

Genes, Pubs, and Drinks: Gene-environment interplay and alcohol licensing policy in the UK



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What do we do?

Embed **rGE** and **GxE** in a potential-outcomes framework (Neyman, 1923, Fisher, 1935, Roy, 1951)

Research Question:

Does genetic predisposition shape:

1. Selection into treatment?
2. Response to treatment?

$$\begin{cases} D = \mathbb{1}[[E(Y_1 - Y_0 - C(X, Z, G)|Z) > 0]] \\ Y_0 = \mu_0(X, G) + U_0 \\ Y_1 = \mu_1(X, G) + U_1 \end{cases}$$

- Treatment = alcohol availability **D = living next to a pub**
- Outcome = alcohol intake **Y = drinks per week**
- Moderator = PGS for drinking **G = GSCAN PGS**

Environment: Pubs and Retail Store density

Pubs and supermarkets geo-codes:
 + Cross-section of all pubs in the UK in 2017 via (TheGoodPubGuide)
 + Panel of UK's major grocery chains
 → Number of pubs and retailers within 1km

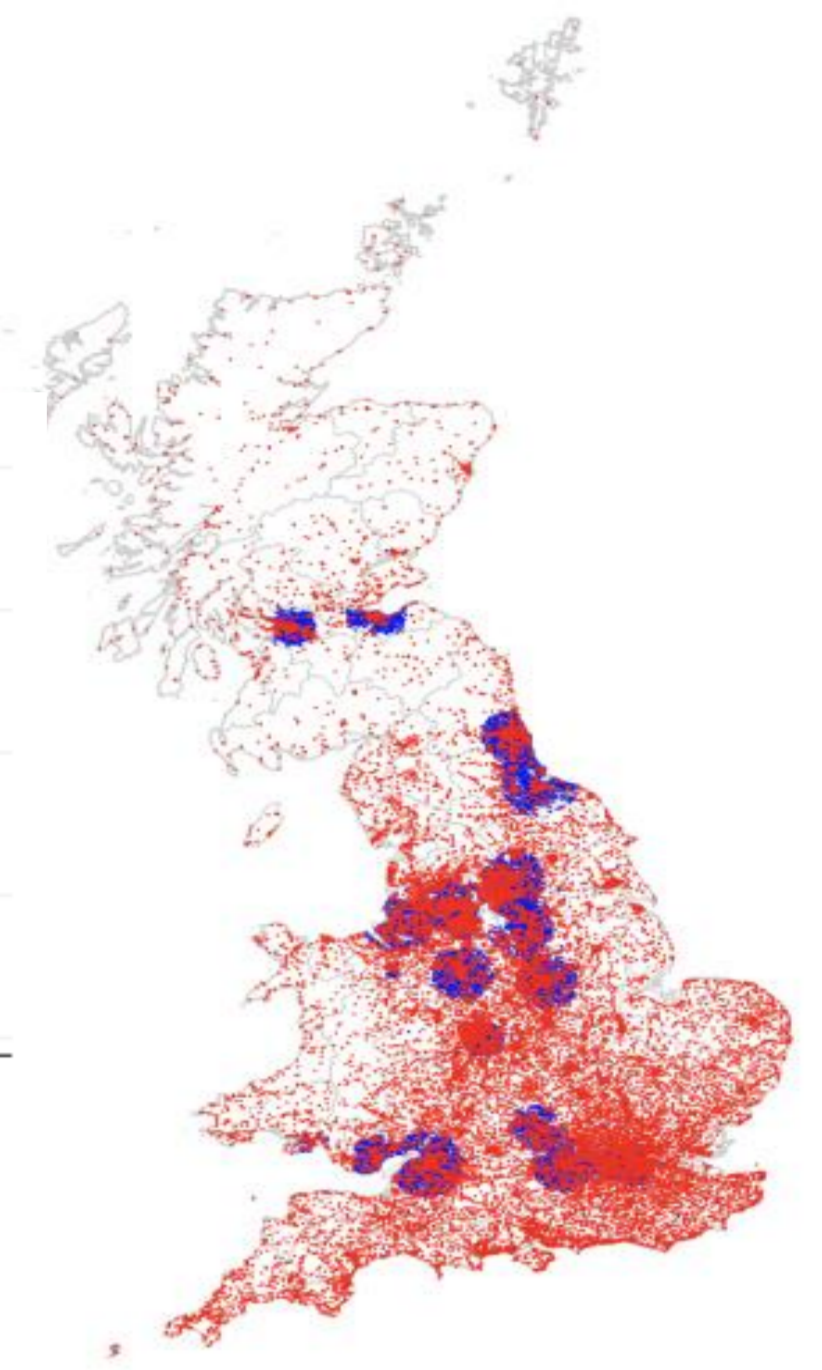
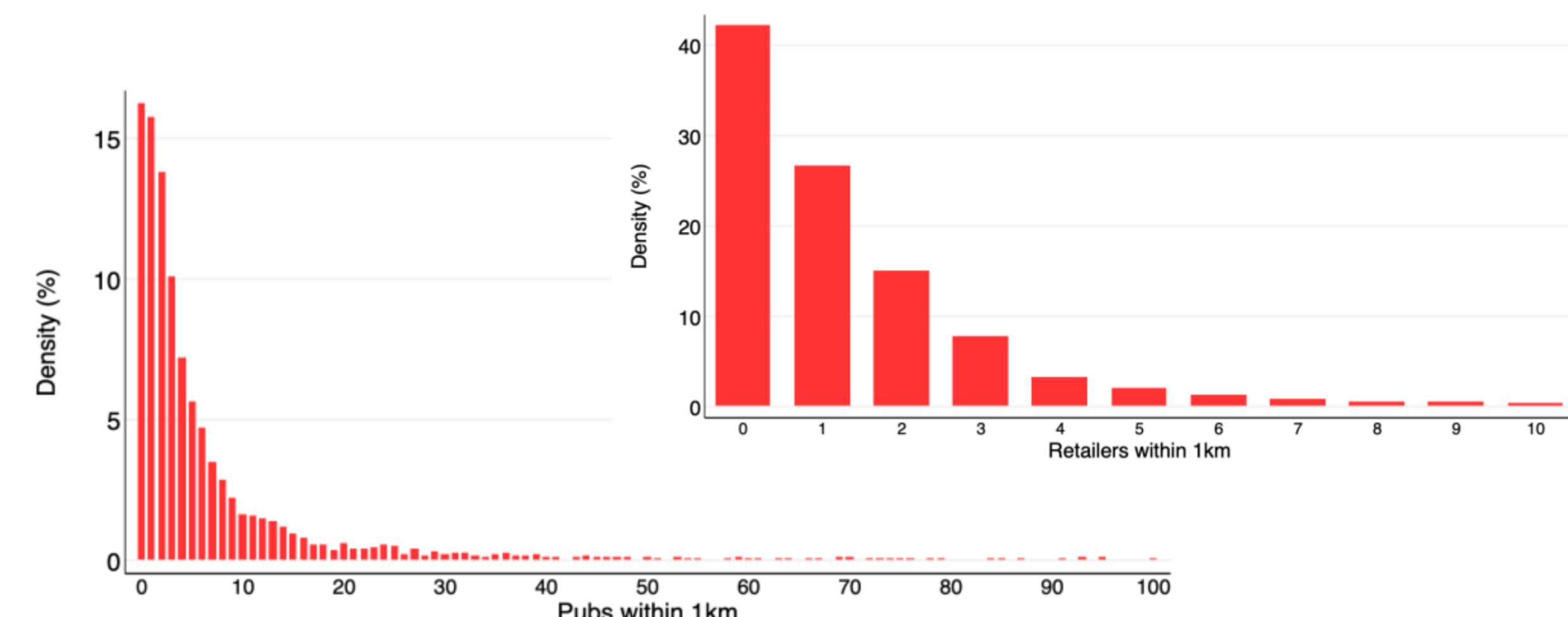


