Multi-Market Contact in International Trade; Evidence from U.S. Battery Exporters*

James R. Boohaker†

November 17, 2018

Abstract

When competitors compete in more than one market they are said to have multi-market contact (MMC). Firms with MMC are more likely collude to avoid cross-market retaliation. This paper investigates the impact of MMC among U.S. battery exporters on the prices they set in foreign markets using confidential export transaction data provided by the U.S. Census Bureau. The ability of firms to exploit MMC for collusive gain in international markets can be both detrimental to import-dependent consumers and harder for anti-trust authorities to detect. Motivated by litigation finding evidence of collusive behavior by multi-national battery manufacturers, MMC has an upward effect on export prices set by U.S. battery exporters. However, MMC can have pro-competitive effects in certain situations. These results are robust across different panel regression specifications using different measures of MMC.

JEL Classification: D43, F12, F13, F14, L13, L14, L40, L63
Keywords: multi-market contact, oligopoly, export prices, collusion

**Any opinions and conclusions expressed herein are those of the author and do not necessarily represent the views of the US Census Bureau. All results have been reviewed to ensure that no confidential information is disclosed. I thank my dissertation committee members: Robert Feinberg, Nathan Larson and Alan Isaac. In addition, I would like to thank Fariha Kamal, Emek Basker, Emin Dinlersoz and Mary Hansen for valuable advice and counsel; Shawn Klimek for his guidance and direction in finding materials needed to complete this research. I also thank Michael Freiman for timely disclosure avoidance assistance. All mistakes and omissions are my own.

†Department of Economics at American University: jb2037a@student.american.edu

1 Introduction

In *Hanlon vs. LG Chem*, battery purchasers accused 27 lithium-ion battery (LIB) producers of engaging in a "textbook price-fixing cartel" in the United States and elsewhere (*Hanlon vs. LG Chem* (2017)). The first complaint was filed in late 2012 and the case took five years to come to a verdict. The plaintiffs alleged that manufacturers secretly met to coordinate prices and allocate markets. Most of the defendants pled guilty and paid the plaintiffs over $64 million in damages.

Most interestingly, these manufacturers were able to "enforce adherence" to the collusive agreements in place (*Hanlon vs. LG Chem* (2017)).[1] Motivated by a different collusion case involving multi-national vitamin manufacturers, Choi and Gerlach (2012) theorize that cartels are more likely to succeed if members can coordinate pricing strategies across international markets. Zhou (2016) finds empirical support for this theory by first observing that a majority of cartel members prosecuted by the European Comission (EC) met in multiple markets and then finding that anti-trust regulation in one market decreased the probability of joining the cartel in different markets. Understanding the antecedents of collusive behavior in international markets is an important step to preventing global markets from exploiting consumers.

When the same set of firms competes in multiple markets, they are said to have multi-market contact (MMC).[2] One result of MMC could be an increased willingness to operate at a collusive equilibrium in order to avoid cross market retaliation. Edwards (1955) first posited this theory of "mutual forbearance" (MF). This paper examines the effect of MMC on firm export pricing strategies using transaction level trade data collected by the U.S. Census Bureau. I focus on U.S. battery exporters where collusive behavior by certain types

[1] It is unclear how cartel members policed each other as the publicly released court documents are heavily redacted. See *In re Lithium Ion Batteries Antitrust Litig., No. 413MD02420YGRDMR (N.D. Cal. Mar. 20, 2017), appeal dismissed sub nom.*

[2] Examples of this include two airlines offering trips on two or more routes, two cement firms owning production facilities in different regional markets, or a single set of competitors exporting a product to the same countries.

of battery producers (e.g. LIB manufacturers) has been well documented. Using conclusions from a EC analysis on identifying appropriate battery markets, I define markets as country-HS pairs (Council of European Union (2009)).[3]

A mutual forbearance outcome can arise from MMC by formalizing two-firm/two-market oligopoly competition models where the optimal response for a competitor would result in actions taken in multiple markets (Bernheim and Whinston (1990), Thomas and Willig (2006)). The general framework asserts that firms may be wary of competing aggressively against competitors they face in many markets to avoid potentially complex punishment schemes after deviating from the cooperative equilibrium. For instance, if two firms compete in two markets, then a deviation from the collusive strategy could lead to retaliation in both markets. If those markets are asymmetric then it is more likely that colluding will reap more lifetime profit than a short-term gain from undercutting their competitor.[4]

The effects of MMC have been most studied in the empirical industrial organization literature.[5] Most work corroborates the MF hypothesis, but few address MMC outside of nationally defined markets. One exception is Tieying et al. (2009), who finds that MMC decreases the likelihood of competitive action by firms in individual export markets.[6] Additionally, Alcantara and Mitsuhashi (2015) show that MMC among Japanese auto-parts exporters tend to dampens these firms' FDI in foreign countries. Finally, Feinberg (2015) uses bilateral country and product level U.N. Comtrade (UNCTD) data to show that MMC among prominent exporting countries in the fats and oils trade has a significant and positive relationship on country level export prices.

