



Vertical integration, foreclosure and learning-by-doing: evidence from the Chinese electric vehicle and power battery industries



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Abstract

This paper studies the competitive and welfare effects of the vertical integration and foreclosure strategy employed by BYD, the leading Chinese manufacturer in successive oligopoly markets of power batteries and electric vehicles (EV). Our findings reveal that integration generates procompetitive effects by eliminating double marginalization, while foreclosure generates both anti-competitive effects by raising BYD rivals' input prices and efficiency effects by switching battery outputs to firms with less experience while diminishing returns exist in the learning-by-doing process. The counterfactual analysis suggests that BYD would have yielded even higher profits if it had not applied the foreclosure strategy, and consumer welfare would have been higher as well. The study highlights the importance of considering learning-by-doing in assessing the efficiency of vertical integration and foreclosure.

Introduction

This paper investigates the competitive effects of vertical integration and foreclosure strategies in the context of the Chinese electric vehicle (EV) and power battery markets in the presence of learning-by-doing in battery production. Vertical integration and foreclosure have not been informed by much empirical analysis because of limited essential industry data, and especially transaction data between upstream and downstream firms (Martin et al., 2001). To overcome these limitations, we use the relationship between EV manufacturers' market shares and equipped batteries, as well as observed consumer EV choices, to infer the values consumers place on batteries.

We provide preliminary evidence of the equilibrium and welfare effects of leading battery and EV manufacturer BYD's vertical integration and foreclosure by running regressions of EV sales and a hedonic EV price model. However, these preliminary analyses cannot disentangle the effects of vertical integration from foreclosure since BYD's comparative advantage in costs and prices could have come from both sources. Therefore, we apply a structural model and counterfactual analysis to break down these two effects.

More importantly, the structural model is used to investigate the crucial role of learning-by-doing in assessing the effects of vertical integration and foreclosure. The learning-by-doing of the upstream foreclosing firm can be slowed down due to reduced sales, which may be picked up by the upstream competitors. Consequently, upstream foreclosing firms will lose its cost advantage gradually, which makes foreclosure less appealing in the long run. This paper intends to provide rare empirical evidence of the learning-by-doing effects on the equilibrium and welfare analysis of vertical integration and foreclosure.

Moreover, factors driving the aggregate demand, such as EV purchase subsidy, could further amplify the welfare effects of vertical integration and foreclosure, since they can significantly stimulate sales and so expand the welfare effects through learning-by-doing.

Methods and Materials

The methodology employs a structural model that captures the interplay between consumer choices, manufacturer pricing strategies, and the vertical relationships between battery suppliers and EV manufacturers. Key components of the model include:

- Consumer Choice Model: This model estimates consumer preferences for different EVs based on their characteristics, allowing for the calculation of demand for each vehicle model. The consumer utility is derived from various attributes such as price, range, and battery performance.
- Price Competition: Following the method proposed by Villas-Boas (2007), our model incorporates competitive pricing strategies among manufacturers in both the EV and battery markets, reflecting how firms respond to changes in market conditions and strategies employed by competitors.
- Learning-by-Doing Effects: A crucial aspect of the model is the incorporation of learning-by-doing, which reflects the cost efficiencies gained through accumulated experience in battery production. This factor plays a significant role in determining the cost structure of manufacturers over time.

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Results

Our empirical findings suggest that BYD's vertical integration generates efficiency effects by eliminating the double marginalization, while its foreclosure strategy generates both exclusion effects and efficiency effects, whose magnitude depends on learning-by-doing status. In the presence of learning-by-doing, foreclosure raises BYD's costs because its learning-by-doing process slows down. More importantly, foreclosure also raises its rivals' costs because EV manufacturers have to switch to high-cost suppliers when BYD excludes them from access to its batteries. This is the exclusion effect of foreclosure. However, since most EV manufacturers switch from BYD to other battery suppliers---whose cumulative experience is lower and so their marginal returns of experience to cost reduction are higher---average market battery costs decrease at a higher rate than in the scenarios of no foreclosure (Chart 1). This is the efficiency effect of foreclosure. Our empirical results suggest that exclusion effects dominate efficiency effects, and so foreclosure raises the costs of batteries and Evs (Fig 1). The increased EV production costs are passed through to the consumers (Fig 2) and result in a loss of consumer surplus by RMB 3.55 billion over the sample period of 2016-2019.

