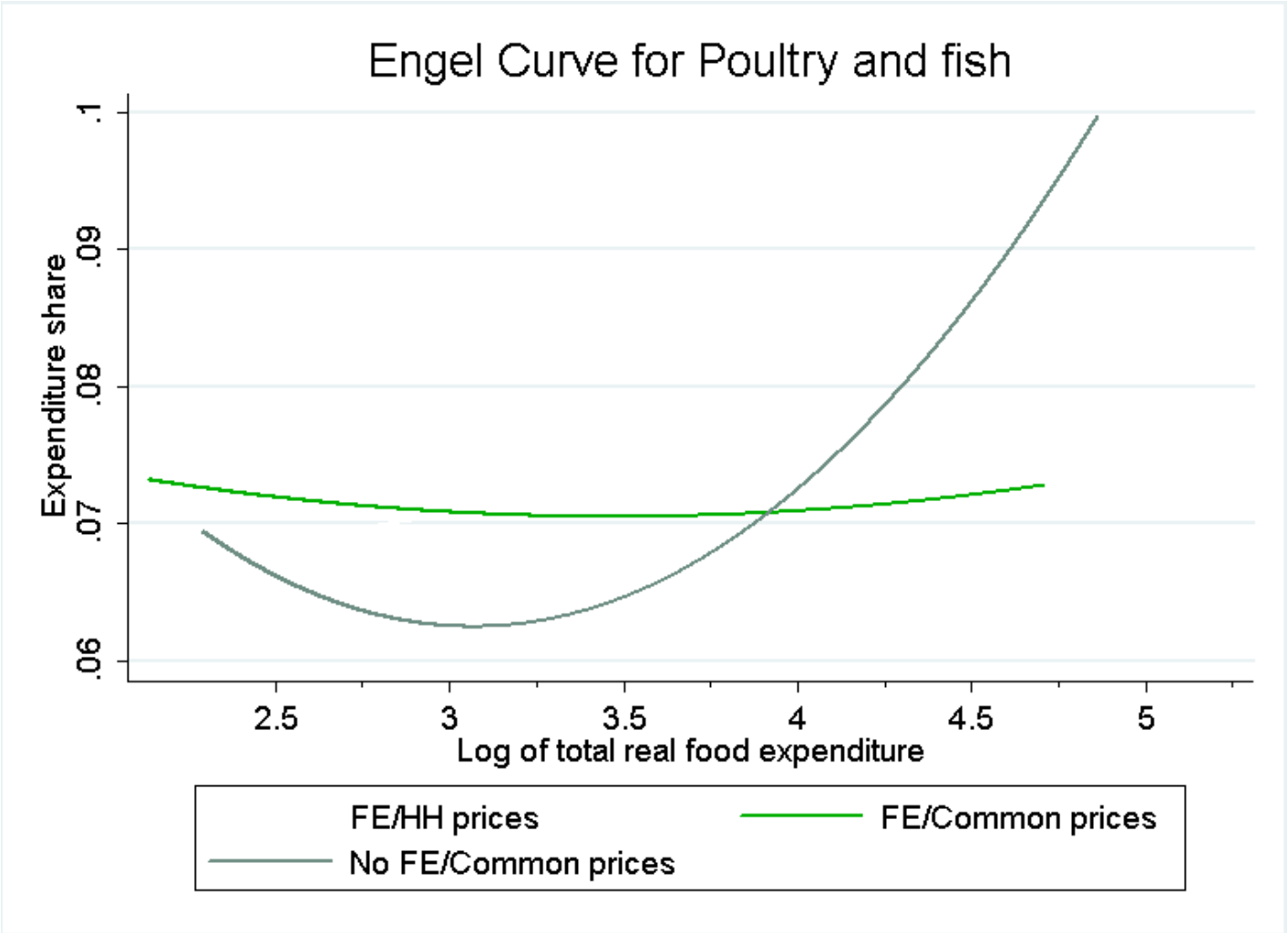
Engel curve


Engel Curve for Poultry and fish
Expenditure share
.06
.07
.08
.09
.1
2.5
3
3.5
4
4.5
5
Log of total real food expenditure
FE/HH prices
FE/Common prices
No FE/Common prices

