Dynamic Heuristics

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One Slide Summary

Research Question:

- (How) do consumer heuristics respond to prices?

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- Describe heuristics in transaction-level data.
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Who cares about UK?

CULTURE

More Than 4.1 Billion Watch Queen's Funeral, Surpassing Every Royal Wedding

BY JON JACKSON ON 9/19/22 AT 3:14 PM EDT

Heuristics Important To Study

Decades of psychology literature studying **heuristics** 'mental rules-of-thumb used to simplify decisions'. Gilovich, Griffin & Kahneman, 12

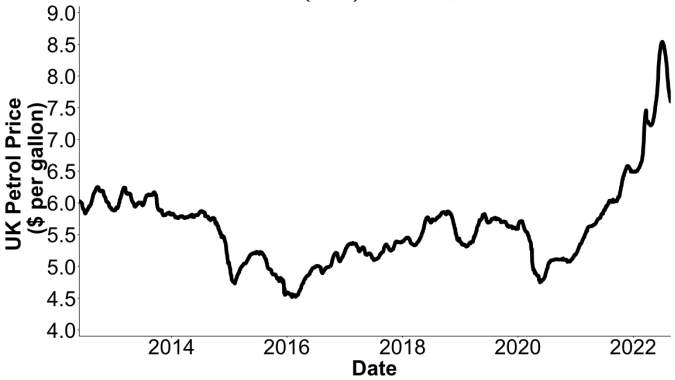
Many economic studies find consumers use heuristics across domains:

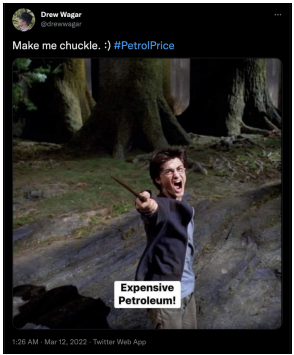
- Naive diversification in pensions
  (e.g. Read & Loewenstein, 95; Benartzi & Thaler, 01)
- Left-digit bias in used car purchases
  (e.g. Lacetera, Pope, & Sydnor, 12)
- Balance-matching heuristic in credit cards
  (e.g. Gathergood, Mahoney, Stewart & Weber, 21)

Heuristics in financial domains often find money non-fungible:
Mental accounting (e.g. Thaler, 85, 90, 99).
e.g. Hastings & Shapiro (13) evidence in US gas: when $P \uparrow$, choose regular-share more.

UK consumers face volatile petrol prices. Large squeeze on consumer finances.

UK Petrol (Gas) Prices ↑ 82% 2020 to 2022 (Source: BEIS).





In old money...peaked at 192 pence per litre in July 2022.

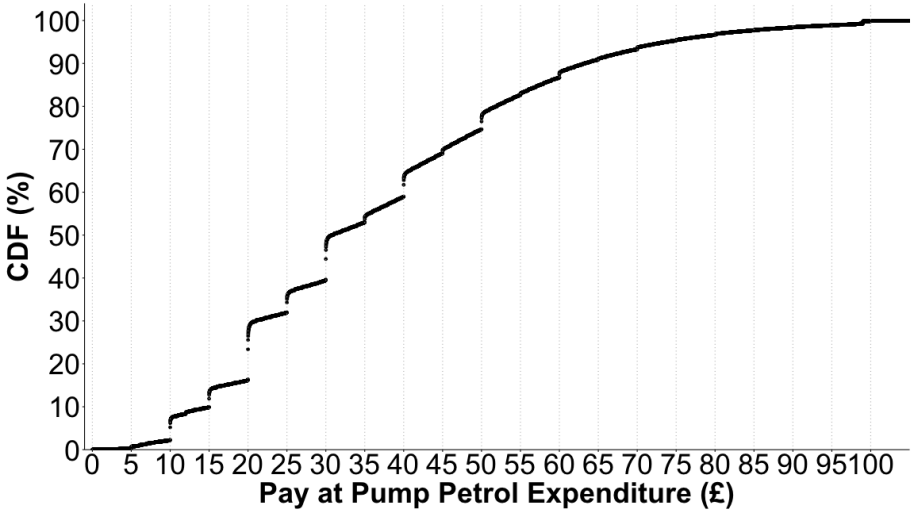
Institutional Details: How to to Pay for Petrol in UK

- P is price per litre.
- As you fill the (PQ) and Q (Litres) update.

