# When Trade Drives Markup Divergence: An Application to Auto Markets

Agnes Norris Keiller[1] Tim Obermeier[2]
Andreas Teichgräber[1] John Van Reenen[1]

[1]LSE [2]University of Leicester

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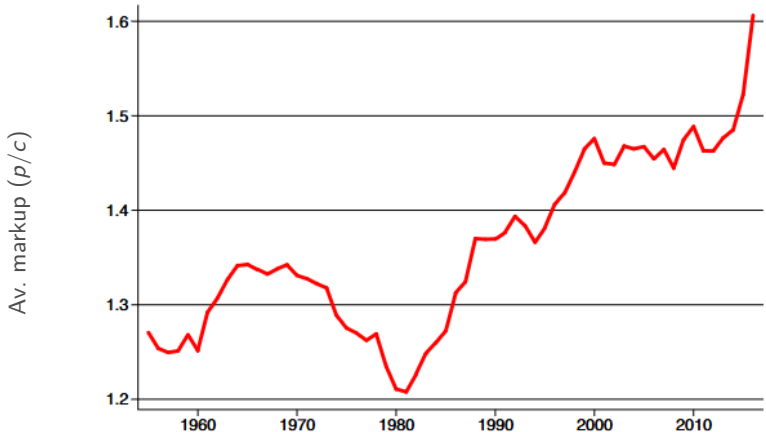
# How have markups evolved over time?

1. Common belief that aggregate market power has risen since early 1980s, (De Loecker et al., 2020)
    - Markups measured from estimating **production** function and using ratio of output elasticity wrt variable factor divided by the variable factor's share in revenue (De Loecker and Warzynski, 2012)

# De Loecker et al. (2020): US aggregate markups have risen since 1980 (production approach)



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   - **Demand** approach to markups produces different results from **production** approach (e.g., Grieco et al., 2024, on US cars)
3. **This Paper:** reconciles differences in markups using **trade patterns**. **Production approach** aggregates across **multiple foreign markets** served by firm with different markups, whereas **demand approach** typically only looks at **one domestic market**

# Production (supply)-side and demand-side markup estimates often differ

## Production-side approach

Data on output (usually including exports) & inputs

**Finding:** markups have **risen**

e.g. De Loecker et al. (2020)

## Demand-side approach

Prices, quantities, product characteristics of brands

**Finding: mixed, often falling**, industry-dependent

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**Why do they disagree?**

- Different data (Benkard et al. 2025; Durand & Jaoui 2023)
- Different assumptions
- **Potentially trade**

# Idea: trade can account for divergence in markup trends in UK car industry

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**What we do**

1. Note that **production based markups** are **revenue-weighted averages** across domestic & foreign markets
2. Estimate both **demand and production approaches** for UK cars, 1998–2018. Use firm-level and brand (market)-level panel data

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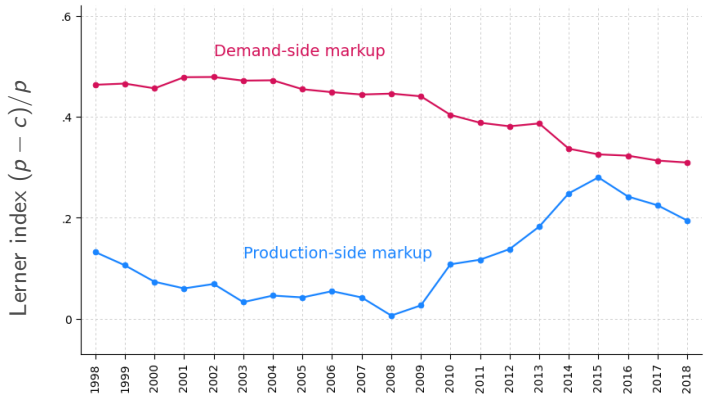
**What we find**

1. Find usual result that production based mark-ups trend up, while demand based markups trend down
2. Using trade data, argue that increasing sales to higher markup regions (e.g., JLR in China) accounts for this