Engel curve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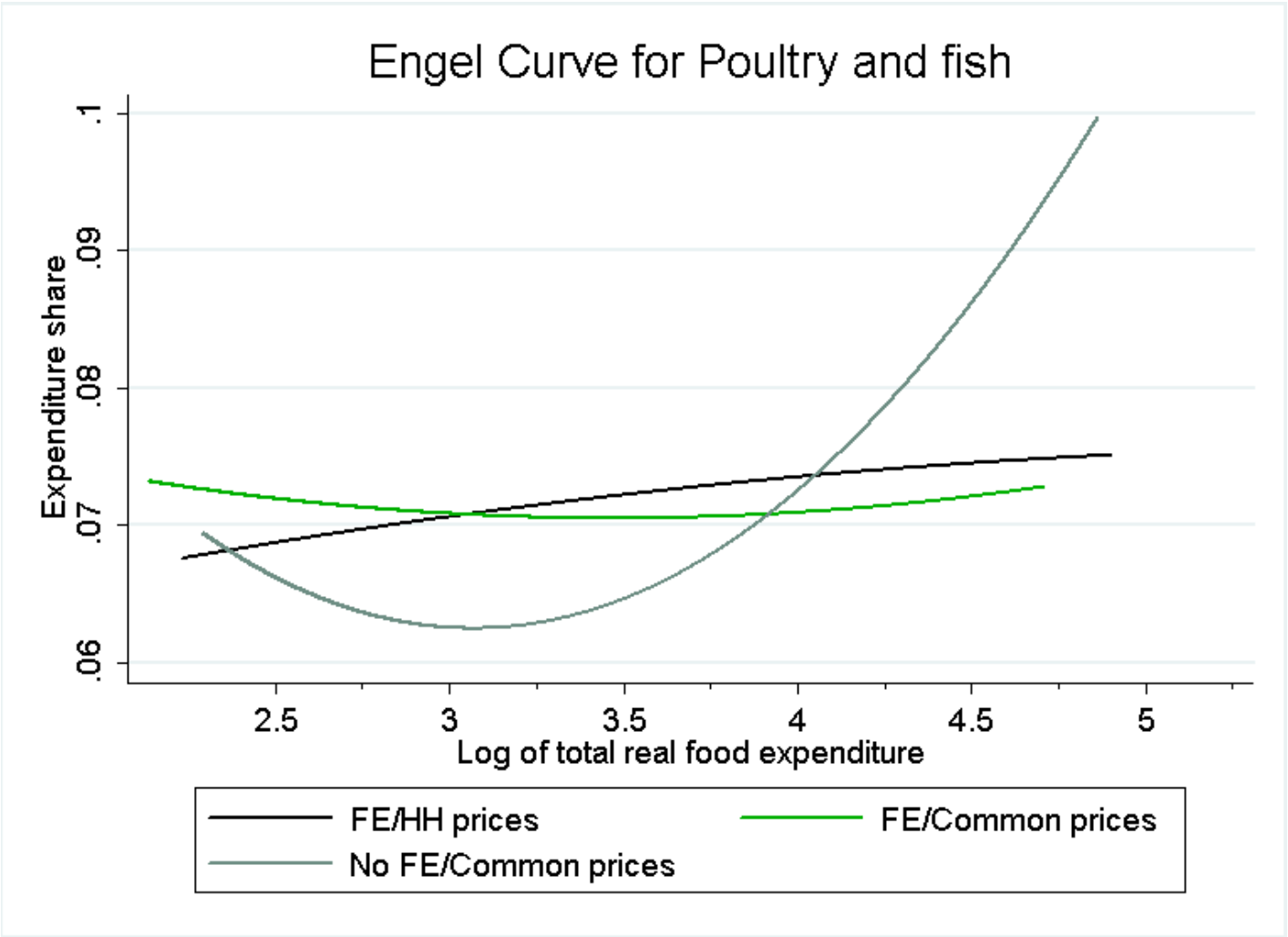
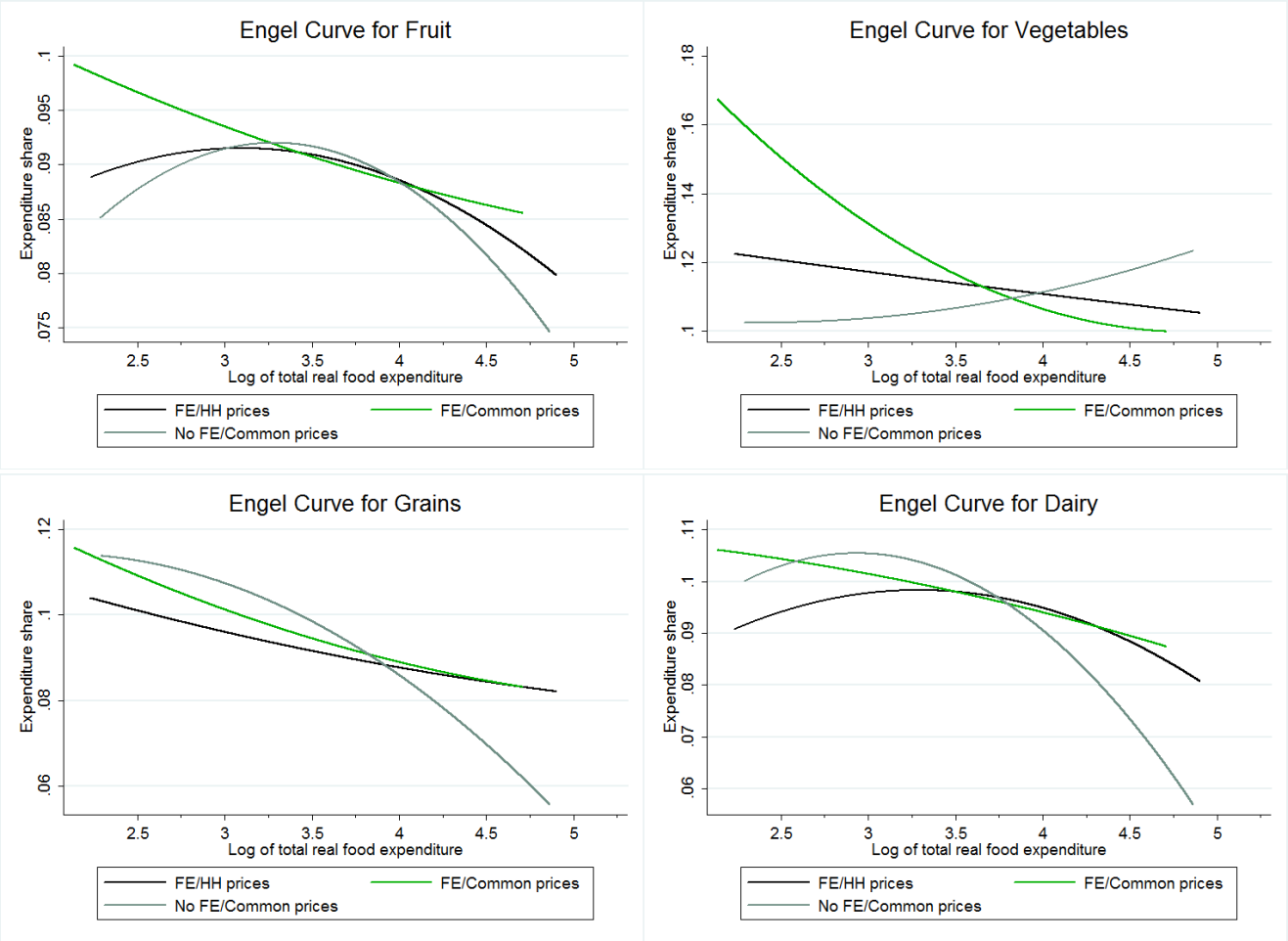
Engel curve