While these papers have suggested that mutual forbearance arising from MMC potentially exists in international trade, they have not definitively explored the result using firm-level

[3]HS stands for "Harmonized System" and is used by governments to classify products in customs records.

[4]Bernheim and Whinston (1990) shows that 2 firms competing in identical markets replicates the single market outcome.

[5]For some notable studies that look at the impact of MMC on price, see Feinberg (1985), Evans and Kessides (1994), Jans and Rosenbaum (1997), Parker and Röller (1997), Feinberg (2014) and Ciliberto and Williams (2014). See Yu and Cannella (2013) for a survey of the literature.

[6]In their paper, competitive action was determined through text analysis of automotive news articles.

price setting strategies in foreign markets. In addition, I implement different measures of MMC to assess the robustness of the relationship. Overall, I find that firms charge higher prices in markets where they have MMC. More specifically, a one standard deviation increase in a firm's MMC in a market corresponds to roughly a 1% increase in the price it sets in that market. These results are consistent with those highlighted in other empirical studies (Ciliberto and Williams (2014), Feinberg (2015), Evans and Kessides (1994)). However, upon disentangling MMC to highlight contacts within country (but across different product lines) and within product (but across different countries), I find that the former significantly and negatively effects price, while the latter has the anticipated positive effect. This provides further evidence of the mutual forbearance hypothesis, although there could be circumstances where MMC could translate to more competitive effects.[7]

Section 2 motivates the susceptibility of the battery industry to MF from MMC (*Hanlon vs. LG Chem* (2017), Council of European Union (2009)) using market research on the U.S. battery industry and export activity. Section 3 introduces the data and describes steps taken to identify the correct sample of battery competitors and define market boundaries. Section 4 describes the empirical specification and addresses estimation issues related to the effects of external competition stemming from foreign countries. Section 5 shows the main results in addition to some key robustness checks. Finally, Section 6 concludes with some suggestions for future research.

2 The Global Battery Industry

In the average year from 1997-2013, Tables 1 and 2 indicates there is roughly 350 manufacturing firms that export a battery and around 1,875 non-manufacturing firms that export a battery, respectively.[8] According to publicly available information from the Economic

[7]Arie et al. (2017) asserts that if a firm's investment is transferable across markets then MMC could have competitive effects.

[8]I define manufacturers as a firm owning at least one manufacturing establishment. See Section 3 for more information.

Census, there are roughly 200 establishments that have battery production as their primary activity in 2012. Original equipment manufacturers (OEMs), for instance computer and automobile manufacturers, are typical consumers for battery suppliers (Hoover's (2017)). However, these same OEMs can also turn against their battery suppliers and behave competitively in the battery market (IBISWorld (2017)). For instance, Daimler, a German car manufacturer, opened 5 battery manufacturing plants in Asia, Europe and North America.[9] Non-manufacturing exporters are typically wholesalers or retailers that largely participate in battery aftermarkets.[10] It is common for even medium-sized battery suppliers to own subsidiaries abroad (IBISWorld (2017)), meaning that many foreign owned battery firms are likely to have subsidiaries exporting from the U.S.

Figure 1 shows U.S. export trends for rechargeable and non-rechargeable batteries from 1992 - 2016 from the UN Comtrade Database. Interestingly, In 2000, around the same time collusive activities allegedly started between battery suppliers, there was a precipitous drop in U.S. battery exports, but this could also be attributed to the recession in the early 2000s. U.S. exports in non-rechargeable batteries is small in comparison and has remained relatively steady from 1992-2016. This is consistent with market research indicating that battery manufacturers are more focusing on non-rechargeable battery production (IBISWorld (2017)). Furthermore, according to Figure 2, U.S. battery exports reach a wide range of different countries from year-to-year.

[9] See https://media.daimler.com/marsMediaSite/en/instance/ko/Under-the-microscope-Battery-production-Daimler-to-build-global-production-compound-for-batteries.xhtml?oid=29798176.

[10] An aftermarket is a market for spare or unused parts. In this case, one example of an aftermarket would be the sale of batteries a manufacturer was unable to sell itself.

Previous empirical studies have not investigated the effects of MMC in the battery industry, let alone in an international trade context. Feinberg (2018) identifies the prerequisite industry characteristics likely to engender MF from MMC. These are:

- Clear market boundary identification.
- Oligopolistic and concentrated markets.
- Quasi-centralized decision making.

Any study using measures of MMC needs to clearly discern between different markets. Defining markets too narrowly, may result in omitting some competitors from the computation, leading to a possible downward bias in measurement of MMC, but it may also lead to overestimating the MMC measure by counting existing rivals more frequently across markets. The opposite is true for overly broad market boundaries. Although the direction of bias is an open question with arbitrarily drawn boundaries, preliminary research on alternative industry market definitions should be done to mitigate spurious relationships in the data (Feinberg (2018)). Using the rich data structure of trade data introduced in Section 3, I define markets as country-HS6 pairs.[11]

The battery industry differs from these prior MMC studies in that battery types, in general, are substantially differentiated. However, a regulatory decision by the European Commission, with regard to a proposed merger by Panasonic and Sanyo, finds that the battery industry is also highly segmented across battery types. Figure 3 shows how the EC defines product markets within the battery industry. It asserts that product markets are clearly divided by different chemistries (i.e. at the HS6 level), but product markets for some non-rechargeable and rechargeable LIB batteries can be further subdivided by shape and sub-chemistry (Council of European Union (2009)).[12] Furthermore, these more specialized batteries are often tailored according to custom specifications that are negotiated between

[11] In Chapter 1 of my dissertation, I conduct robustness exercises using broader definitions of markets (e.g. at the country-HS4 level).