# Idea: trade can account for divergence in markup trends in UK car industry




*We focus on markup trends, not levels.*

# Literature: production-, demand-side markups & car industry

1. **Supply-side markups**

   Hall (1988); De Loecker and Warzynski (2012); De Loecker et al. (2020); Bond et al. (2021); De Ridder et al. (2026); Benkard et al. (2025); De Loecker et al. (2025); CMA (2024)

2. **Demand-side markups**

   Berry et al. (1995); Grieco et al. (2024); Miller et al. (2023); Atalay et al. (2025); Döpper et al. (2025)

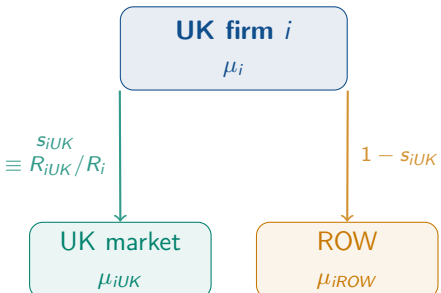
   $\rightarrow$ De Loecker & Scott (2022): divergence small in US brewing ($\sim$2% exported)

3. **Car industry and trade**

   Goldberg (1995); Verboven (1996); Goldberg and Verboven (2001); Berry et al. (1999); Lacetera and Sydnor (2015); Norris Keiller et al. (2026)

# 1 — Markup Aggregation

# Firm $i$'s markup $\mu_i$ = rev-weighted mean of market markups



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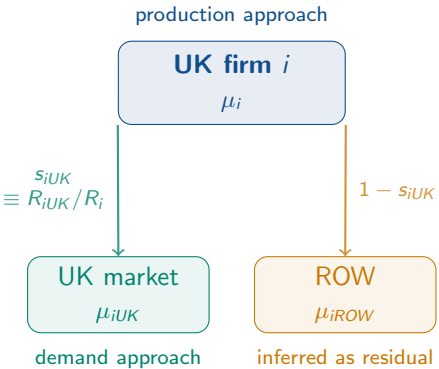


$$\mu_i = \frac{P_i - c_i}{P_i}$$

$$= \underbrace{s_{iUK}}_{\text{UK rev share}} \mu_{iUK} + \underbrace{(1 - s_{iUK})}_{\text{export rev share}} \mu_{iROW}$$

# 2 — Production-Side Markups ($\mu_i$)

# Cost minimisation identifies the production markup $\mu_i$

From **variable input first-order condition** (De Loecker and Warzynski, 2012):

$$\mu_{it} = \frac{\overbrace{\theta_{it}}^{\text{output elasticity of variable input}}}{\left( \underbrace{C_{it}}_{\text{variable input costs}} / \underbrace{R_{it}}_{\text{revenue}} \right)}$$

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With data from **Historical Orbis** firm accounts (1998–2018):

$$\hat{\mu}_{it} = \frac{\overbrace{\hat{\theta}_i}^{\approx 0.9 \text{ (production function estimates)}}}{(\text{material costs}_{it}/\text{revenue}_{it})}$$

▸ e ▸ t ▸ make

# 3 — Demand-Side Markups ($\mu_{iUK}$)

# Demand model, instrumented for prices

**Households** $i$ choose a car model $k$ or outside option to **maximise utility**:

$$U_{ikt} = \beta_{it} \underbrace{x_{kt}}_{\text{characteristics}} + \alpha_{it} \underbrace{p_{kt}}_{\text{price}} + \underbrace{\xi_{kt}}_{\text{unobs. quality}} + \epsilon_{ikt}$$

- **Data:** JATO vehicle characteristics & registrations, 1998–2018

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- **Data:** JATO vehicle characteristics & registrations, 1998–2018
- **Estimation:** Nested logit (Berry, 1994), robustness BLP (Berry et al., 1995)
- **Instruments:** aluminium×weight for price & nest-size; robustness BLP instruments
- **Price sensitivity estimates:** $\frac{\partial s_{kt}}{\partial p_{kt}}$