Confidence intervals



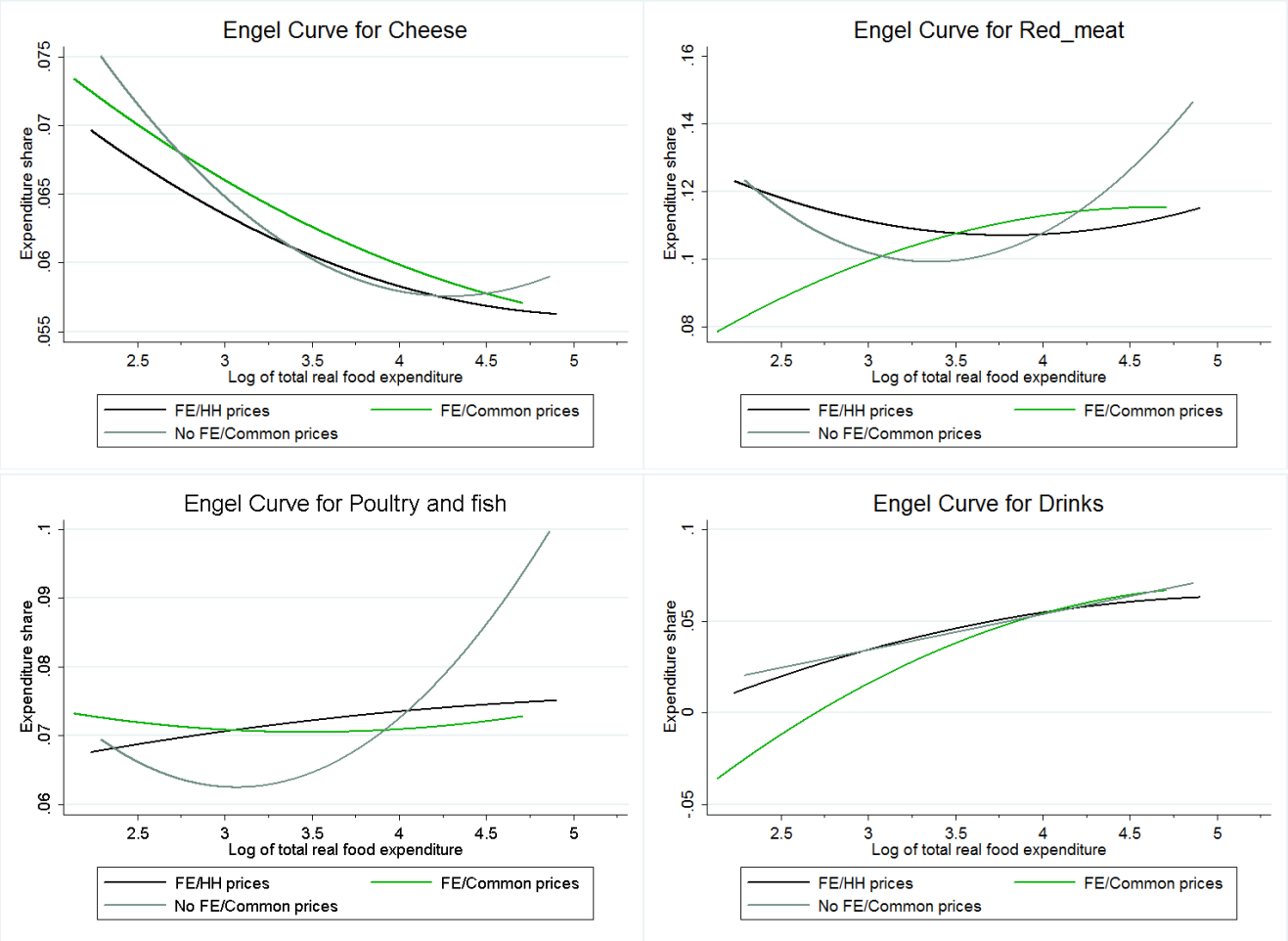
Engel curve

Fruit, vegetable, grains, dairy



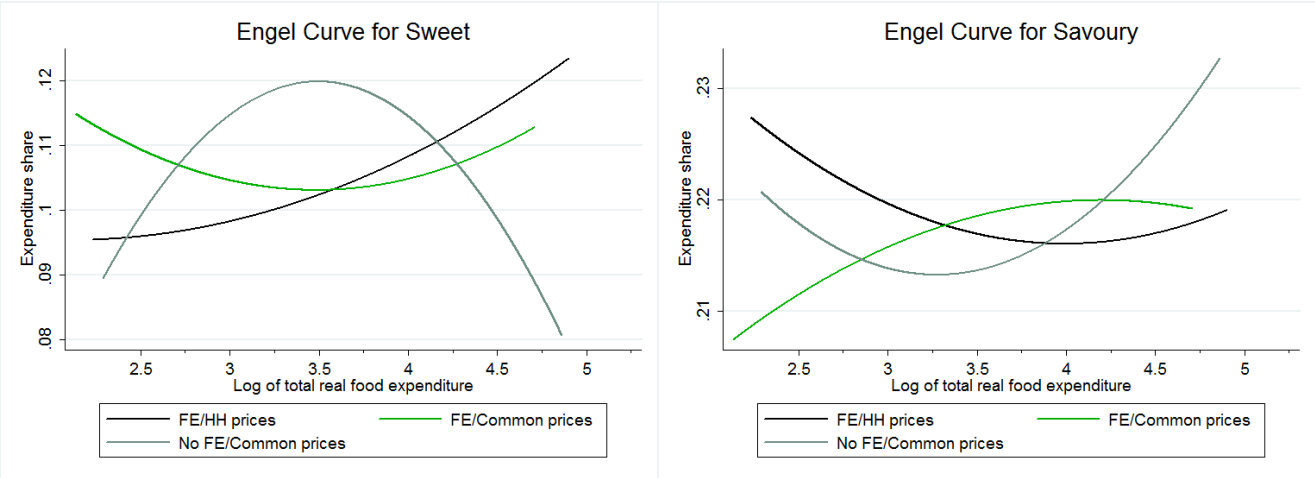
Engel curve

Cheese, red meat, poultry and fish, drinks



Engel curve

Prepared sweet and prepared savoury



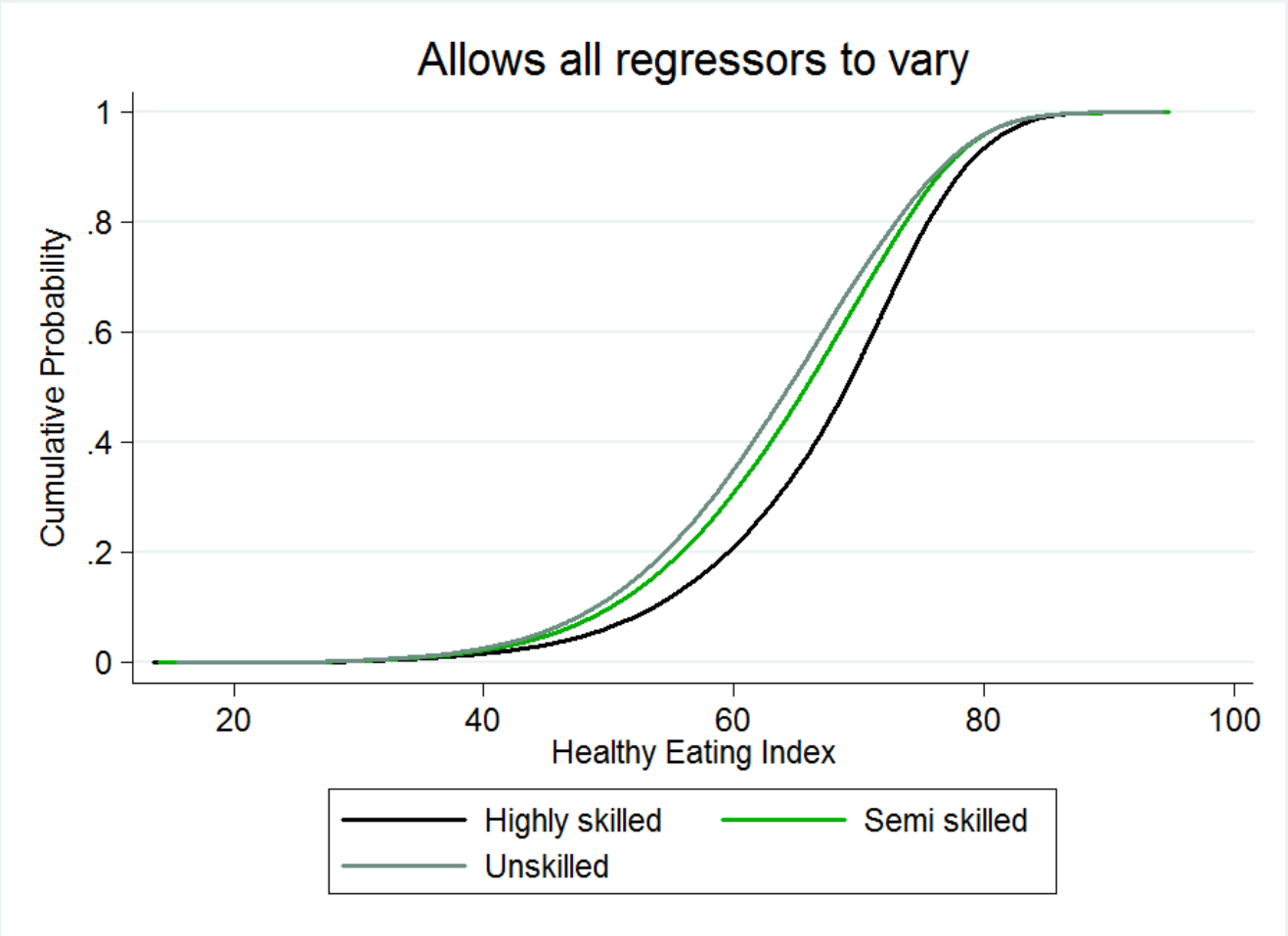
The determinants of the SE gradient in diet

- Use model to assess the relative contributions of differences across household in:
  1. Expenditure
  2. Prices
  3. Preferences

  in explaining the SE gradient in diet

- Hold two factors at mean and allow third to vary across households
- See what implication is for variation in HEI across SE groups