[12] Their justification is that it would be costly for purchasers to substitute between different battery types.

the buyer (e.g. OEM) and supplier during the contract negotiation process (Hoover's (2017)). Hence competition, or the lack thereof, between suppliers could manifest in how aggressively they negotiate a contract with buyers before production even takes place.[13]

Both the theoretical and empirical literature of MMC in international trade settings assume markets divided at the country level. For instance, Bond and Syropoulos (2008) and Choi and Gerlach (2012) assume a home and foreign country firm and Feinberg (2015) and Feinberg (2013) assume markets are defined at the country-product level. Additionally, in the CCAC, plaintiffs allege that firms had "conversations and communications" on "prices for [LIBs] in the *United States and elsewhere*", thus showing that manufacturers at least considered markets within the United States as distinct from international markets, but it is unclear how conspirators classified other regions (*Hanlon vs. LG Chem* (2013), p.10). It is noteworthy that there is vast evidence in the trade literature of considerable export price differences within firm-product, but across different countries.[14]

Firms with market power in multiple markets create opportunities for competitors in those markets to exercise leverage through retaliation on multiple platforms. Hence, one prerequisite for mutual forbearance to occur is that markets are concentrated and that retaliation between competing firms is possible Ma (1998). In the court case of Hanlon vs. LG Chem. et al, purchasers of lithium-ion batteries (LIB) alleged that manufacturers engaged in horizontal price fixing on a global scale.[15] In a consolidated class action complaint (CCAC) filed on July, 2 2013, plaintiffs (purchasers) strongly suspected that 27 LIB manufacturers made "agreements to fix prices, restrict output, and allocate markets". Furthermore, defendants engaged in " meetings, conversations and communications in the U.S. and elsewhere for the purpose of monitoring and enforcing adherence to the agreed upon price-fixing scheme" (*Hanlon vs. LG Chem* (2017)).

[13]That being said, the possibility of quality upgrading as a response to MMC is an interesting alternative theory. I discuss this further in Section 4.

[14]See Görg et al. (2010), Manova and Zhang (2012) and Harrigan et al. (2015).

[15]Horizontal price fixing occurs between competitors whereas vertical price fixing would perhaps involve a subsidiary and a parent.

In international trade, many contemporary empirical models of firm-level export behavior are inspired by monopolistic competition models like Melitz (2003), where products exported by a firm are sufficiently different from those of other firms to the point where strategic interaction would not play a prominent role. However, theoretical models of MF arising from MMC stem from well-known oligopoly models such as Cournot (See Feinberg (1984)) and Bertrand (See Bernheim and Whinston (1990)). Empirical literature in MMC typically focuses on service related industries (e.g. airlines or health administration) or the sale of homogenous goods across different geographically defined markets. Ciliberto and Williams (2014) and Evans and Kessides (1994) study MMC among airline carriers, Lin and McCarthy (2018) is the latest study looking at the effects of MMC between health insurance providers and Jans and Rosenbaum (1997) focus on the ready-to-mix cement industry and delineates markets by city area in the United States.

Finally, decision making by firms should consist of some mix between headquarter and local market offices. If all the decisions are made at the headquarter level, then the notion of multiple markets is blurred and if decisions are made completely at the local level then coordination across markets is unlikely (Feinberg (2018)). For instance, a CEO might see one global market, but a plant manager will only see their own local market. In the CCAC, plaintiffs allege that "high-level executives engaged in a series of collusive meetings and communications" with the objective of "inflating [LIB] battery prices. Furthermore, "high-level executives with pricing authority discussed confidential future plans and strategies" and "discussions were also used to police, enforce and verify" that each firm was "adhering to Defendants' plan to artificially raise [LIB] prices" (*Hanlon vs. LG Chem* (2013), p. 13-15). The qualifying language by the plaintiffs on the colluders suggest that decision making on prices and quantities were determined by company officials who were not subsidiary managers, but also not CEOs.