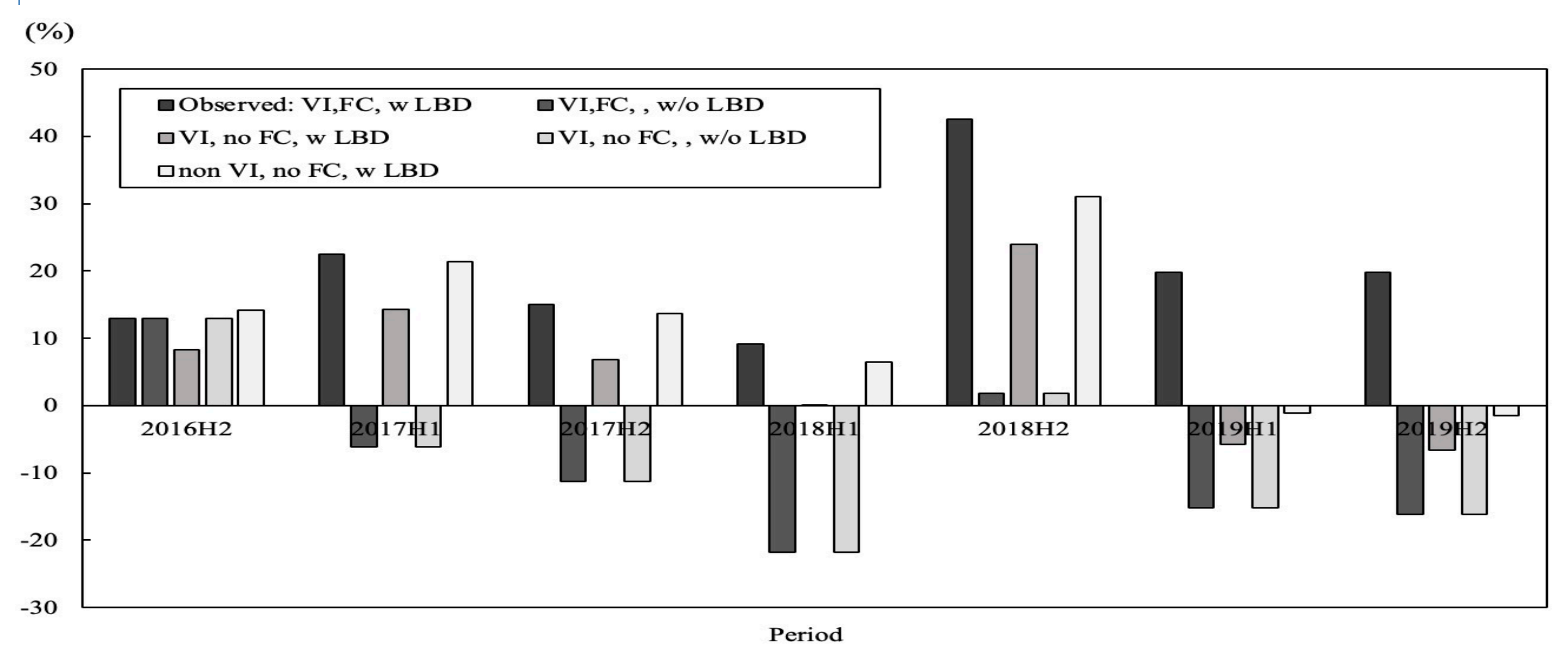


Chart 1. Difference in the marginal costs of batteries (per Wh) between BYD and CATL relative to CATL costs (%).

Discussion

The inception stage of these high-tech industries makes learning-by-doing a salient feature in assessment of the competitive effects of vertical integration and foreclosure. Previous research (e.g., Crawford et al., 2018; Suzuki, 2009; Hortaçsu and Syverson, 2007) has studied well-established markets. In these industries, the efficiency of vertical integration mainly comes from the elimination of double marginalization. In our study, another source of efficiency gain stems from learning-by-doing, which could significantly influence the impact of vertical integration and foreclosure.