SE gradient in the data



Healthy Eating Index

Interpretation

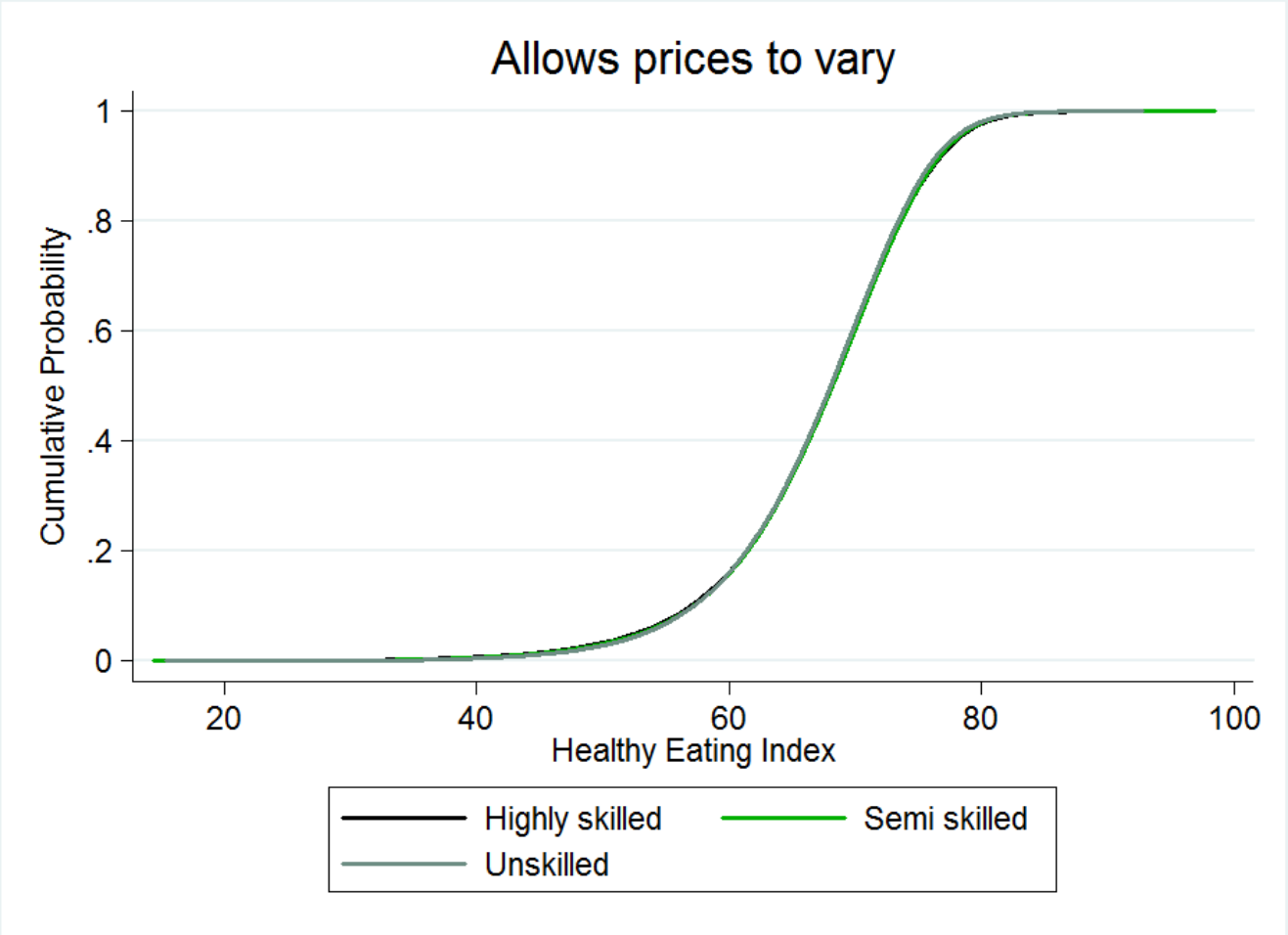
- Can express a given change in the HEI in terms of a change in one of its components (holding other components fixed)

Table: *Required changes in diet that correspond to an increase in the HEI of 4 points.*

HEI component	Change per 1000 kcals	Notes
Fruit	↑ by 96g	One portion is equal to 80g
Vegetables	↑ by 132g	One portion is equal to 80g
Sodium	↓ by 0.52g	Equivalent as salt: 1.25g. Recommended daily allowance of salt: 6g.
Saturated fat	↓ by 1.6ppt	Guidance is to consume less than 10% of calories as saturated fat

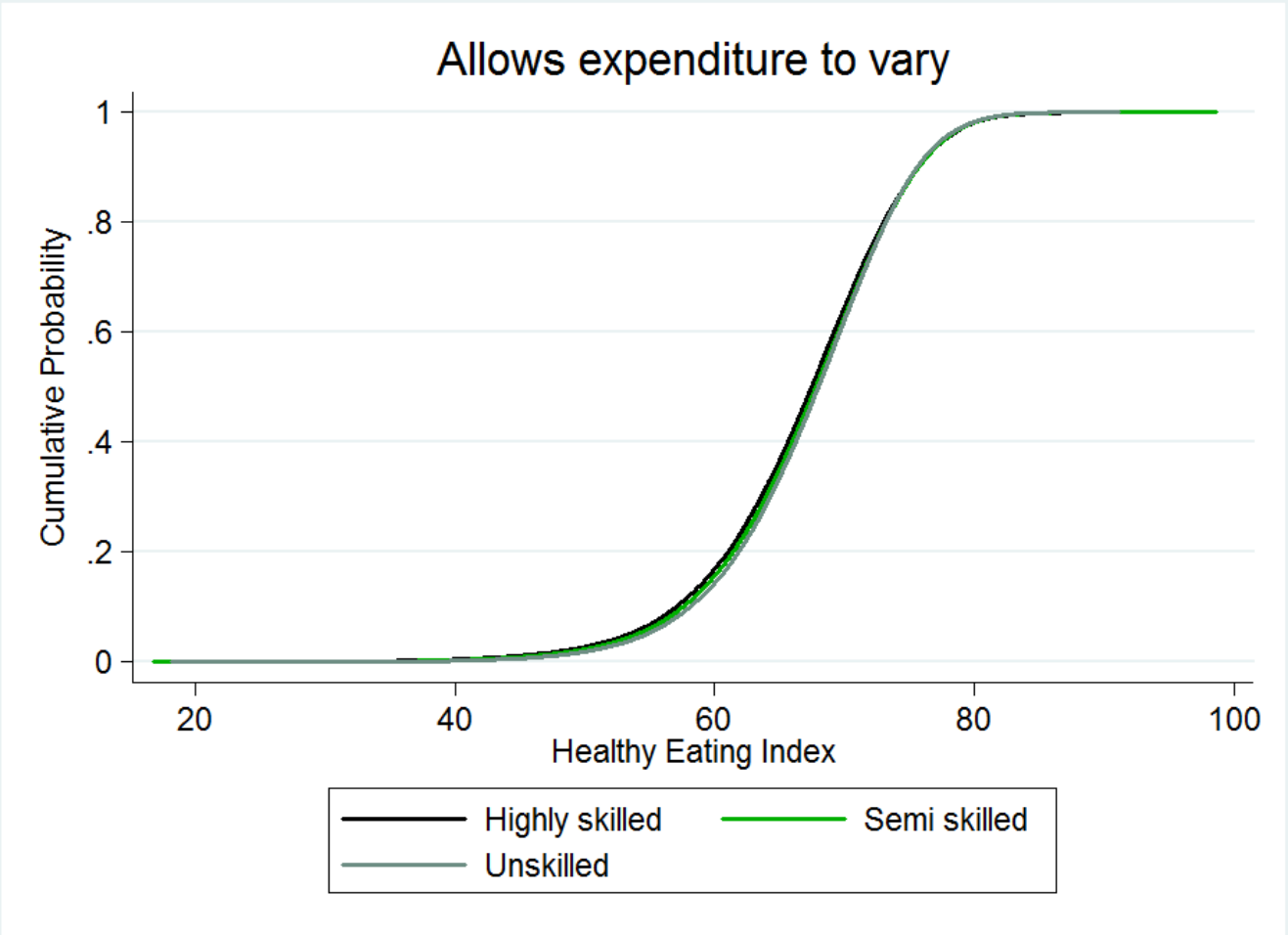
Contribution of differences in:

Prices



Contribution of differences in:

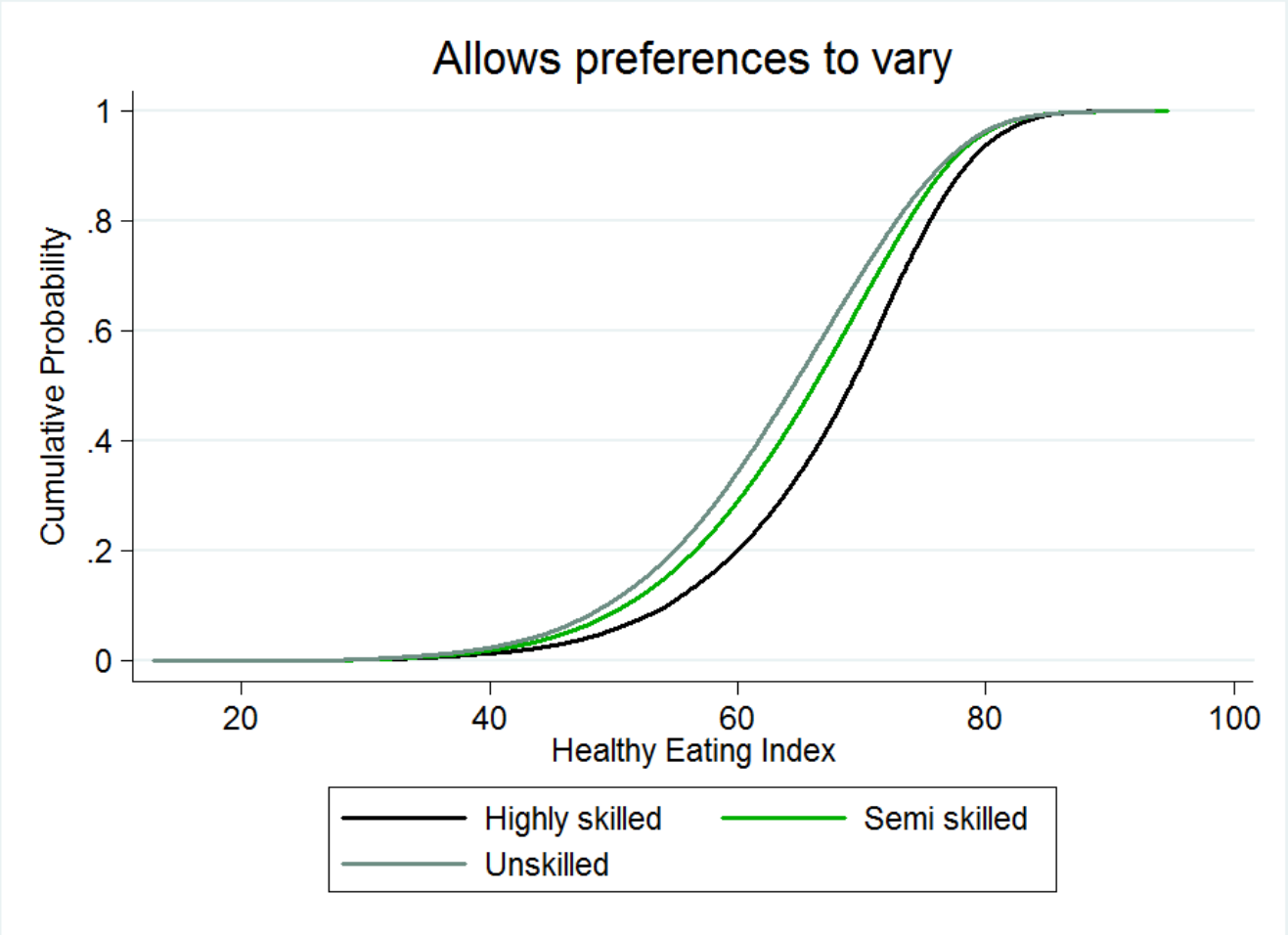
Expenditure



▸ Expenditure variation

Contribution of differences in:

Preferences



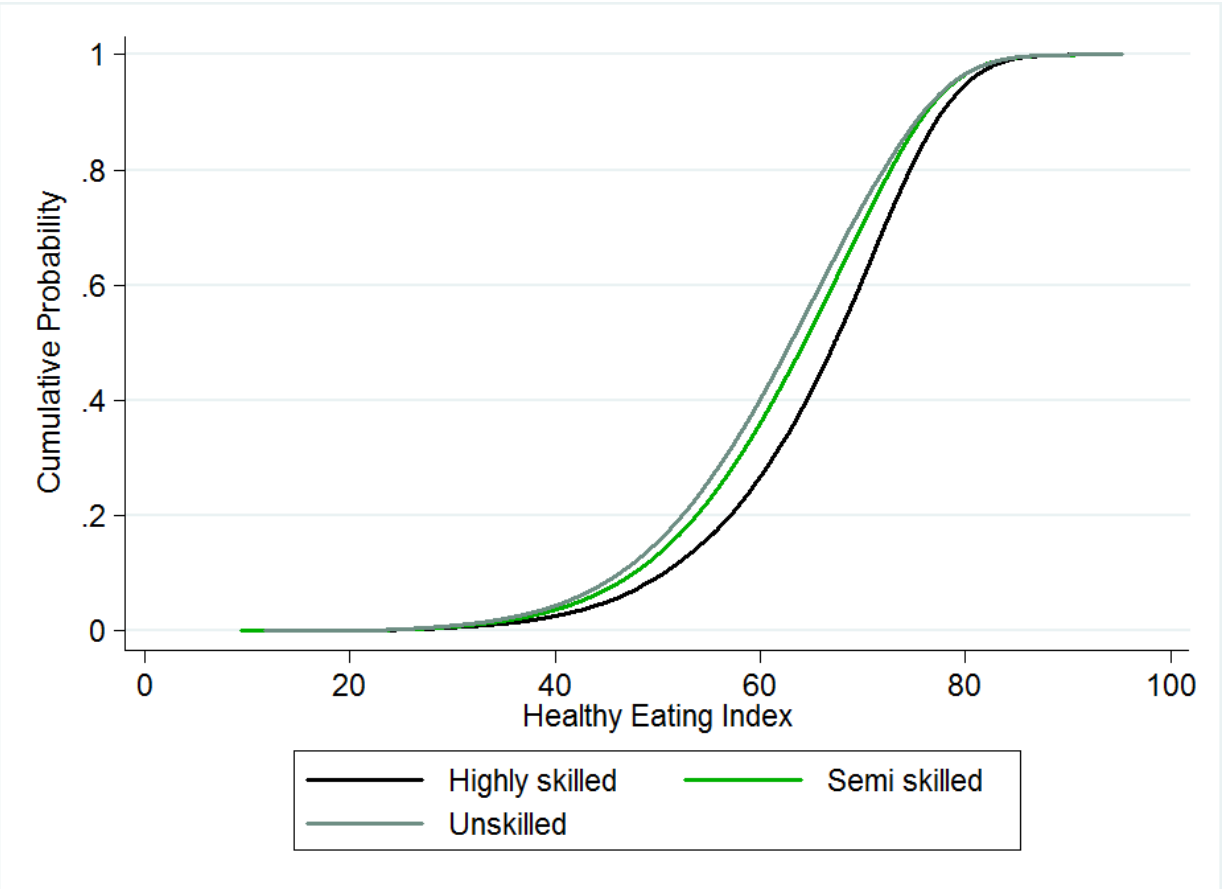
Summary

- Quality of diet and socioeconomic status are correlated
- Correlation could be driven by income differences or households having different preferences or facing different prices
- We estimate a model of food demand to separate out these effects
- We find (preliminary) evidence that differences in preferences are responsible for the socioeconomic gradient in diet