3 Data

To study competition in multiple markets, the ideal sample would consist of all firms that strategically interact across clearly defined markets. Using stylized facts from the LIB industry (see Section 2), these would be battery manufacturers competing across country-product markets. I use a combination of product information in the Census Bureau's confidential transaction level Longitudinal Firm Trade Transaction Database (LFTTD) and establishment level information in the Longitudinal Business Database (LBD) to identify the sample and define markets. In addition, I link publicly available information from the bilateral-product level UN Comtrade Database (UNCTD) and the World Bank's Development Indicators (WDI) for information on local market characteristics such as market size and extent of local competition. Specific to international trade, I use information on related party trade to isolate buyer-seller transactions (inter-firm trade) instead of transactions between subsidiaries (intra-firm trade).[16]

My main sample is battery exporters that own a manufacturing establishment. I first identify battery exporters using HS code information in the LFTTD and then subset those firms that own at least one establishment whose primary activity falls under a manufacturing NAICS code.[17] While choosing exporters that own a battery manufacturing establishment is feasible, it could also exclude potential competitors for two reasons. The first is that the Census Bureau uses the establishment's *primary* activity (defined as the activity that generates the most revenue) to assign NAICS codes. Therefore, it is certainly possible that firms could produce batteries as a secondary activity and act as a minor competitor. [18]

The LFTTD is a database built and maintained within the U.S. Census Bureau. The database contains information on the universe of transactions that make up U.S. international trade. The export data is generated by export declaration form 7525-V submitted by

[16]In export data, related parties are defined as one party owning at least 10% stake of the other.

[17]Manufacturing NAICS codes are “31”, “32” or “33”.

[18]I consider all battery exporters and only battery exporters with a battery manufacturing establishment as a key robustness check, but these results are pending disclosure review.

exporting establishments and is unique at the transaction level. Each transaction contains information on the type of product being shipped (up to 10 digit HS codes), the amount and value of each shipment, whether the transaction was between related parties (subsidiaries within a multinational, e.g.) and to where the product is being shipped (at the port level).[19] The data used in this chapter is aggregated up to the year-firm-country-HS6 level and spans the years from 1997 to 2013.[20]To emphasize transactions between buyers and sellers, I isolate arm-length transactions.[21] Battery shipments are identified by HS codes starting with "8506" (non-rechargeable fuel-cells) or "8507" (rechargeable fuel-cells) in the LFTTD. Finally, it is unlikely that the effect of MMC with firms earning minimal revenues in markets will have much effect on a larger players' actions. For this reason, I drop firms from markets if they earn less than $\$10,000$ before computing the MMC measure.

The LBD is generated from the Census Bureau's Business Register (BR) which contains all business entities in the United States. The BR is used by the Census Bureau and other statistical agencies to identify business establishments for various censuses (such as the economic census) and surveys (such as the annual survey of manufacturers).[22] The data contains establishment-level payroll and employment information. This data can be aggregated to a firm level identifier that is readily linked to other Census data. Furthermore, one can capture activity of foreign owned if they have subsidiaries operating in the United States.[23]

The UNCTD contains export and import information at the reporter, partner and six-digit HS code level from 1988 to 2017. Over 170 countries provide the UN with annual trade statistics at the commodity and country level and covers roughly 90% of total trade at the bilateral country and six-digit HS code level. This data can provide information on the level of foreign party trade (countries other than the U.S.) into every market and

[19]HS codes refer to Schedule B numbers that U.S. exporters use to identify types of products that are exported.

[20]I look at country-HS4 markets as a robustness check.

[21]Related party transactions are shipments that go between subsidiaries within a firm. Recent research has shown that multi-nationals use transfer pricing to purposely under-price related party shipments from high-tax countries to low-tax countries to maximize profits (Cristea and Nguyen (2016), Flaaen (2017)).

[22]In Census data, a firm is defined as a set of establishments with common ownership.

[23]Reference Jarmin and Miranda (2002) for a more detailed description of the LBD.

volume of exports from domestic competition. I am primarily concerned with retaining the structural information (importing country, exporting country, product) along with the total value of imports for each reporting country from all partner countries in HS codes starting with "8506" and "8507". Reporter and partner countries are represented by three-digit country ISO codes. I use this information to assess the extent of missed contacts coming from third-party countries.

4 Model

Equation 1 shows the baseline specification.

$$Log(P_{imt}) = \beta_{mmc}\mathbf{MMC}_{imt} + \beta_F \mathbf{F}_{it} + \beta_{FM}\mathbf{FM}_{imt} + \alpha_{mt} + \varepsilon_{imt} \tag{1}$$

In this analysis, P_{imt} is the average unit value that firm i sells in market m in year t and is created by dividing total value of exports by number of units exported for i in m in year t.[24] I then sum total export value and number of units sold from all the exporter's arm-length HS6 transactions to the destination country made before computing unit prices. $\mathbf{MMC}_{imt}$ is a vector of MMC measures for i in m at t.[25] $\mathbf{F}_{it}$ is a vector of firm level controls and $\mathbf{FM}_{imt}$ captures export activity of i in m. α_{mt} are market$\times$ year fixed effects. ε_{imt} are errors clustered at the market-year level.

4.1 MMC

I use a variety of computations to measure MMC. These include:

1. the count of how many times a firm meets its rivals in other markets.

[24] Some products only have weight information (e.g. HS code 850690 and 850790, or battery parts for primary and secondary batteries, respectively) and are clearly flagged and omitted from the analysis. However, I include those markets in computing MMC.

[25] Later in the analysis I disaggregate the measure to emphasize contacts across markets sharing certain attributes and implement all measures in one regression.

