Product Entry in the Global Automobile Industry

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Research Question

- **Motivation**: In the global auto industry, firms offer evolving product portfolios across countries. National subsidies, like those in the U.S. Inflation Reduction Act, can distort competition by shifting consumer and producer outcomes globally. However, the role of product entry decisions in shaping these global effects is underexplored.
- **Research Question**: How do national subsidies affect firms' global product portfolios and market outcomes in the auto industry?

Data and Setting

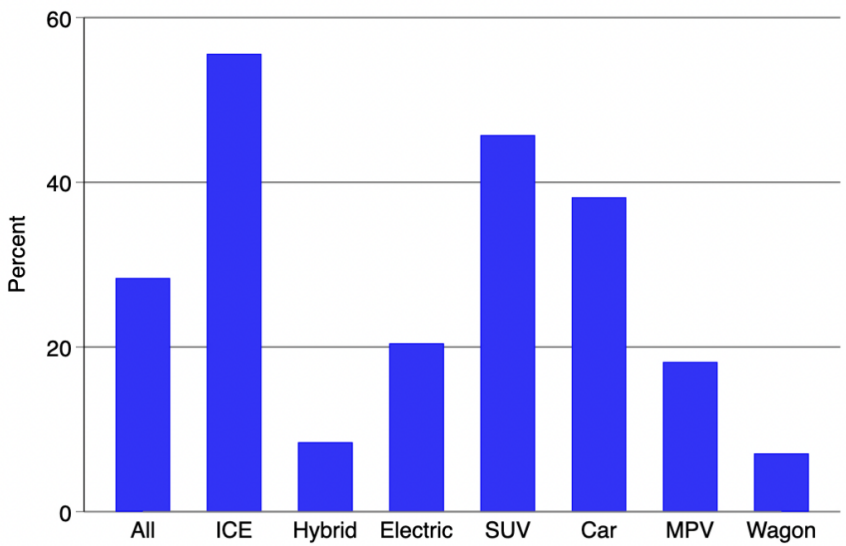
- **Data Source**: 2019 IHS Markit data on new passenger vehicle registrations in 12 countries (Australia, Brazil, China, France, Germany, India, Italy, Japan, Mexico, Spain, the United Kingdom, and the United States)
- **Variables**: prices, sales, product characteristics, product market shares, firm-level characteristics
- **Market Structure**: 49 firms, 130 brands, 1530 potential products

Data and Setting

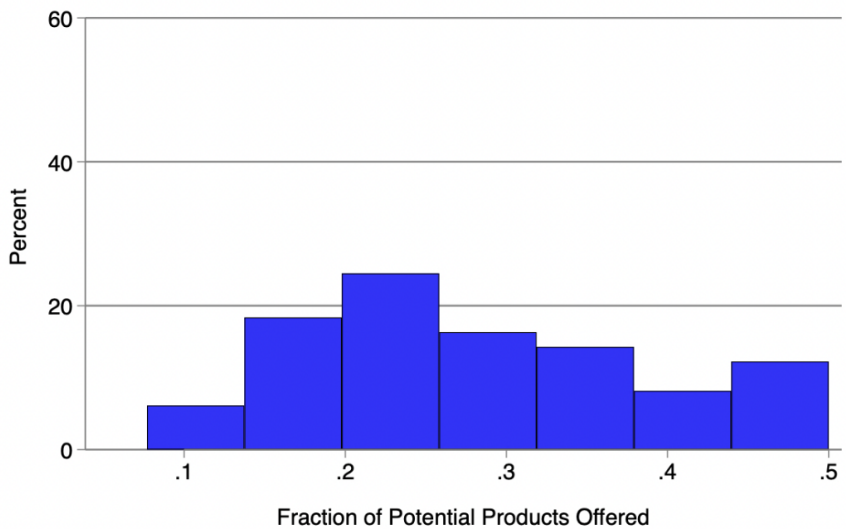
- Most firms offer a strict subset of potential products across all markets