# IV raises estimated price sensitivity threefold

| Dep. var.: $\ln s_{kt} - \ln s_{0t}$ | (1) OLS | (2) IV |
|---|---|---|
| Price ('000£) | -0.033** | -0.087*** |
| | (0.013) | (0.005) |
| HP/W | -5.549* | 18.818*** |
| | (3.098) | (6.280) |
| In/Out Indicator | -0.374*** | -1.779*** |
| | (0.038) | (0.201) |
| Log(Share within nest) ($\lambda$) | 0.845*** | 0.196** |
| | (0.018) | (0.095) |
| Constant | -3.282*** | -7.001*** |
| | (0.371) | (1.128) |
| $R^2$ | 0.840 | 0.441 |
| Year FE | Yes | Yes |
| Brand FE | Yes | Yes |
| First Stage F | | 418, 83 |
| Observations | 5590 | 5590 |

Standard errors clustered at the model level

HP/W: horsepower to weight ratio

In/Out Indicator: 1 if model observed first or last time in data (entry/exit)

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

▸ estimating equation

# Bertrand–Nash pricing gives model-level markup formula

Under **static Bertrand–Nash competition**, markup of model $k \in \{1, \ldots, K\}$ is:

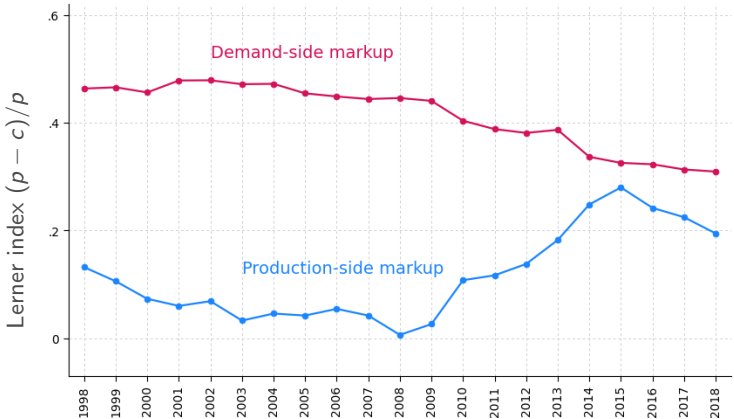
$$\mu_k = \underbrace{\frac{p_k - c_k}{p_k}}_{\text{Lerner markup}} = \frac{-\Big[\overbrace{\Omega(p)^{-1}_{K \times K}}^{\text{price derivatives}} \overbrace{s(p)_{K \times 1}}^{\text{market shares}}\Big]_k}{p_k}$$

⇒ Aggregate to **revenue-weighted average markup by year ($\mu_{iUK}$)**

▸ demand markups

# 4 — Reconciliation Through Trade ($\mu_{iROW}$)

# Production markup ↑; demand markup ↓



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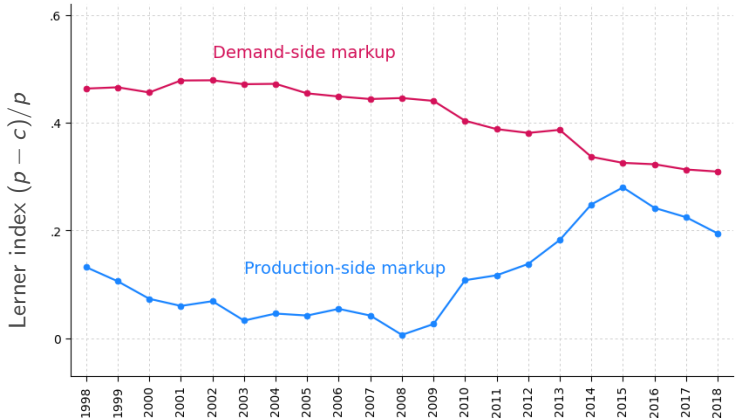
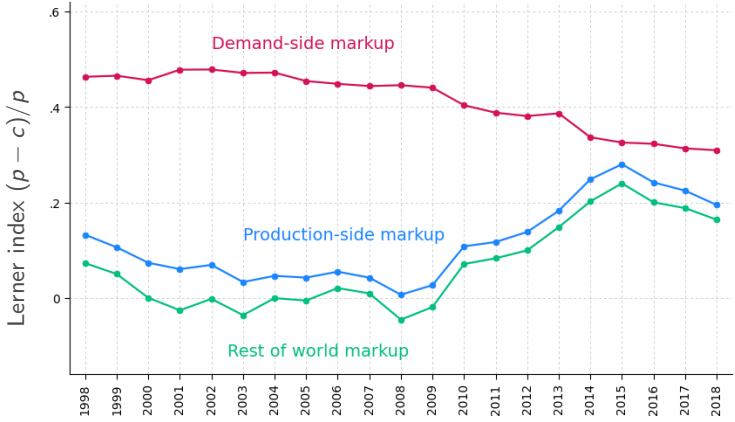