2. Exports-At-Risk: export revenue that i in m has in other markets where the firm meets the same other competitors (inspired by Feinberg (2015)):

3. disaggregated measures of MMC that emphasize the possible similarities (and differences) between markets where a firm has MMC.

To compute item 1, let ω_{ij} be the number of markets where firm i and j are both exporters. Equation 4.1 shows how to calculate the degree of MMC for firm i in market m.

$$MMC_{im} = \sum_{j \in C_{im}} \omega_{ij} - |C_{im}|. \tag{2}$$

C_{im} is the set of competitors for i in m and ω_{ij} is the number of export markets where competitor $j \in C_{im}$ and i both export. Hence, MMC_{im} is the number of markets i faces all competitors j in m in markets besides m. Figure 4 shows an example of the MMC computation. Here, Firm 1 and Firm 2 compete in Markets 1, 2 and 3 and Firm 3 only competes in Market 1 and 2. Firms 2 and 3 are Firm 1's competitors in Market 1. Firm 1 faces Firm 2 twice in other markets and Firm 3 once in another market. Hence $MMC_{11} = 3$.[26]

For item 2, it is certainly conceivable that firms can place asymmetric importance onto different markets, meaning that they could place different weights onto each market contact it has with competitors. It is therefore appropriate to create a weighted measure of MMC inspired by (Feinberg (2015) and Feinberg (2013)), called Exports-At-Risk (XAR), which gauges the importance of outside markets relative to market m. To create XAR, one can replicate the procedure to create MMC by substituting ω_{ij} with $\hat{\omega}_{ij} = \sum_{\hat{m} \in M_i} R_{i\hat{m}} \mathbb{1}[j \in \hat{m}]$ or the total revenue firm i earns in all markets it is present (M_i) where competitor j is also present. Equation 3 shows how to calculate XAR_{im}:

[26] I developed Python code that computes MMC for any data provided that it is at the firm-market level. The code is posted on my website: www.jamesboohaker.com.

$$XAR_{im} = \sum_{j \in m} \hat{w}_{ij} - |C_{im}| R_{im} \tag{3}$$

Table 3 shows summary statistics for MMC in addition to the number of other U.S. exporters a focal exporter is expected to meet. A firm i in a country-HS6 market m at time t can expect to meet its competitors 35 times in other markets.[27] This is despite the observation that a firm in a country-HS6 market can expect to see only 2 to 3 fellow U.S. competitors. This suggests that exporters on average are likely quite familiar with the few exporters they meet. In country-HS4 markets, MMC increases dramatically to just over 100 contacts in other markets. This implies that MMC is highly sensitive to the inherent market structure of global battery markets and that robustness checks using differing definitions of markets is necessary.[28] Additionally, there is considerable variation in all measures of MMC used in this analysis, where a one standard deviation increase translates to at least a doubling in the frequency firms meet their competitors in other market.

In the literature, using the airline industry as their setting, Arie et al. (2017) shows that if firms can easily transfer investment between markets while also having access to markets where rivals are not present (private markets), MMC can actually have pro-competitive effects. Furthermore, Gimeno and Woo (1999) differentiate between between pairs of markets with strong and weak resource sharing opportunities and compute separate measures of MMC for each type of pairwise market. In this analysis, I extend this concept and disaggregate the MMC measure into contacts that occur across markets with the same country (MMC_{ctry}), but different products; across different countries, but in the same product (MMC_{prod}); and across different countries in different products (MMC_{cross}).[29]

[27] For example, assume 2 firms compete in 3 markets. In any one market, that firm will meet it's competitors twice in other markets.

[28] In Chapter 1 of my dissertation, I show that it could be the case that firms have lower MMC in broader markets than in narrow markets.

[29] For MMC_{ctry}, think of two firms that compete in both the (Guatemala,LIB) market and (Guatemala,lead-acid) markets; MMC_{prod} would be two firms that compete in the (Guatemala,LIB) and (Honduras, LIB) markets and MMC_{cross} would be two firms that compete in the (Guatemala, LIB) and (Honduras, Lead-Acid) markets.

Table 4 exhibits disaggregated measures of MMC introduced in item 3. Assuming country-HS6 markets, firms meet competitors just below 3 times in other markets that share the same country. However, a majority of MMC takes place across markets in different countries. More specifically, firms meet competitors almost 15 times in other markets that share the same product and over 11 times in markets that share neither a country nor a product. One obvious reason driving this result is that there are more countries than product types meaning that firms have more opportunity to meet rivals across country as opposed to product. That being said, the high degree of variance in all three measures provides an opportunity to understand the effects of MMC when they occur across markets that share certain attributes.