Fig 1: Density of pubs and retail stores in the UKB

rGE and selection: High PGS individuals live closer to pubs

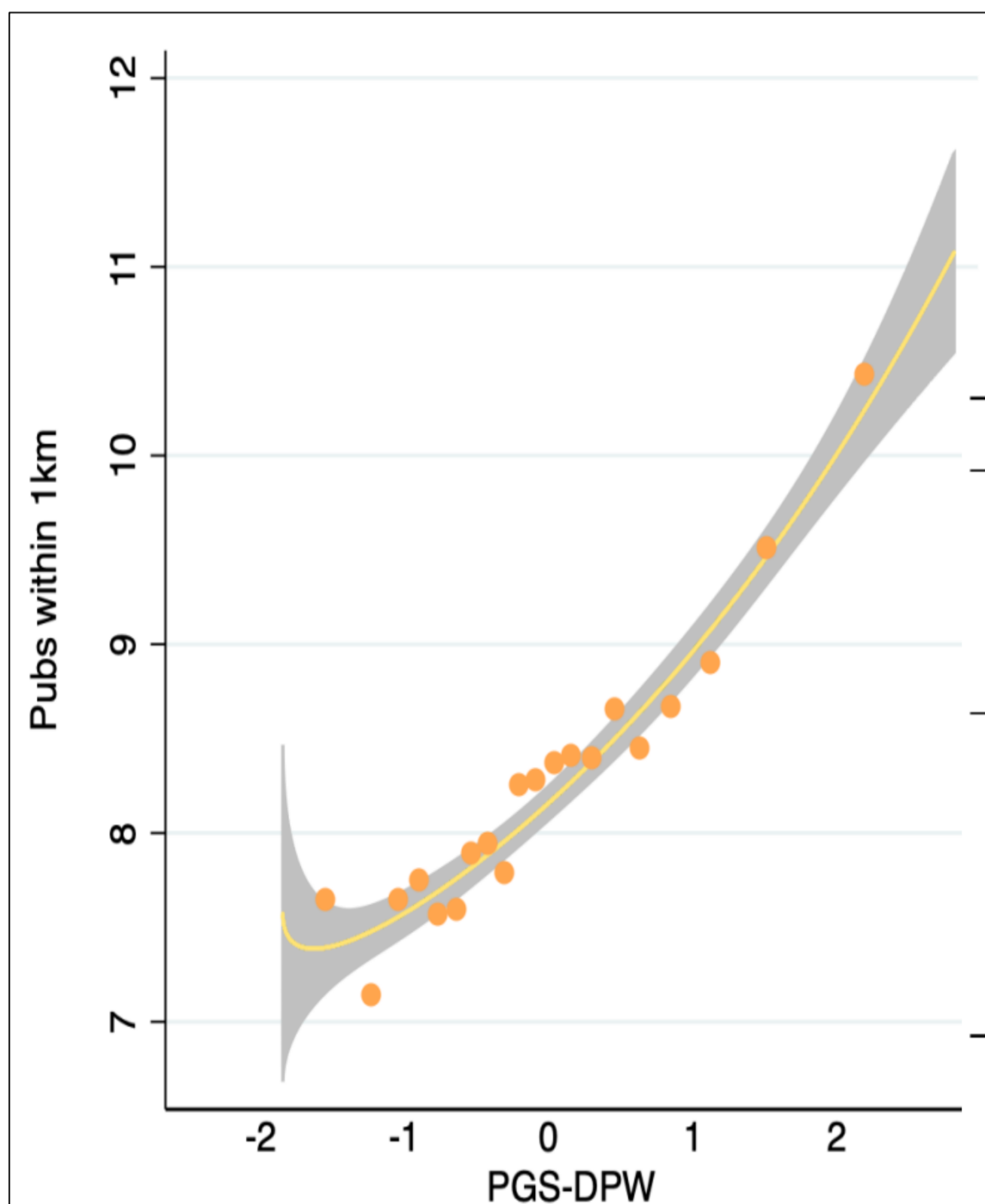


Table: Selection on current pub density based on polygenic score

	(1)	(2)	(3)	(4)	(5)
PGS-DPW	0.741*** (0.034)	0.449*** (0.061)	0.457*** (0.061)	0.117* (0.052)	0.430*** (0.059)
Constant	8.271*** (0.034)	8.341*** (0.034)	8.340*** (0.034)	8.276*** (0.029)	7.748*** (0.039)
First 40 PCs	No	Yes	Yes	Yes	Yes
Age X Sex	No	No	Yes	Yes	Yes
Local authority FE	No	No	No	Yes	No
Local authority at birth FE	No	No	No	No	Yes
R2	0	0	0	0	0
N	488247	488247	488246	487637	432654