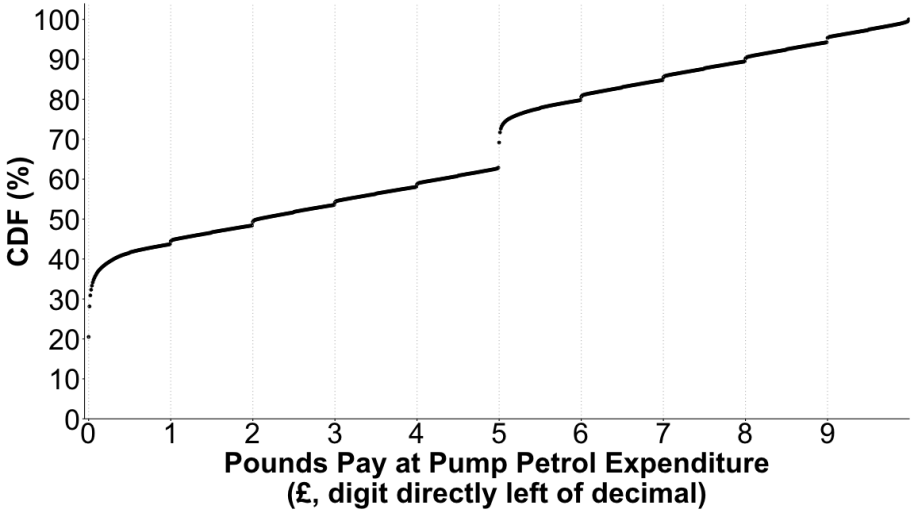
- No 'hold-open clips'. Need to physically keep holding to keep pumping. Can stop & restart.

Study using UK credit card transaction data where observe pay at pump expenditures & visits.

Petrol Expenditures Commonly at Round Numbers - Expenditures (XXX.XX)



UK Petrol (Gas) Expenditures Commonly at Round Numbers - Pounds (X.XX)



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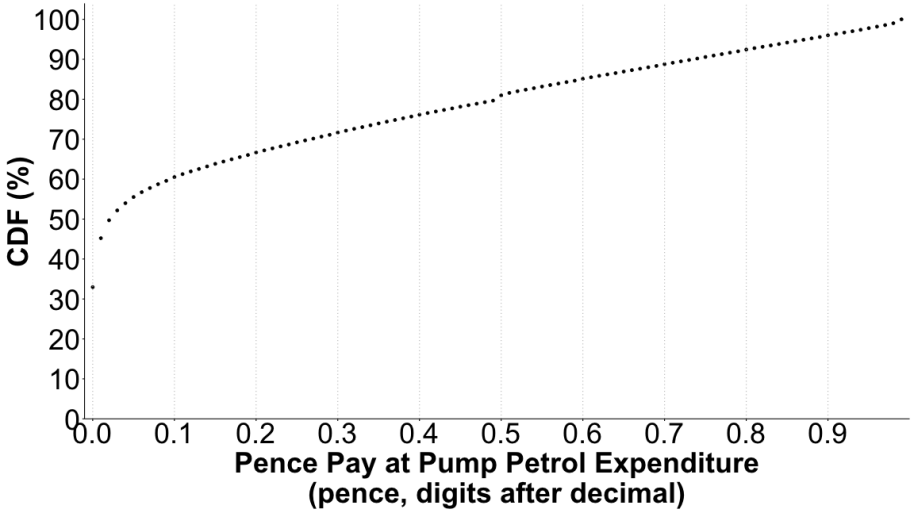
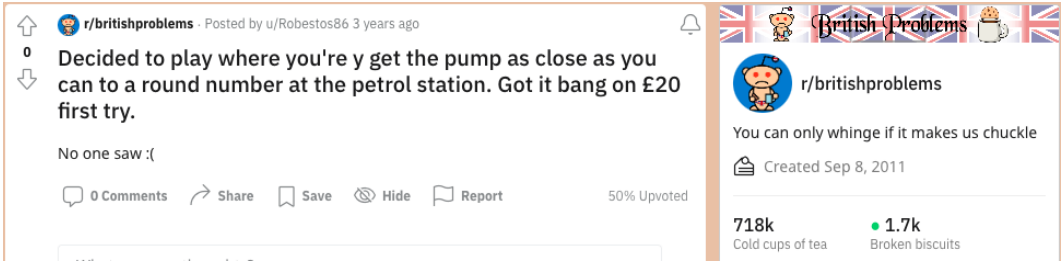


External Validity Check

British Reddit



- Replicates psychology study of 1,301 US pay at pump transactions at 1 convenience store in New York, 2005 (Ly, Flynn & Helion, 13).