4.2 Dependent Variable

Table 5 shows considerable variation in firm-market prices. After reaching a similar conclusion using the same data, Harrigan et al. (2015) finds that this variation is heavily explained by destination country, product and firm information. It will therefore be prudent to control for known effects of export price fluctuations at both the market and firm level to correctly identify effects from MMC. Furthermore, a log-linear transformation is warranted as the distribution for export prices is heavily skewed. It is worth noting that some types of batteries can be quite expensive. For instance, the average cost of production of one lithium battery can exceed $1,000.[30]

4.3 Controls

Table 1 also describes firm-level controls used in the analysis. Recall that a firm is included in the sample if it ships batteries to any market *and* also own a manufacturing establishment. Notice that only 20% of electronic sales come from batteries, which implies that a majority

[30] See `https://www.ucsusa.org/clean-vehicles/electric-vehicles/electric-cars-battery-life-materials-cost#.W-8RzOhKiUk`.

of the sample are multi-product exporters. As mentioned in Section 3, even manufacturing plants owned by a firm can produce multiple products and downstream OEM buyers can also themselves turn against their suppliers. Hence, it would be prudent to include these potentially minor exporters in the sample, but also control for the fact that they could be relatively small players. As a robustness check, I interact "% Total Exp. in Batt" with MMC to see how more predominant battery exporters respond to MMC compared to firms with a more diversified export portfolio.[31] Bernard et al. (2007) find that exporters tend to be larger in terms of sales and employment and more capital intensive. In addition, they find that larger exporters tend to ship more products to more destinations and experience lower trade costs. Hence, larger, more capital intensive firms will likely correlate positively with MMC and negatively with price. Table 1 shows these exporters are relatively large and tend to operate in many export markets. This means that many, instead of just a few outlying firms could coordinate actions (or resources) across different export markets.

Firm-market independent variables in the specification are meant to control for. These include: firm experience in exporting into that market (measured in years) and the share of shipments going to a related party.[32] Alvarez et al. (2013) finds, using Chilean exporters, that previous experience exporting a product to a country lowers export costs related to search. Helpman et al. (2004) also finds that the most cost efficient firms tend to have FDI (or related party trade). Specific to the battery industry, a subsidiary presence likely indicates that the exporter has easier (cheaper) access to buyers, which makes the firm more competitive. Therefore, the effect on intra-firm shipments should also be negative on inter-firm export prices. In Table 6, 11% of firm export transactions go between related parties or between subsidiaries owned by the firm. Furthermore, exporters are experienced in the markets. This easier access significantly lowers firms search costs, which could translate to lower prices, but it could also give competitors easier access to each other in foreign markets

[31] I run robustness checks on the set of only those battery exporters with a battery manufacturing establishment (NAICS5 = 33591). I am currently working to get these results approved for disclosure.

[32] Firm experience is calculated as the number of total prior years a firm has exported a product to a country.

where firms can coordinate. The resulting effect of these effects is ambiguous, but should also be controlled for in the specification.

α_{mt} are year-market fixed effects. The level of market competitiveness in general, but specifically market concentration, are included in most other empirical MMC analyses, however they are not included in this analysis. Feinberg (1985), Bernheim and Whinston (1990) from the economics literature and Ma (1998) and Jayachandran and Varadarajan (1999) from the strategic management literature assert that a necessary prerequisite for firms to use MMC to mutually forbear is market power. If one has earnings information for every firm in every market, one could use a measure of market concentration assess whether firms in the market are behaving competitively. Unfortunately, in studying this question in a global trade context, I do not have information on every firm in every market. It is therefore prudent to emphasize market-year fixed effects to control for market competitiveness and market power in addition to other confounding variables that could occur at the market-year level not covered in the data.

Finally, ε_{imt} are error terms. By construction, the assertion that cross-dependencies exist across markets leads to a violation of the independence assumption for a linear regression model. Empirically, MMC_{imt} is necessarily positively correlated with MMC_{jmt}, MMC_{ilt} and MMC_{jlt} for firms i, j and markets l, m. While estimated coefficients are still consistent, the dependence between different observations of MMC can lead to over-restricted coefficient variances resulting to over-inference or mistaking significant for insignificant relationships. I mitigate this by showing results with year-firm or year-market clustered errors in all regression specifications. Nonetheless coefficient variances will be restricted because correlation between either MMC_{imt} and either MMC_{jmt} or MMC_{ilt} and MMC_{jlt} will be unaccounted. As a key robustness check, I also use a feasible GLS estimator using random-effects estimation to check that the correlation of residuals across different clusters does not impact inference. To find exact coefficient variances, one could try using techniques from the spatial econometrics literature (I push this to future research), but the simple models presented below are sufficient to show the general relationship between the independent and dependent variables.

4.4 Estimation Issues

4.4.1 Omitted Variable Bias

In addition to year × market fixed effects, I implement a series of other fixed effect specifications to assess the robustness of the main result. These include: year, year and firm, year × firm, and year, firm, country and product fixed effects. With 5,500 firm-years and 8,000 market-years, I do not have enough power in my analysis to run the full set of fixed effects. As such, I include a vector of market level controls in each robustness specification to control for the remaining variation not accounted for by the fixed effects being used.