Relationship between socioeconomic status and nutrition

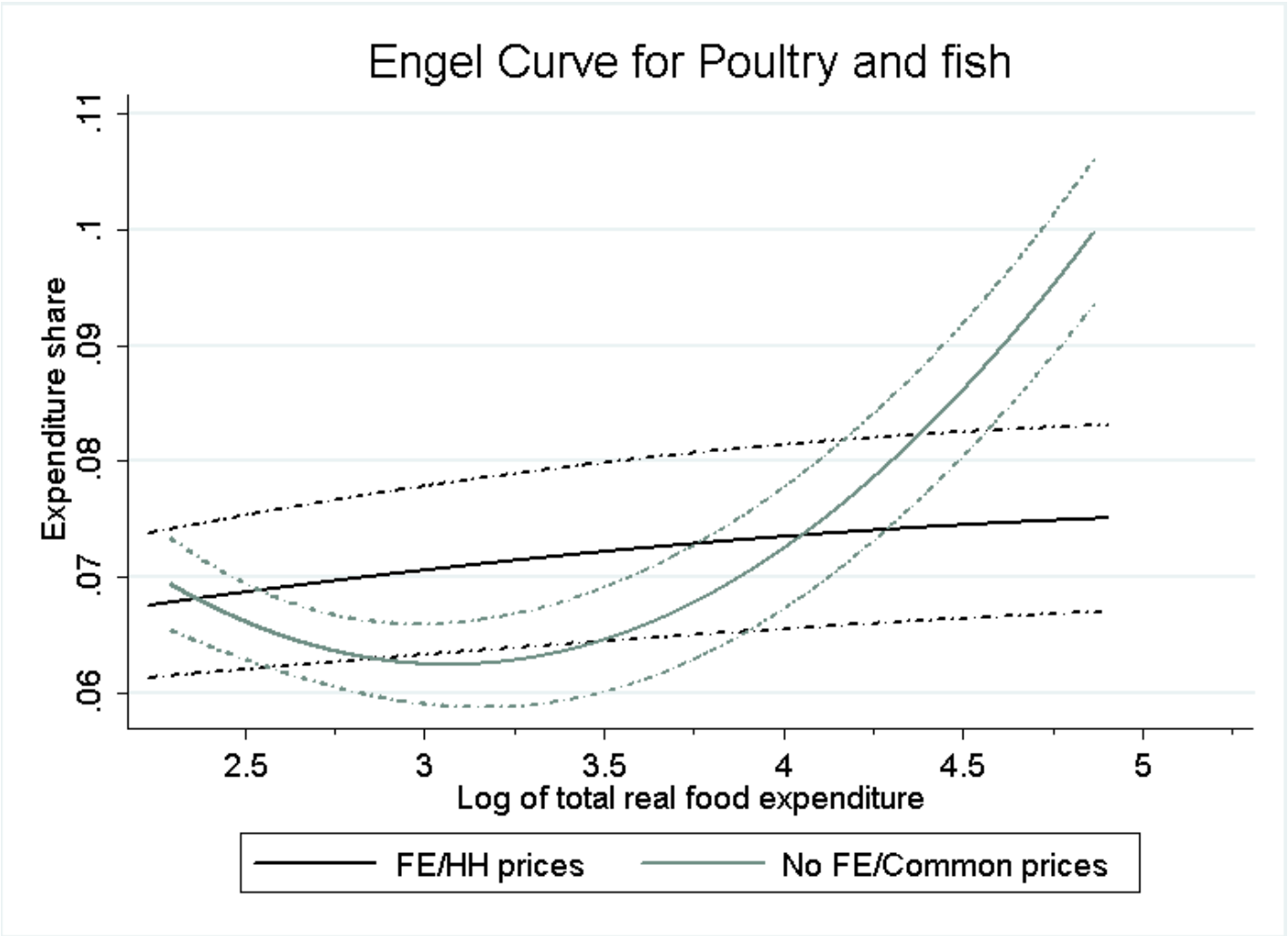
Back: Motivation

Figure: *Cumulative density functions of the Healthy Eating Index by social class*

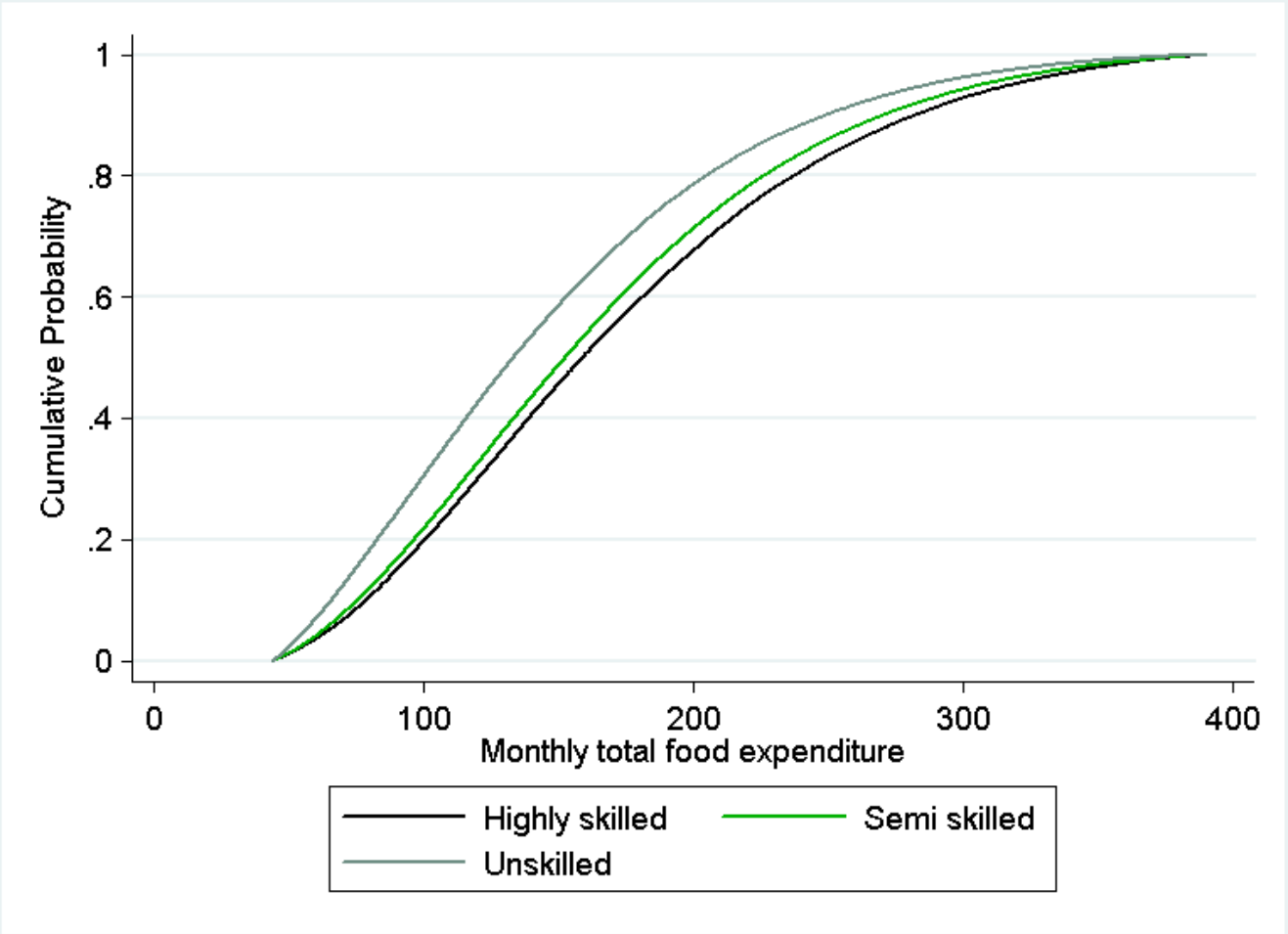


Engel curves: confidence intervals

Back: Engel curves



Variation in expenditure



Back: Diet gradient