Empirical Facts on Round-Numbered Expenditures

1. Highly-prevalent

- 33% end in .00 (vs. 1% if chance).
- 50% end in .00, .01, .02 (vs. 3% if chance).

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3. Clustered at a few round-numbered expenditure amounts

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- 41% end in 0.00, 0.01, 0.02, 5.00, 5.01 or 5.02 (vs. 0.6% if chance)

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$\Rightarrow$ Targeting (PQ) ending in 5.00 or 0.00 is a common budgeting heuristic.

Elasticity of heuristics (H) to P?

Define H % using round-numbered heuristic.

Define Round-Numbered Heuristic if (PQ) ending in 0.00 or 5.00 (can relax).

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3. **Stop Using Heuristic** $\frac{\partial log(H)}{\partial log(P)} < 0$
   - If budget constraint binding, consume constrained max.
   - If budget constraint non-binding & $E[P_{t+j}] > 0$ then switch to filling tank.
   - More attentive to budget.

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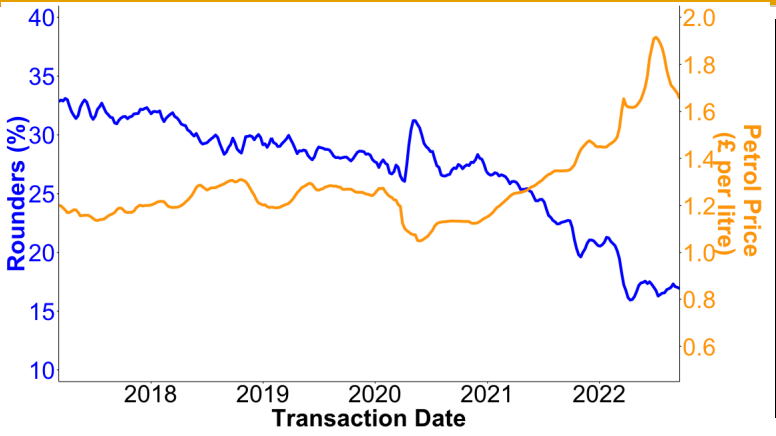
4. **Start Using Heuristic** $\frac{\partial log(H)}{\partial log(P)} > 0$
   - Consumers previously filling tank, become more attentive or consume constrained max.

Weekly Petrol Prices (orange) Vs. Round Number Expenditures (blue)



Correlation: -0.86

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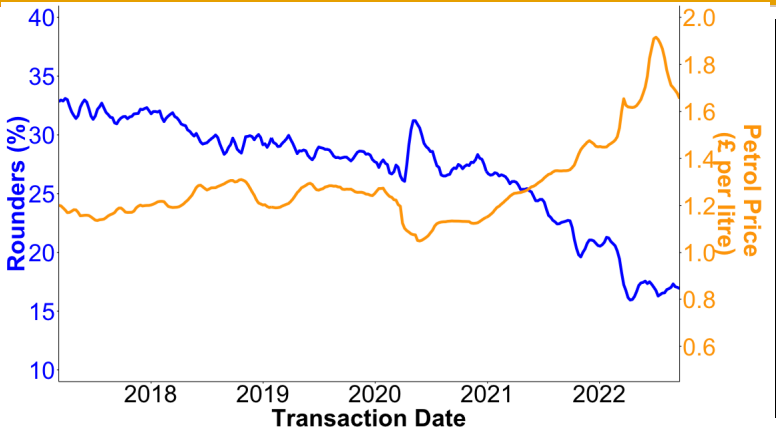