Table 7 provides descriptive statistics on these international battery markets. It is evident that U.S. exporters can face competition from competitors that are outside the scope of the data available. Firstly, 70% of battery imports into a market come from non-U.S. countries. Exporters located in foreign destinations are certainly a source of competition, but they themselves could have MMC with U.S. competitors leading to potential downward bias in measuring MMC. Therefore it is unclear what the effect of foreign party trade has on U.S. exporters' ability to collude in the market by exploiting MMC. Secondly, roughly $2.5 million of the approximately $5.5 million of U.S. exports in batteries to an average market come from non-manufacturers. Although these firms tend to be much smaller and less active than firms in the sample (see Table 2), it's possible that a large presence of these types could hinder the ability of firms to leverage MMC across markets. Still further, these wholesaler types could also be acting on behalf of a competitor leading to potential upward bias in computing MMC. Hence, the impact of their presence would also have an ambiguous effect on how firms in the sample respond to MMC. Nonetheless, to deal with these sources of endogeneity, I interact both the share of foreign party trade and the number of non-manufacturing exporters to the measure of MMC as a key robustness check.

Additionally, U.S. exporters could weight competition with a pure battery manufacturer differently than say an automobile producer that conducts only a few battery transactions. To measure the importance of battery sales to competitors in a market, I compute the average share of revenue earned by competitors in market m. An average share close to zero would imply that competitors in market m mostly export batteries, but an average share close to one indicates that competitors are not heavily reliant on batteries to maintain international revenue streams. In Table 7, I find that 61% revenue come from non-battery markets for U.S. exporters in any given market. I expect interacting MMC with this proxy for the importance of battery sales to market competitors would mitigate the effect of MMC on export prices. That being said, the stand alone effect of MMC should be larger than that in the baseline result as the competitors that predominantly export batteries should be more sensitive to MMC.

4.4.2 Mismeasurement of MMC

While the LFTTD contains highly disaggregated firm-level export transaction information, it does not observe that level of granularity from third-party countries or domestic information on local producers. For instance, the LFTTD will capture all shipments from the U.S. exporting LIBs to Guatemala, but it does not have shipments from Japan. This possibly creates downward bias in computing MMC as an exporter in Japan could also export to other markets where the U.S. firm is present. To understand the ability of firms to use MMC when faced with foreign competition, I interact MMC with the *average share of foreign party trade* ($\overline{impShare}_{it}^{fpt}$) in exports markets for U.S. exporters using information from the UNCTD database in Equation 4:

$$\overline{impShare}_{it}^{fpt} = \frac{1}{|M_{it}|} \sum_{m \in M_{it}} impShare_{mt}^{fpt} \mathbf{1}[Exports_{imt} > 0] \tag{4}$$

where $impShare_{mt}^{fpt}$ is the share of imports in market m that come from non-U.S. countries and M_{it} is the set of export markets for firm i at time t.[33] A negative interaction would suggest a weakened ability for U.S. firms to retaliate when faced with foreign competition, but a positive one would suggest that firms could perhaps meet foreign rivals in other markets as well.[34] Table 1 shows that firm i can expect 66% of imports into it's export markets to come from competitors in foreign countries.

Similar to competition from foreign parties. U.S. manufacturers could experience competition from non-manufacturing distributors (e.g. wholesalers). To address this, I employ a similar strategy as I did above for foreign competition and calculate $\overline{NumNonManuf_{it}}$. I assume these distributors will be the noted earnings recipient when in fact they just passed on the price set by the firm; the true benefactor from exporting.[35] Similar to the reasoning above, the presence of non-manufacturing exports is a source of market competition which would suggest a negative interaction, but could be positive if either the distributor or the manufacturer they work for have MMC with U.S. exporters. See table 2 for a discussion of these firms.

As mentioned in section 2, LIB exporters have been shown to collude in non-battery product markets. Firms that compete in both battery and non-battery markets will undoubtedly have MMC. To address this, I calculate the average value of non-battery exports for all U.S. battery exporters in market m ($\overline{NonBattExp_{mt}}$) and interact that total with MMC_{imt}. A positive interaction effect indicates that even firms who predominantly export non-battery products respond to MMC. On the other hand, a negative interaction effect and a positive effect on the stand-alone MMC coefficient suggests that battery dominant exporters are more sensitive to MMC.

In addition, I use the sample of all battery exporters that own a manufacturing estab-

[33] I emphasize average share of foreign party trade because MMC is computed across markets where firm i is present. I also interact MMC with $impShare_{mt}^{fpt}$ to understand how foreign competition in the market itself impacts the effect of MMC on price.

[34] Other theories could also hold true here. For instance, U.S. firms with MMC could further band together with multi-market rivals against foreign competitors to keep prices artificially high.

[35] I also run similar models with the full set of U.S. battery exporters, those results have not yet been approved for release.

lishment. Admittedly, this sample is a bit broader than the set of firms that self define primarily as battery manufacturers. However, as mentioned in Section 2, manufacturing establishments, let alone entire firms, produce a variety of products. Additionally, automobile and computer companies vertically integrate to themselves enter the battery industry. That being said, it is likely there exists considerable variation within each exporter that could influence how they react to MMC in foreign markets. For this reason, I also emphasize firm and firm-year fixed-effects as a key robustness exercise to control for variation that stems from within firms themselves.