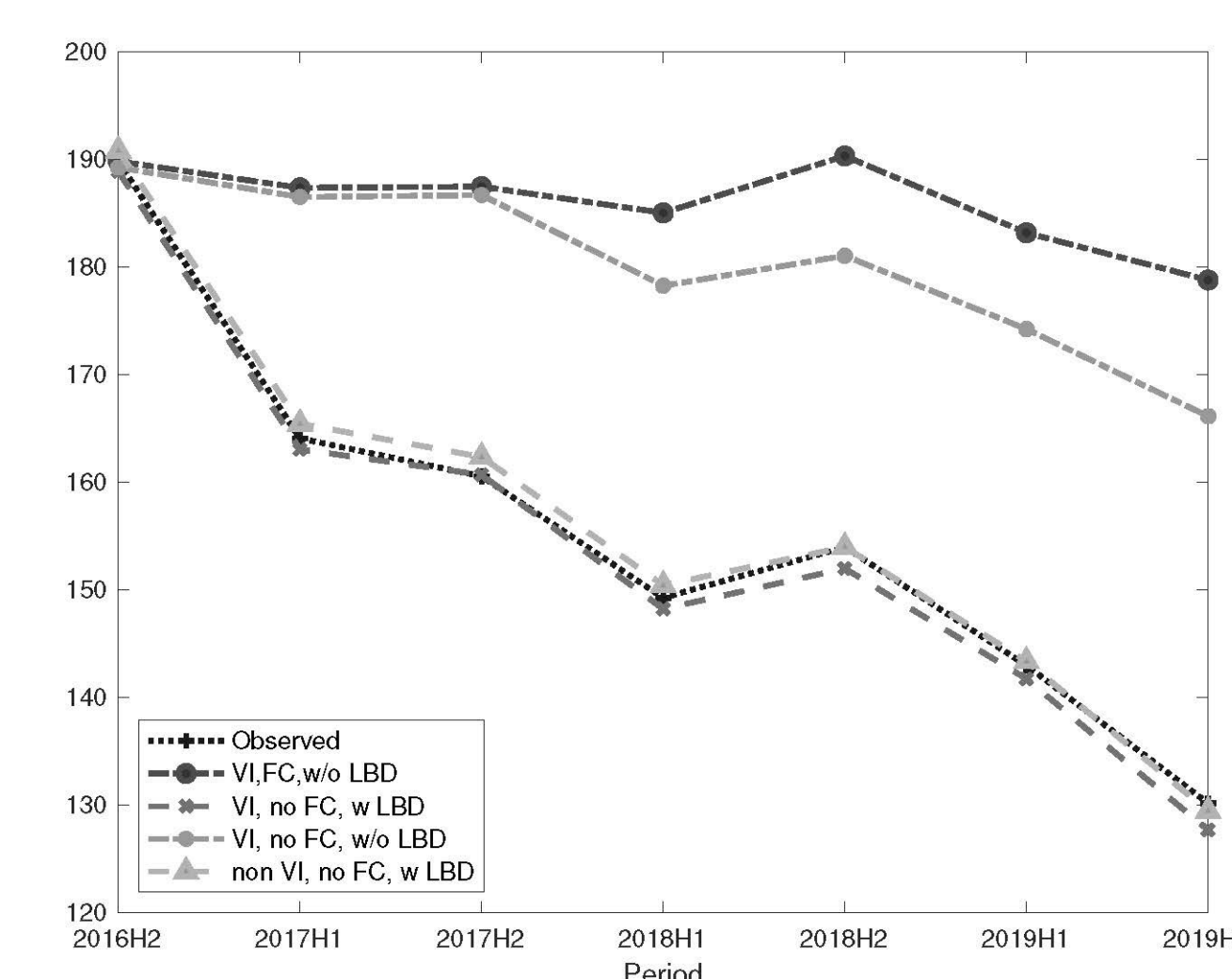


Figure 1. Marginal Costs of Evs over Time.