se in parentheses
 + p < 0.10, * p < 0.05, ** p < 0.01, *** p < 0.001

- The PGS is predictive of:
1. Pub density in 1km around home
 2. Moving (since birth or over time)

Within-sibling results: similar magnitude of the rGE coefficient, but imprecisely estimated

Table: Selection on current pub density over pub density at birth based on polygenic score

	(1)	(2)	(3)	(4)	(5)
PGS-DPW	0.116* (0.049)	0.081** (0.030)	0.082** (0.030)	0.034 (0.021)	0.087** (0.030)
Constant	1.436*** (0.131)	1.443*** (0.130)	1.435*** (0.128)	1.398*** (0.010)	1.445*** (0.120)
First 40 PCs	No	Yes	Yes	Yes	Yes
Age X Sex	No	No	Yes	Yes	Yes
Local authority FE	No	No	No	Yes	No
Local authority at birth FE	No	No	No	No	Yes
R2	0	0	0	0	0
N	371671	371671	371670	371616	371425

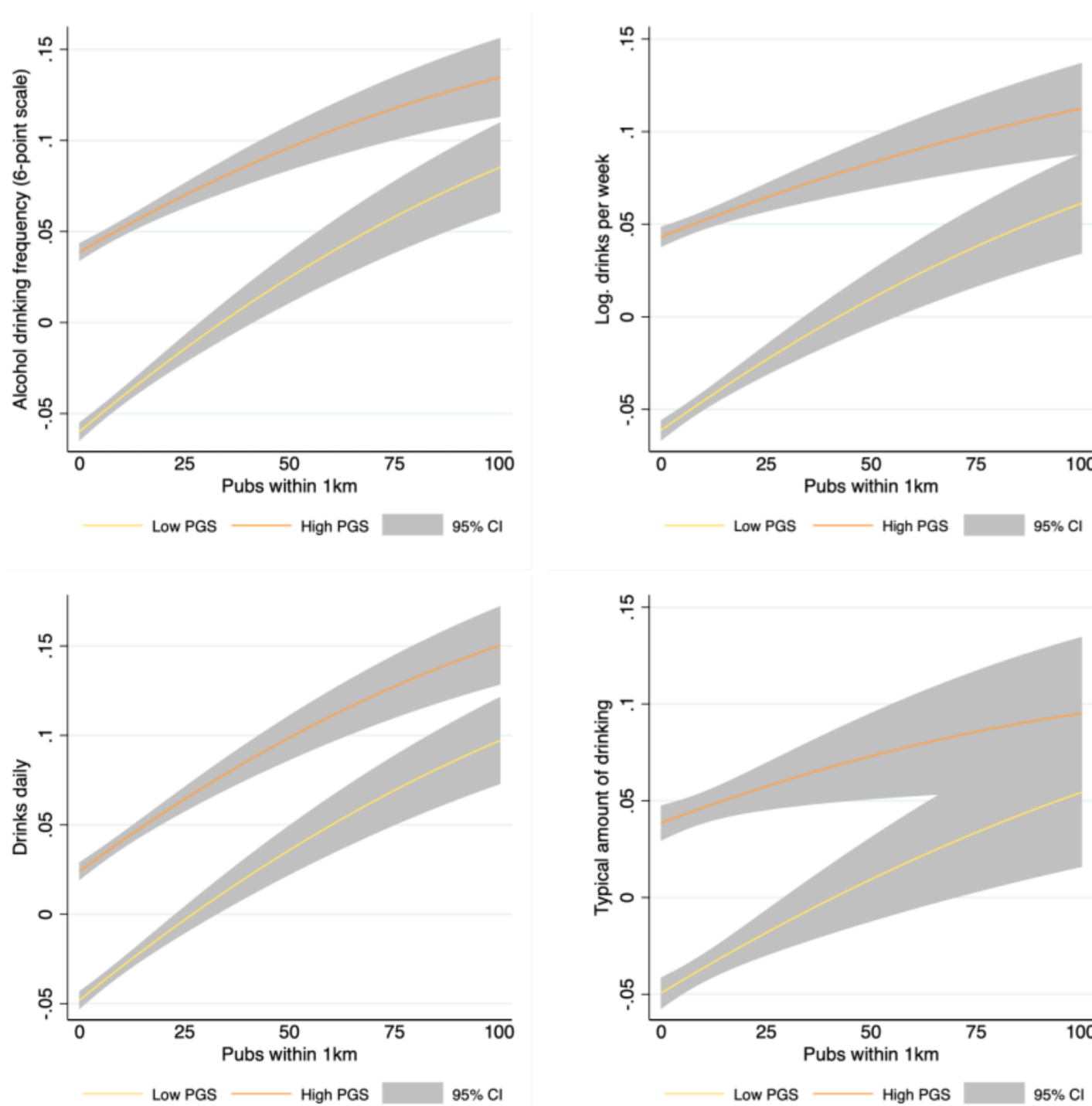
GxE and treatment effects: High PGS drink more regardless of distance to pub