$$\hat{\mu}_i = \underbrace{s_{iUK}}_{\text{UK rev share } \sim 20\%} \hat{\mu}_{iUK} + \underbrace{(1 - s_{iUK})}_{\text{export rev share } \sim 80\%} \hat{\mu}_{iROW}$$

▸ UK revenue share

# Production markup ↑; demand markup ↓; ROW markup ↑

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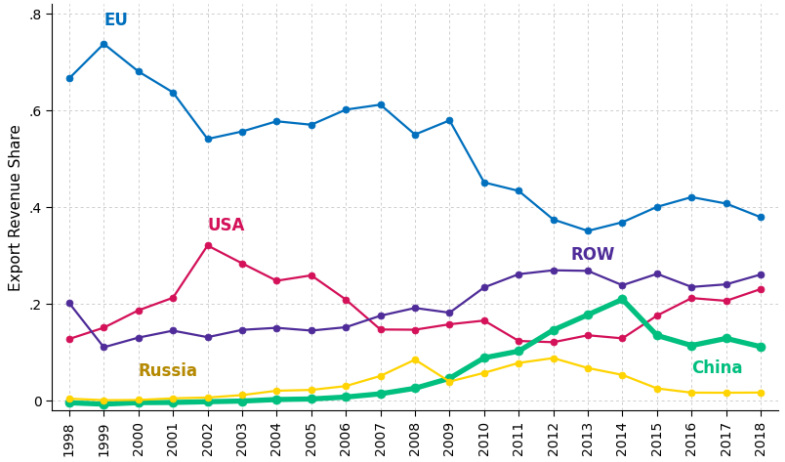
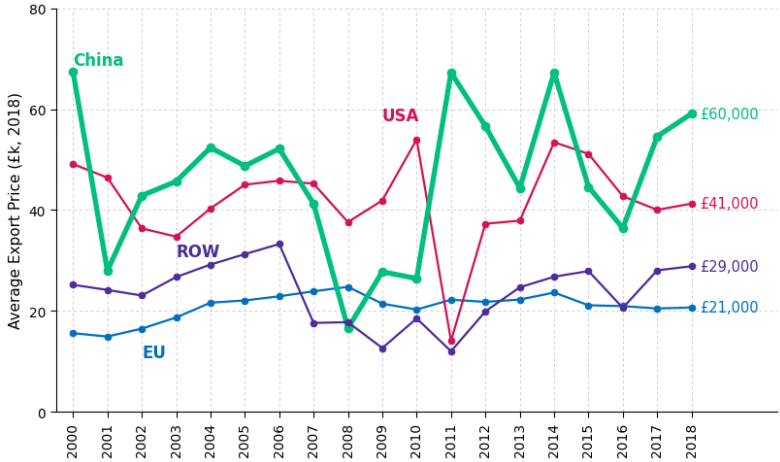
# Why $\hat{\mu}_{iROW} \uparrow$? China's share of UK car exports $\uparrow$ ...




Shares of total UK car export revenue by destination. Source: UN Comtrade

# . . . average export prices to China > prices elsewhere . . .




Average export unit values by destination. Source: UN Comtrade.