Figure 1: Fraction of Potential Products Offered Globally

Panel A: Across Product Categories



Panel B: Across Firms



Data and Setting

- Many products are sold in a single market

Figure 2: Number of Markets Offered Conditional on Portfolio, by Body Type

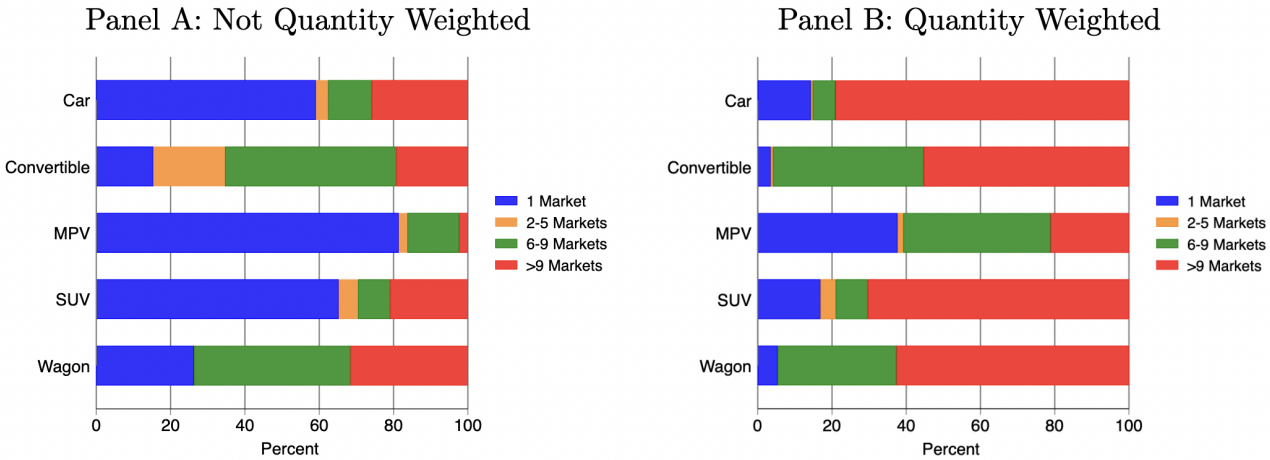
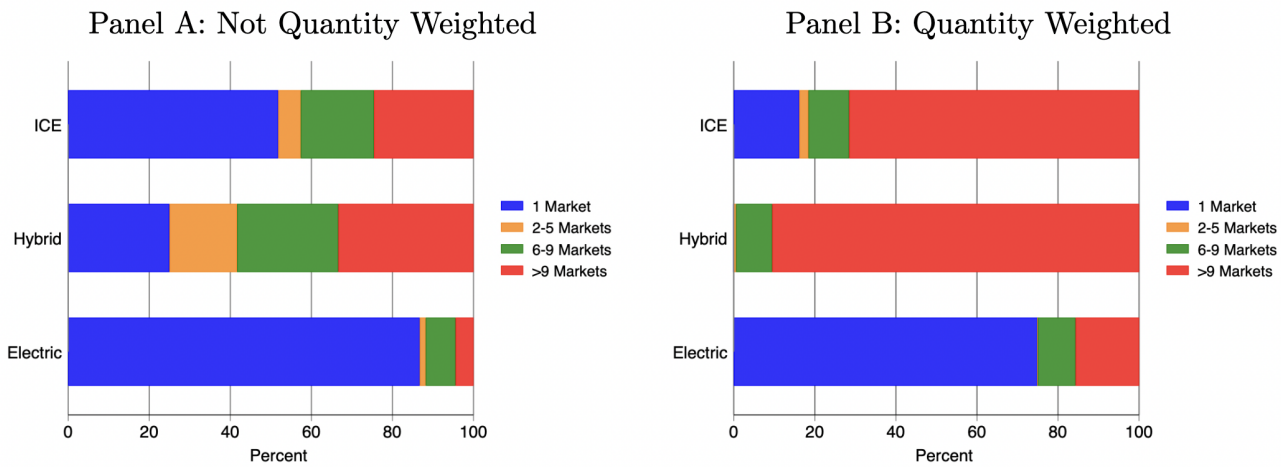