OLS

- High PGS drink more
- Especially if far from pubs

→ **Differential elasticity of demand?**

Problem: endogeneity of pub location

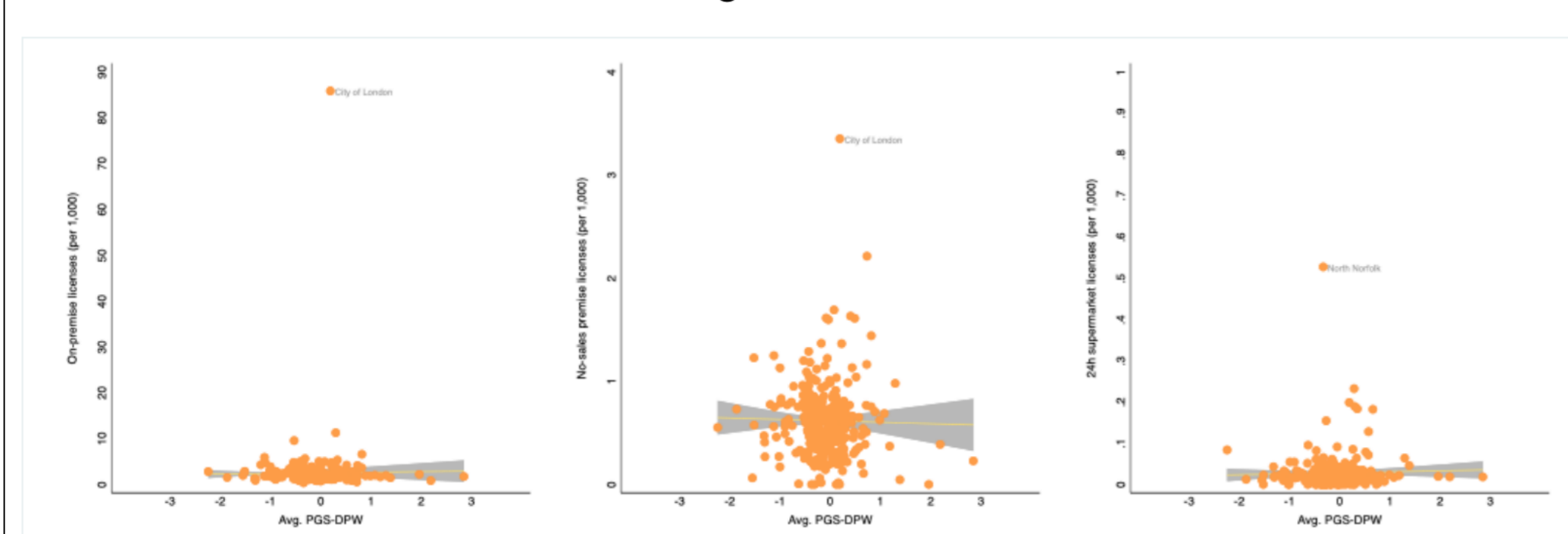


⇒ use Licensing Act of 2003 as source of variation

Local Authorities decide places that can sell alcohol. Decision can be based on:

- Public noise, crime and disorder, presence of school/children
- Note: not allowed to take public health into consideration

PGS is uncorrelated to number of licenses granted



Reduced Form

- High PGS less responsive to licenses
- Drink more regardless

→ **Differential elasticity of demand?**

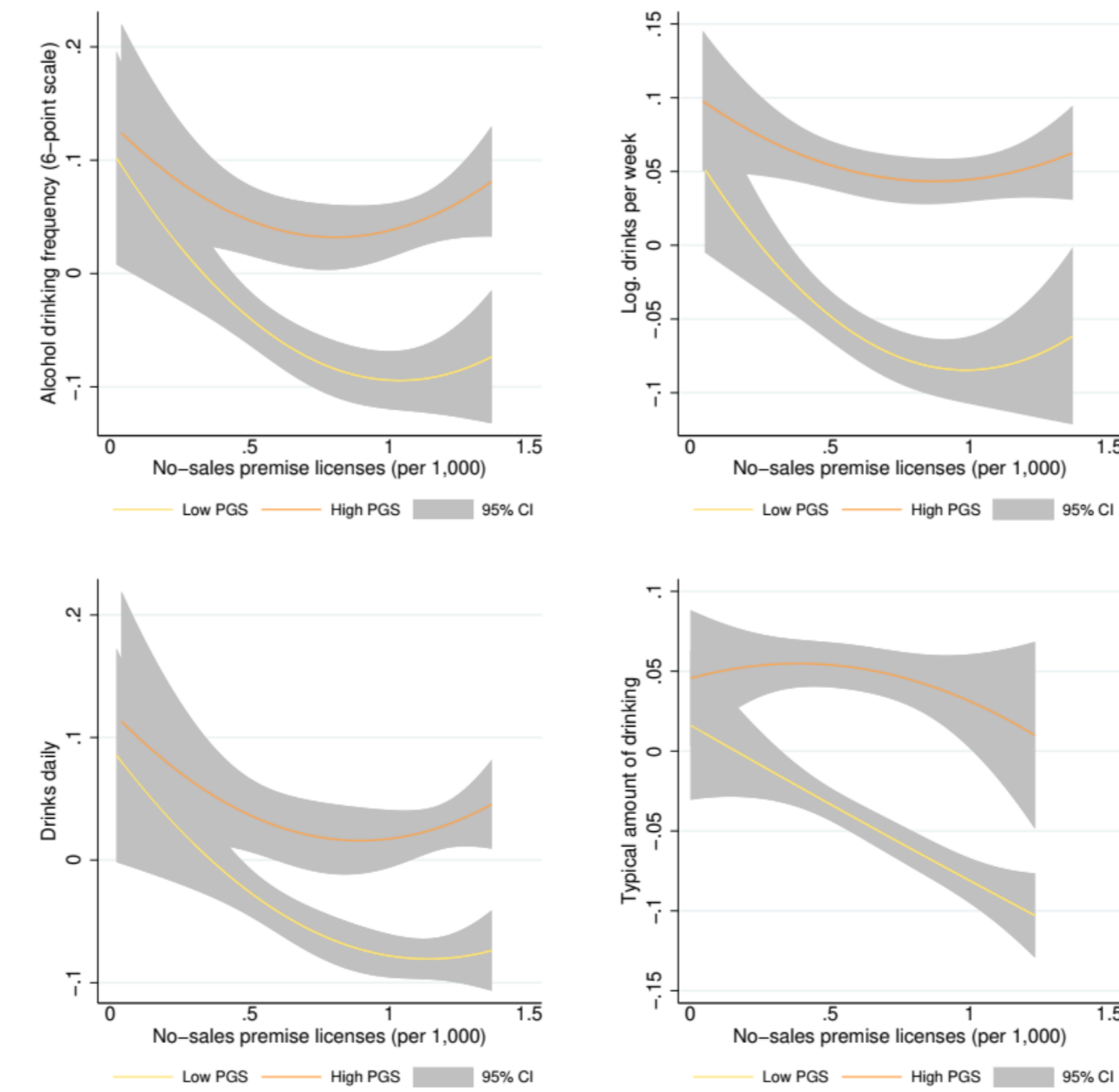


Table: Drinks per week as a function of licenses × PGS

	Drinking frequency (1)	Daily drinker (2)	IHS drinks per week (3)	Typical amount (4)
No-sales premise licenses (per 1,000)	-0.081* (0.033)	0.076* (0.032)	-0.084** (0.030)	-0.060* (0.022)
PGS-DPW	0.135*** (0.007)	0.112*** (0.008)	0.146*** (0.007)	0.125*** (0.011)
No-sales premise licenses (per 1,000) × PGS-DPW	0.035* (0.013)	0.021* (0.010)	0.022* (0.011)	0.022* (0.015)
Constant	0.045* (0.025)	0.041* (0.025)	0.056* (0.025)	0.022* (0.015)
First 40 PCs	Yes	Yes	Yes	Yes
Age X Sex	Yes	Yes	Yes	Yes
R2	0.099	0.097	0.098	0.130
N	385443	385409	385900	296467

se in parentheses
 + p < 0.10, * p < 0.05, ** p < 0.01, *** p < 0.001

	Drinking frequency (1)	Daily drinker (2)	IHS drinks per week (3)	Typical amount (4)
On-premise licenses (per 1,000)	0.024* (0.011)	0.024* (0.011)	0.027* (0.011)	0.017* (0.008)
PGS-DPW	0.160*** (0.004)	0.135*** (0.004)	0.157*** (0.004)	0.143*** (0.005)
On-premise licenses (per 1,000) × PGS-DPW	-0.006** (0.002)	-0.004** (0.002)	-0.005** (0.002)	-0.004** (0.001)