# . . . and firm-level markups rise with China export share.

$$\hat{\mu}_{it} = \beta_1 r_{itCN} + \beta_2 r_{itUS} + \beta_3 r_{itEU} + \beta_4 X_{it} + \eta_i + \tau_t + \epsilon_{it}$$

- $\hat{\mu}_{it}$: markup firm $i$ in year $t$ *(ABS)*
- $r_{itCN/US/EU}$: export revenue shares *(TIG)*

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| | |
|---|---|
| China revenue share | 0.329** |
| | (0.146) |
| US revenue share | 0.055 |
| | (0.136) |
| EU revenue share | -0.130 |
| | (0.099) |
| Ln(Exports) | 0.053*** |
| | (0.020) |
| Year dummies | Yes |
| Firm FEs | Yes |
| Exporter dummies | Yes |
| N obs. | 387 |
| N firms | 107 |

Standard errors clustered at firm level in parentheses.

Estimates weighted by revenue.

Revenue share: value of exports to destination / total revenue.

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

# 5 — Conclusion

# We show: trade drives markup divergence in UK car industry

## What we did

1. Production markup = revenue-weighted average across markets
2. Estimate **both approaches** for **UK cars, 1998–2018**

## What we found

1. Supply-side ↑; demand-side ↓
2. Reconciled by ↑ **export markups** (e.g., more sales of quality brands like Jaguar Land Rover to Chinese consumers)

**Main takeaway**

**Markup divergence** expected when firms **export** to **heterogeneous markets**.

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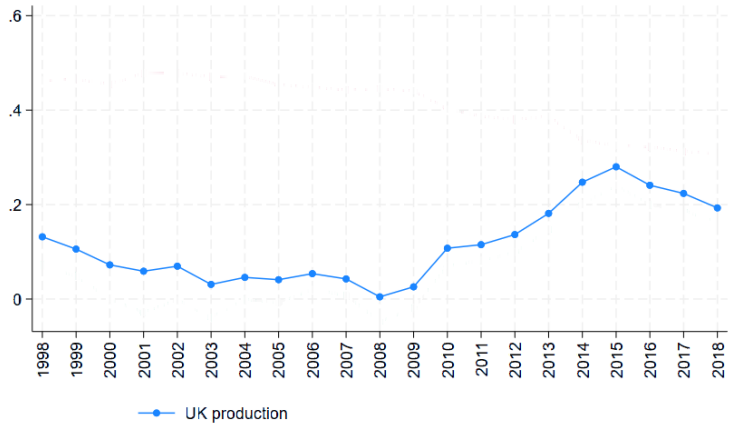
# Production function estimates

| | (1) OLS Levels | (2) OLS 1st diffs | (3) OLS FE Levels | (4) OLS Levels | (5) OP |
|---|---|---|---|---|---|
| Ln(Materials) | 0.893*** | 0.919*** | 0.899*** | 0.891*** | 0.915*** |
| | (0.052) | (0.076) | (0.062) | (0.053) | (0.046) |
| Ln(Wagebill) | 0.066 | 0.092* | 0.096** | 0.061 | 0.038*** |
| | (0.052) | (0.047) | (0.041) | (0.050) | (0.013) |
| Ln(Fixed Assets) | 0.072 | -0.029 | 0.075* | 0.085 | 0.054*** |
| | (0.046) | (0.029) | (0.038) | (0.048) | (0.006) |
| Year FEs | Yes | Yes | Yes | Yes | Yes |
| Firm FEs | No | No | Yes | No | No |
| N obs. | 169 | 158 | 169 | 160 | 160 |
| N firms | 10 | 10 | 10 | 10 | 10 |

back

# Production markups over time

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# Nested logit: estimating equation & price derivatives

**Estimating equation** (Berry, 1994):

$$\ln s_{kt} - \ln s_{0t} = x'_{kt}\beta + \alpha\, p_{kt} + \lambda \ln s_{k|g,t} + \xi_{kt}$$