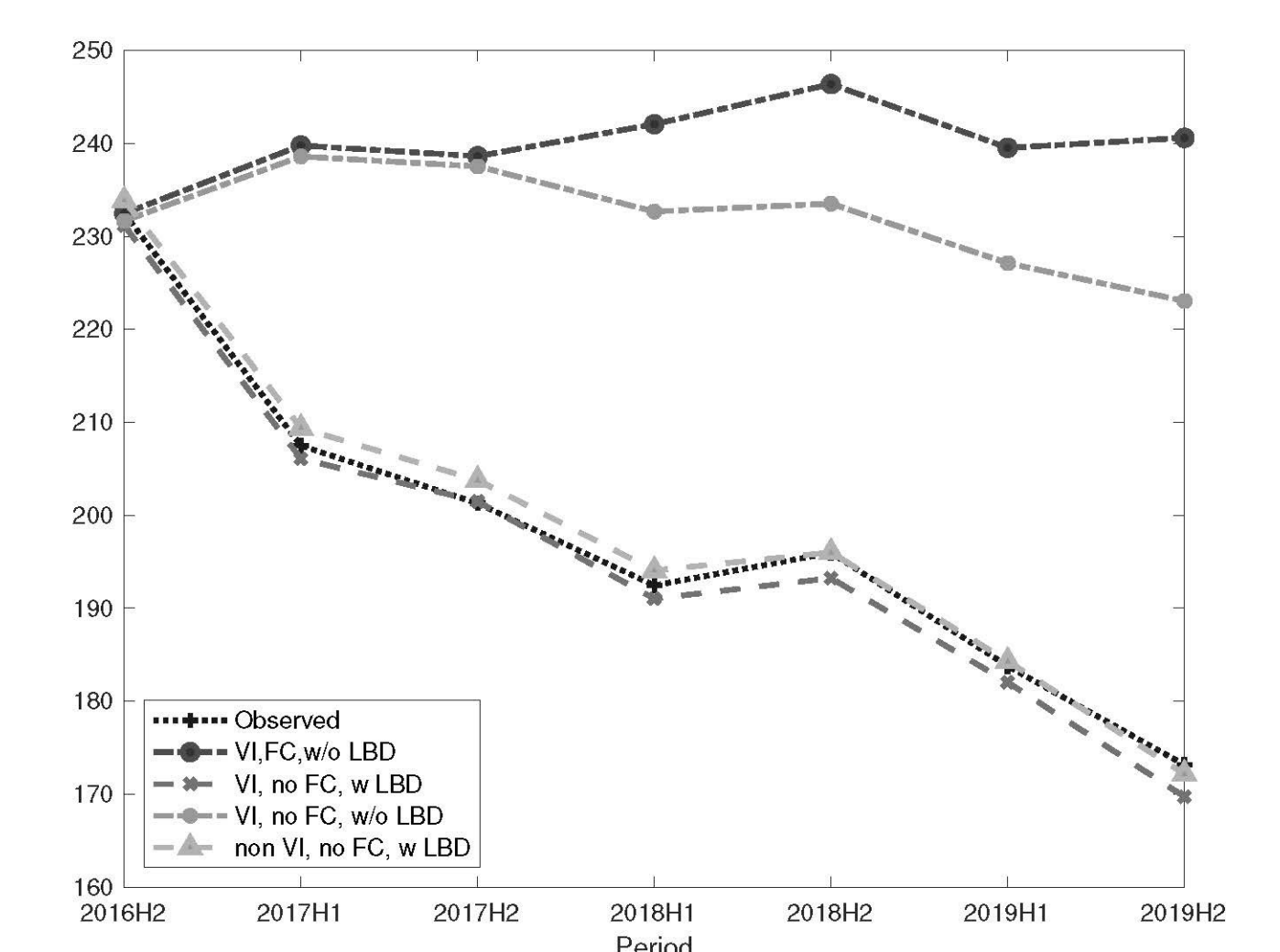


Figure 2. Prices of Evs over Time.

Conclusions

Counterfactual analysis suggests that if BYD had not applied the foreclosure strategy, it could have achieved even higher profits and consumer welfare could have been higher as well. This highlights the potential drawbacks of anti-competitive practices such as raising rivals' costs. It is crucial that policymakers in the industry consider the long-term implications of such strategies and strive to create a more competitive and efficient market that benefits both consumers and the industry as a whole.

References

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