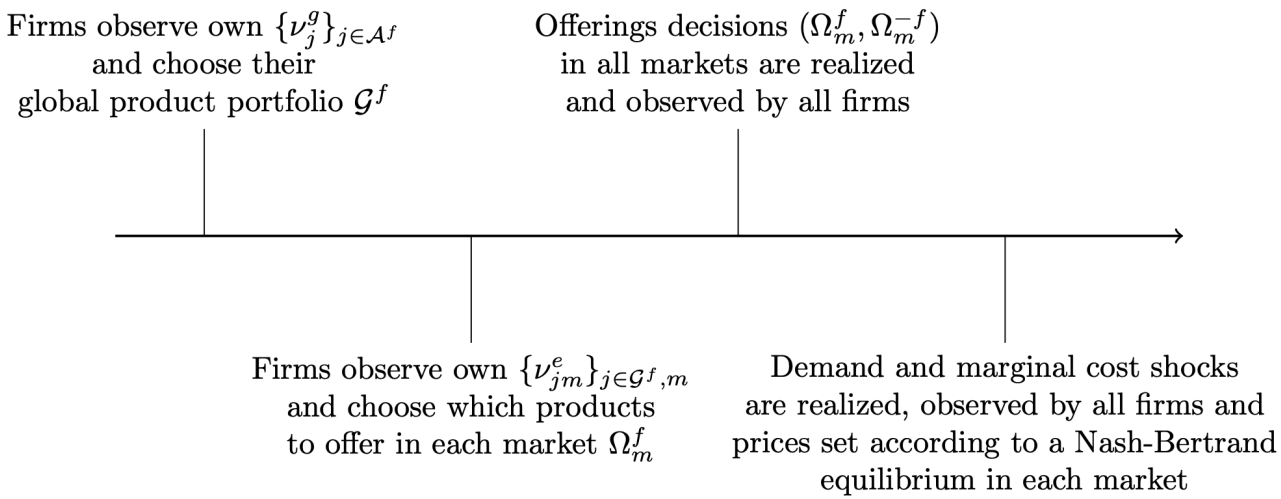
Figure 3: Number of Markets Offered Conditional on Portfolio, by Fuel Type



Model of Strategic Global Multi-Product Entry

- F firms compete in M markets

Figure 5: Timing of the Game



- Firms solve model by backward induction
- **Key Assumption:** Firms' fixed cost shocks are private information during product portfolio and market entry decision

Stage 3: Global market equilibrium

- Demand follows a BLP style mixed logit specification

$$\begin{aligned} U_{ijm} &= \beta_m + \beta_{b(j)} - \alpha_i p_{jm} + \beta^x \boldsymbol{X}_{jm} + \xi_{jm} + \varepsilon_{ijm} \\ &= \tilde{\delta}_{jm} - \alpha_i p_{jm} + \xi_{jm} + \varepsilon_{ijm}. \end{aligned}$$

- Marginal cost depends on attributes and distance to market

$$\begin{aligned} \log(c_{jm}) &= \gamma_m + \gamma_{b(j)} + \gamma_{fueltype(j)} + \gamma_1 \log(hp_j) + \gamma_2 \log(hpw_j) \\ &\quad + \gamma_3 \log(size_j) + \gamma_4 \log(dist_{jm}) + \omega_{jm} \\ &= \tilde{c}_{jm} + \omega_{jm} \end{aligned}$$

- Firms choose prices to maximize variable profits

$$\Pi_m^{f,3} = \sum_{j \in \Omega_m^f} (p_{jm} - c_{jm}) M_m s_{jm}(\Omega_m^f, \Omega_m^{-f}, \boldsymbol{p}_m^f, \boldsymbol{p}_m^{-f}, \boldsymbol{\xi}_m)$$

Stage 2: Market Entry Decision

- Global product portfolios have been chosen and market entry fixed cost shocks are (privately) realized
- Firms choose market offerings to maximize expected profits based on their own private fixed cost shock and a common information set
- Critically firms do not observe rivals' fixed cost shocks or global product portfolios (but they know fixed cost shock distribution)

Stage 1: Global Portfolio Decision

- Firms realize product portfolio fixed cost shocks
- Firms choose products in portfolio to maximize expected profits
- Firms incorporate expectations about their own and rival fixed cost shocks, ex-post demand and marginal cost shocks, and equilibrium strategies

Key Tradeoff of Offering Product in Market

Definition 1 *The marginal value of introducing product j in market m at market structure Ω_m under demand and marginal cost shocks $(\boldsymbol{\xi}_m, \boldsymbol{\omega}_m)$ is given by,*

$$MV_{jm}(\Omega_m^f, \Omega_m^{-f}; \boldsymbol{\xi}_m, \boldsymbol{\omega}_m) := \underbrace{\pi^*_{jm}(\Omega_m^f, \Omega_m^{-f}, \boldsymbol{\xi}_m, \boldsymbol{\omega}_m)}_{\text{variable profits from } j \text{ in } m} + \underbrace{\sum_{j' \neq j, j' \in \Omega_m^f} \left[\pi^*_{j'm}(\Omega_m^f, \Omega_m^{-f}, \boldsymbol{\xi}_m, \boldsymbol{\omega}_m) - \pi^*_{j'm}(\Omega_m^f \setminus \{j\}, \Omega_m^{-f}, \boldsymbol{\xi}_m, \boldsymbol{\omega}_m)\right]}_{\text{cannibalization: change in variable profits for other products when } j \text{ is offered}}. \tag{6}$$