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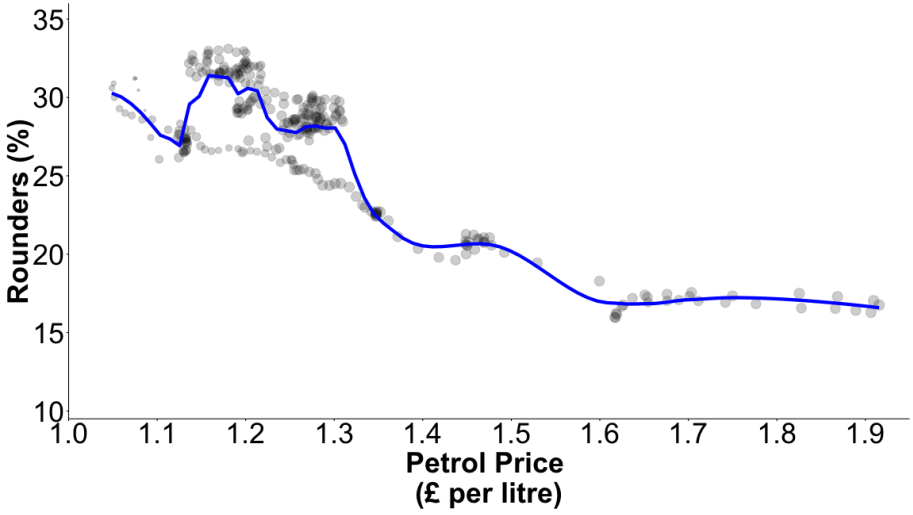
Relationship holds in regression with individual-level F.E.

‘Demand’ for Round Number Heuristics



When ↑ P ⇒ Gas Station Visits ↑ 50%

Regression run separately for rounders (R) vs. non-rounders (NR).

$$Y_{i,t} = \delta log(P_t) + \theta_i + u_{i,t}$$

	# visits in 28 days	
	Rounders	**Non-Rounders**
	(1)	(2)
$log(P_t)$	1.988***	1.232***
	(0.196)	(0.084)
Baseline Mean	4.00	2.58
% Change	50%	48%

*** where significant at 0.1%. Balanced panel, August 2020 - 2022. S.E. clustered card & day.

'Rounders' defined as consumer rounded in days t-1 to t-29.

Interim Conclusions

So Far

- Consumers Use Heuristics.
- Heuristics Respond to Changes in Prices.
- When $\uparrow$ Prices $\Rightarrow$ Visits $\uparrow$

Not shown today:

- Ruled out alternative heuristics
  (e.g. Quantity-Targeting, % Tank-Targeting).
- Heuristics have similar estimated incomes. i.e. learn about behavioral types.

Thank you!

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Motivation in Literature

- **Petrol** macroeconomically important household expenditure (with volatile prices)
  (e.g. Hastings & Shapiro, 13; Lynn, Flynn & Helion, 13; Levin et al., 17; Gelman et al., 22; Gelman & Roussanov, 22)
- Large literature on **heuristics** / mental accounts...
  (e.g. Thaler, 85; Loewenstein & Prelec, 98; Heath, Larrick & Wu, 99; Pope & Simonsohn, 10; Lacetera, Pope & Sydnor, 12; Drexler, Fischer & Schoar, 14; Gathergood, Mahoney, Stewart & Weber, 19; Argyle, Nadauld & Palmer, 20; Köszegi & Matejka, 20; Dube, Manning & Naidu, 20; Akepanidtaworn, Di Mascio, Imas & Schmidt, 22; Strulov-Shlain, 22; Zhang, Sussman, Wang-Ly & Lyu, 22)
  ...but little known about dynamics.
  (e.g. Hastings & Shapiro, 13; Thakral & Lo, 20)
- Large macroeconomics literature estimating **consumption** showing heterogeneity matters
  (e.g. Shapiro, 05; Parker, 14, Kaplan & Violante, 14; Kueng, 18; Ganong & Noel, 19; Fagereng, Holm & Natvik, 20, Havranek & Sokolova, 20; Ganong et al. 21; Golosov et al., 21)

Hastings & Shapiro (13 QJE)

- Uses US data. (1) monthly aggregated national data and (2) transaction data from US grocery retailer with gasoline station: panel covers 2006 - 2009. Data includes fuel choice.
- When prices $\uparrow$, consumers substitute towards lower quality fuel.
- Effect larger than can be explained by income effects.
- Data most consistent with category budgeting (gas money non-fungible).