**Price derivatives** (entering $\Omega_{K\times K}$):

$$\frac{\partial s_{kt}}{\partial p_{kt}} = s_{kt}\left[\frac{\alpha(1-\lambda s_{k|g,t})}{1-\lambda} - \alpha s_{kt}\right] \qquad \text{(own)}$$

$$\frac{\partial s_{jt}}{\partial p_{kt}} = -\alpha\, s_{jt}\left[\frac{\lambda\, s_{k|g,t}}{1-\lambda} + s_{kt}\right] \qquad j \neq k,\ j \in g \quad \text{(same nest)}$$

$$\frac{\partial s_{jt}}{\partial p_{kt}} = -\alpha\, s_{jt}\, s_{kt} \qquad j \notin g \quad \text{(different nest)}$$

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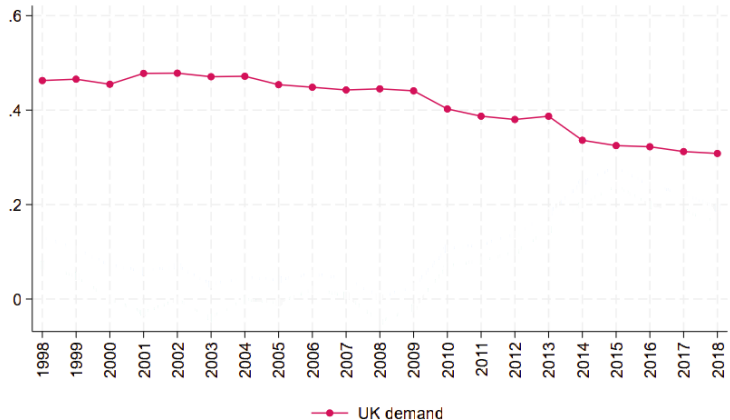
# Demand-side markups over time

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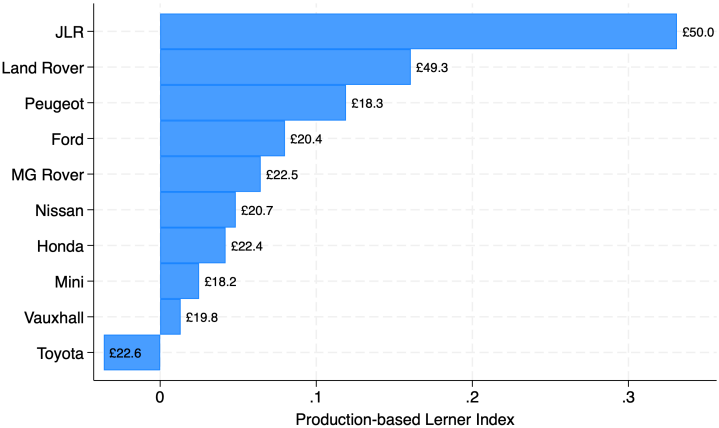
# Production markups by make - JLR dominates




Revenue-weighted mean production Lerner index by manufacturer, 1998–2018. Labels: average retail price in £'000.

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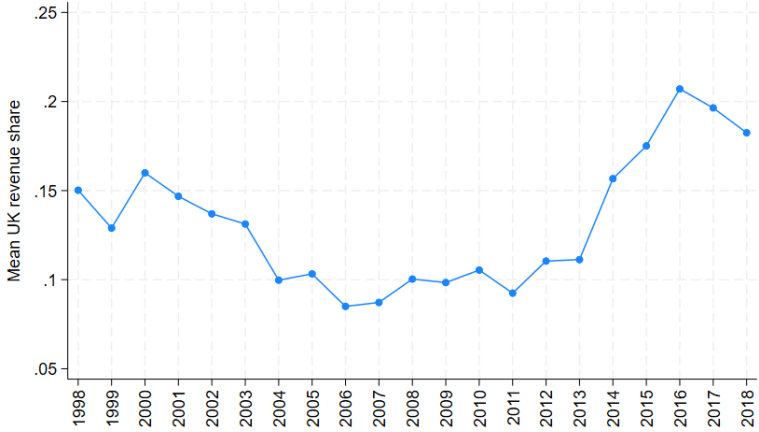
# UK revenue share over time




Share of UK revenue in total revenue of UK-based producers, 1998–2018

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