- Firms balance between earning new profits on a product with reduced demand for their other products
- Submodularity assumption imposes that marginal value decreases with number of products offered

(Very Brief) Estimation Strategy Summary

- Computationally infeasible to fully solve model (more than 10^{60} possible entry configuations!)
- Uniqueness of pure strategy Nash equilibrium not guaranteed
- Partially identify fixed cost parameters via moment inequality estimation

Key Insight: Firms' choice probabilities can be bounded by considering the extreme cases of:

1. offering a single product in a market
2. offering all products in portfolio simultaneously

Intuition of Probability Bounds

- Submodularity assures marginal value of offering product j in market m is maximized when offering a single product (competition is minimized)
- Cannibalization is highest when offering all products in a firms' global portfolio (competition is highest)
- In the solution algorithm, inequalities can be iteratively tightened by expecting that rival firms have similarly derived bounded product offering probabilities
- Similar logic applies to choosing global portfolio in Stage 1

$\Longrightarrow$ Derive moment inequalities that only depend on observed data and estimated parameters

Estimation Results

Table 1: Stage 3 Parameter Estimates

	Parameter estimate	Standard error
Demand		
Mean parameters		
price (α_0)	2.88	0.690
home market	1.01	0.153
horsepower (log)	5.00	2.46
horsepower/weight (log)	-2.19	1.44
Non-linear parameters (price coefficient)		
Income (α_1)	-0.790	0.117
China	-1.51	0.297
Shock Std (σ^y)	0.809	0.131
Marginal Costs (log)		
electric	0.340	0.051
hybrid	0.272	0.030
horsepower/weight (log)	-0.426	0.111
horsepower (log)	1.00	0.112
size (log)	0.251	0.209
distance to brand HQ (log)	0.062	0.007
Observations	1,414	
Mean Share-Weighted Implied Own Price Elasticity	-8.41	
Percent Implied Negative Marginal Costs	0	

Notes: The demand specification includes body-type and electric-hybrid dummies interacted with market dummies. It also includes size interacted with market dummies. Both specifications include brand and market fixed effects. Standard errors are clustered at the brand level.

Estimation Results

- Demand Estimates: High own price elasticity and a strong home bias ($>$ \$1,500 premium for local brands)
- Marginal Cost Estimates: More costly to supply an electric vehicle, more costly to supply markets distant from the brand's headquarters country (1% increase in distance raises the marginal cost by around 0.06%)
- Fixed Cost Estimates: Large scale economies; product line costs \$138–548M, market-entry costs \$8–15M

US Policy Analysis

- The effects of national policies favoring domestic brands on global market outcomes
- Two Policy Simulations:
  - 20% production subsidy on American brands: Boost American brands' global market share and profits, especially in the UK; reduce the profits and market shares for non-American brands
  - 50% consumption subsidy on American brands: Large welfare gains in the US (+42%), shifts market shares and profits towards US brands; limited global impact
- Key Insight: Product portfolio adjustments are crucial - product entry accounts for over 25% of US-brand market shares increase; ignoring these adjustments leads to underestimating the rise in US brand shares and profits & consumer surplus

What we like

- Novel method to estimate and solve multi-product entry games with asymmetric firms under incomplete information

- Most domestic policies are designed without accounting for international spillovers. It's interesting to see the magnitude and mechanisms behind these spillover effects.

- The strategy to bound global portfolio and market entry probabilities is very clever and satisfying

What we dislike

- Would prefer a more comprehensive welfare analysis of counterfactual policies, considering cost of policies, environmental externalities etc.

- Model relies on assumptions like submodularity and unobservability of rival fixed cost shocks that I could imagine counterexamples to

- Why choose data in 2019? It seems like China is so different with other countries due to its aggressive subsidy policy this year. Is it possible to use more data or construct a panel so that we could see the time trend? (e.g. I think the central and local subsidies for EVs in China was cut in mid-2019)

Discussion

- Is it possible to incorporate the government cost of these national policies when doing policy analysis? Maybe add a cost-benefit analysis?
- What if we consider the R&D decision of firms and construct a dynamic model of strategic global multi-product entry? What is your guess for the similarities and differences for the results?
- How credible is the key assumption that rival fixed cost shocks are unobserved?
- Competition in the global car market is a repeated game. What do we miss out on by ignoring dynamic strategies?
- Based on the papers' model, how do you think the recent tariffs will affect firms' global portfolios, market entry, and equilibrium outcomes?