Stylized Example

Suppose consumer uses petrol expenditure heuristic:

$$(PQ) = £30 \text{ each petrol station visit.}$$

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   - Switch heuristic value e.g. (PQ) = £30 to £20 or £40, target Q, filling tank.
   - Stop filling tank $\rightarrow$ start using heuristic.
3. **Change driving** $\rightarrow \downarrow$ # visits
   (e.g. $\downarrow$ miles, $\uparrow$ efficiency, $\uparrow$ search for cheaper fuel).

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Petrol heuristic choice may also spill-over to non-petrol expenditures.

Datasets

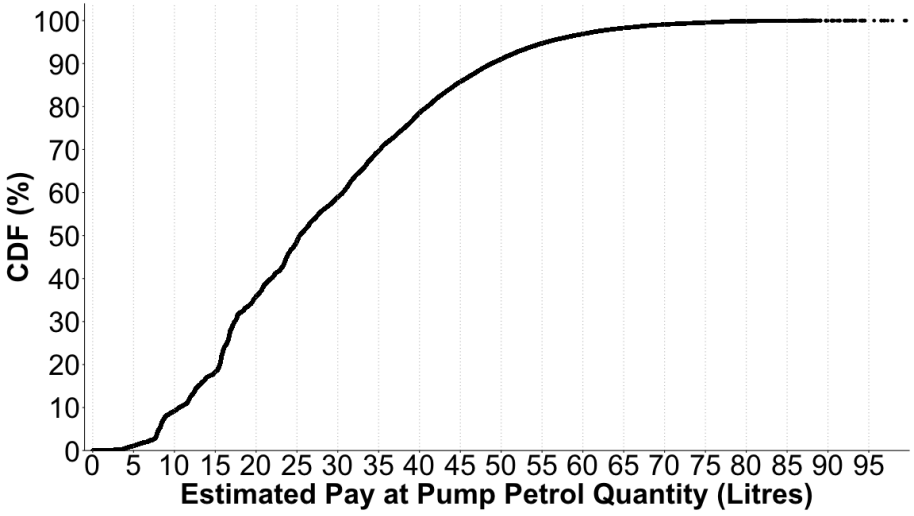
1. Real-time transaction data

- UK credit card expenditures (2017 - 2022).
- Data fully disaggregated at transaction-level
  (e.g. £30.00 spent at Shell on 5 January 2020.)
- Repeated cross-section. Additional data follows cards over time.
- Observe (PQ), # visits. Imputing Q & max fuel tank capacity (L).

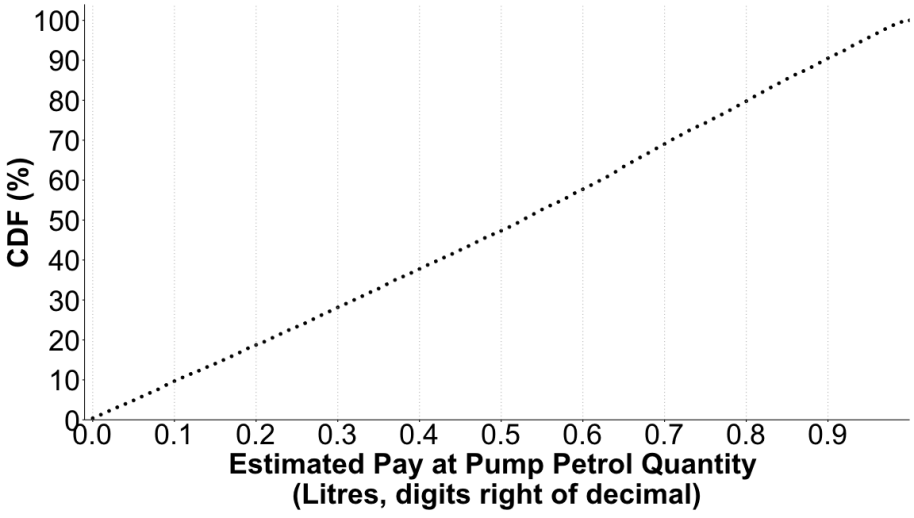
2. Petrol price data

- Daily (RAC Foundation) & weekly (BEIS) UK road fuel retail pump prices.