Constant	-0.049* (0.022)	-0.048* (0.021)	-0.044* (0.022)	-0.043* (0.017)
First 40 PCs	Yes	Yes	Yes	Yes
Age X Sex	Yes	Yes	Yes	Yes
R2	0.090	0.087	0.098	0.130
N	391831	391797	392310	301404

se in parentheses
 + p < 0.10, * p < 0.05, ** p < 0.01, *** p < 0.001

IV

Table: Drinks per week as a function of pub presence and PGS (IV)

	Drinking frequency (1)	Daily drinker (2)	IHS drinks per week (3)	Typical amount (4)	(5)	(6)
Pub in 1km	1.129*** (0.067)	1.162*** (0.071)	1.516*** (0.073)	1.560*** (0.077)	0.872*** (0.072)	0.894*** (0.075)
PGS-DPW	0.155*** (0.003)	0.261*** (0.058)	0.121*** (0.003)	0.266*** (0.064)	0.159*** (0.003)	0.303*** (0.064)
Pub X PGS-DPW		-0.123* (0.068)		-0.168* (0.074)		-0.167* (0.074)
Constant	-1.735* (0.750)	-1.760* (0.754)	-2.426** (0.814)	-2.457** (0.821)	-1.431* (0.725)	-1.438* (0.729)
First 40 PCs	Yes	Yes	Yes	Yes	Yes	Yes
Age X Sex	Yes	Yes	Yes	Yes	Yes	Yes
IV	No	Yes	No	Yes	No	Yes
F	264	258	80	78	318	313
N	340597	340597	340994	340994	262103	262103

se in parentheses
 + p < 0.10, * p < 0.05, ** p < 0.01, *** p < 0.001

Summary

- Higher drinking PGS ⇒
 - Higher selection into treatment (rGE)
 - Lower treatment effect (GxE)
 - ☐ Selection on levels, not on gains
- Sin-tax (supply-side) alcohol policy might increase inequality
 - Reduce consumption on those who already drink less
 - Not effective on those who might benefit the most
 - Matthew-effect