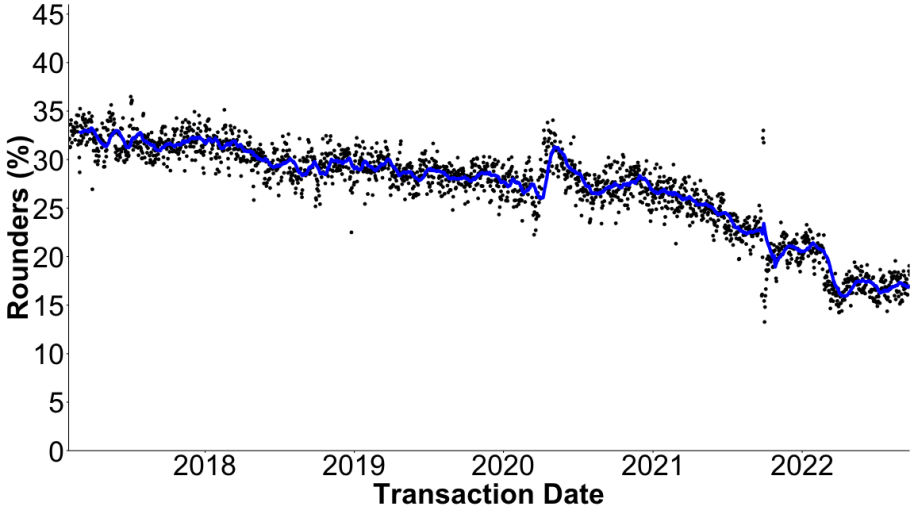
Consumers Don't Appear to Be Targeting Round Numbers of Quantity



Consumers Don't Appear to Be Targeting Round Numbers of Quantity - Linear in .XX



Round Number Expenditures (% Pay at Pump Expenditures) Over Time



Rounders is 7 day moving average.

Consumer Responses Estimated on Daily Balanced Panel

$$Y_{i,t} = \delta log(P_t) + \theta_i + u_{i,t} \quad (1)$$

	Heuristic	**Visits**	(PQ)	$\hat{Q}$
$log(P_t)$	-0.191***	0.009***	2.219***	-0.051
	(0.009)	(0.002)	(0.119)	(0.082)
Baseline Mean	0.169	0.054	2.343	1.678
Card F.E.	X	X	X	X
R^2	0.26	0.02	0.02	0.05

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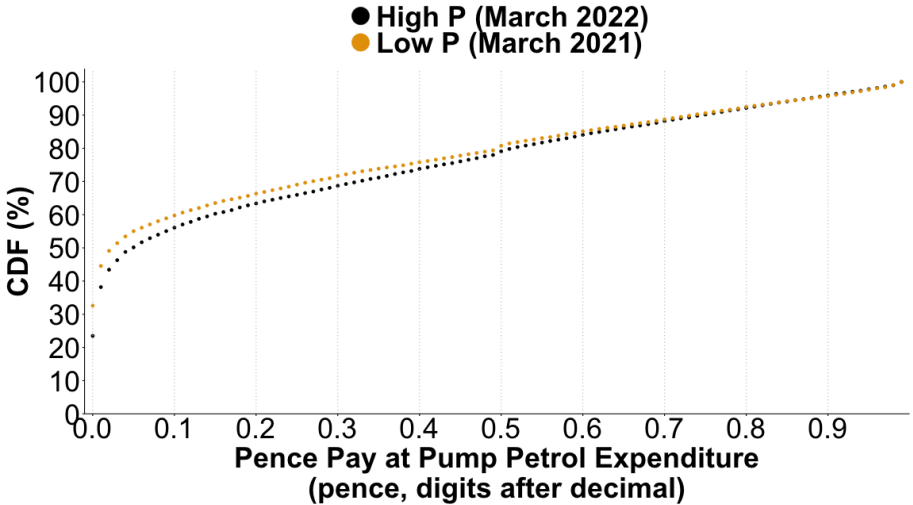
Heuristic estimated conditional on visit.

Low vs. High P Comparison
- Pence (.XX)



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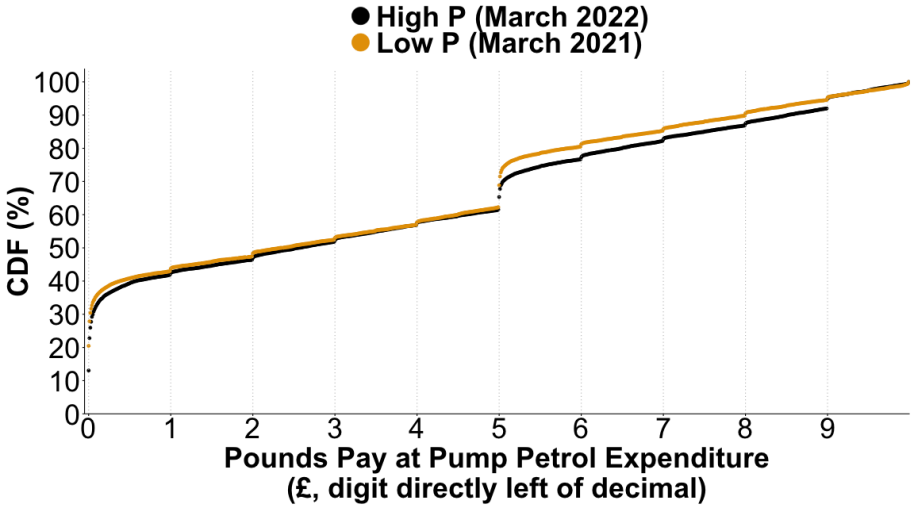

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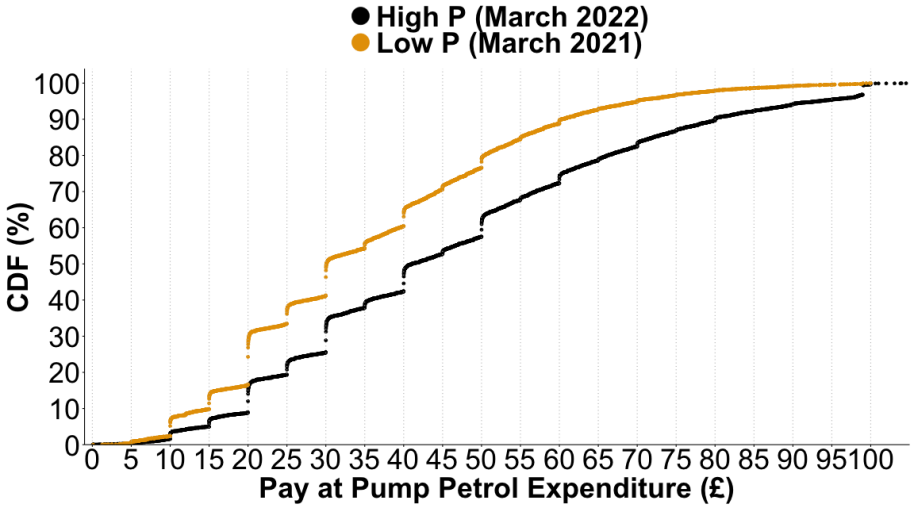
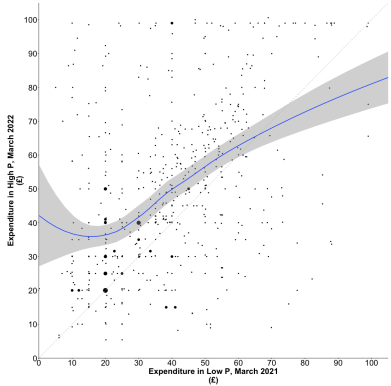


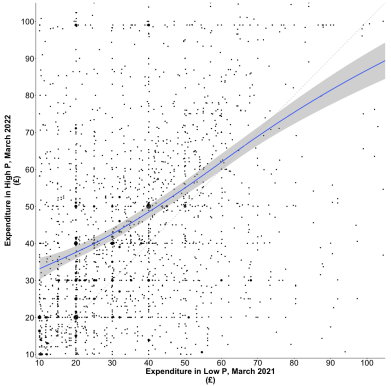
What (PQ) are consumers changing to? Within-person, 7-days 21 vs. 22

1. $P \uparrow \rightarrow Pr(H = 1) \downarrow$
2. $P \uparrow \rightarrow (PQ) \uparrow$ and if still choose round number is generally larger one.

NARROW: Pay at Pump



BROAD: Petrol Expenditures



ΔP from £1.25 (March 2021) to £1.65 (March 2022) per litre.