4.4.3 Reverse Causation

While most of the MMC literature has found that firms with MMC tend to have higher earnings and behave more collusively, there is some evidence suggesting that firms deliberately seek out and use MMC to create suboptimal welfare equilibrium outcomes through mutual forbearance (Haveman and Nonnemaker (2000),Greve (2006),Baum and Korn (1999)). In addition, Scott (1991) finds that MMC is necessary for firms to coordinate in a concentrated industry which paves an argument for reverse causality in that firms disagreement in prices leads firms to seek MMC. To address this possible endogeneity, I include a specification investigating a lagged measure of MMC in previous periods on prices in current periods. The lagged measure counts the number of times a firm meets other rivals exporting to the market in other markets in the previous period.

It should be emphasized that simply substituting a lagged measure for a concurrent one will not by itself sufficiently address the problem of reverse causality. The channel of bias shifts from underlying relationships between independent variables to the (often unaddressed) question as to whether a dynamic relationship is appropriate (Bellemare et al. (2017)). Therefore, it is important to show that a dynamic relationship between MMC and price is theoretically acceptable. In the global battery trade, I assert that a dynamic relationship is plausible because it satisfies some structural concerns of how battery manufacturers conduct trade with some buyers overseas. Typically, exporters negotiate contracts or supply agreements that stipulate a unit price for a number of years. A supply agreement between Panasonic (the manufacturer) and Tesla (the buyer) in July of 2009 suggests the amount and the unit price of LIBs were determined and set for a defined period of time. Hence, the assumption that suppliers predetermine the price they set in markets in future periods is not necessarily strong.

4.4.4 Alternate Mechanism

So far, I have asserted that the mechanism driving the effect between MMC and export prices is one of tacit collusion. An alternate theory could be one related to quality upgrading, where firms are better able to assess products sold by competitors with whom they have MMC and are better able to differentiate their product to better appeal to consumers. To control for this, one could first compute quality-adjusted prices before analyzing effects of MMC.[36] Insignificant coefficient estimates would provide evidence for this theory, where robust estimates would provide evidence for the tacit collusion framework. Although I do not address this approach in this paper, it is a worthwhile pursuit for future research.

5 Results

Regression coefficients in Table 8 and Table 9 show a small, but positive and significant relationship between MMC and the logarithm of arm-length price set by firm i in market m at time t. The regression specifications include a series of market, firm and market-firm level controls, which are introduced in Section 4. The effect is robust across different panel regression fixed-effects specifications and supports the mutual forbearance hypothesis that higher levels of MMC lead to higher prices.

Model 1 in Table 8 indicates that meeting a rival in one more market in the previous period leads to a 0.7% increase in the price set by firm i in market m. Introducing market

[36] Khandelwal (2010) shows how to do this with firm-level trade information.

fixed effects in **Model 2** and firm fixed effects in **Model 3** reduces the magnitude of the coefficient showing that there is some omitted variable bias stemming from time-invariant market and firm characteristics. In **Model 4**, I add country and product fixed effects to the previous specification and find the magnitude decreases further, but remains highly significant.

Model 2 in Table 9 shows my main result, where a one standard deviation increase in MMC (approximately 50 additional contacts) associates with roughly a 1% increase in price. From section 2, the EC found that consumers considered switching between different battery chemistries in the face of a 5 to 10% increase in price indicating that a 1% increase in price can be significant. This is despite the fact that coefficient estimates are likely attenuated due to the afore mentioned measurement error in measuring MMC in Section 4. Furthermore, this coefficient magnitude is similar to past studies, most notably Ciliberto and Williams (2014) when they assume market and year fixed effects. Coefficient standard errors hardly change when using the feasible GLS estimators with market-year and firm-year random effects in **Model 1** and **Model 3**, respectively. Coefficient magnitudes increase when one assumes firm-year fixed effects as shown in **Model 4**, suggesting that omitted firm-year level variables downward bias the coefficient estimates. The general result does not change in **Model 5** when replacing concurrent MMC measures with a lagged measure.

5.1 Disaggregated Measures of MMC

As mentioned in Section 4, it could be that MMC across certain types of markets can have counter-intuitive effects on market outcomes.[37] Here, MMC_{ctry} relates negatively with price providing evidence of competitive effects arising from MMC, which is contrary to most literature. **Model 3** shows the preferred specification with market-year fixed effects. Here a one standard deviation increase in MMC_{ctry} (roughly 8 contacts) associates with

[37] It could also mean the market was defined too narrowly and the MMC measure is really just a proxy for number of competitors. I conduct robustness checks using broader definitions of markets in Chapter 1 of dissertation and the result holds.

roughly a 5% decrease in price. More in line with the mutual forbearance hypothesis, a one standard deviation increase in MMC_{prod} (roughly 27 contacts) corresponds to a 17% increase in battery export prices and a one standard deviation increase in MMC_{cross} (roughly 20 contacts) relates to a 8% increase in price. Exploring this relationship under the framework set forth by Arie et al. (2017) that allows inter-market cost sharing would be an interesting future research topic.

5.2 Exports-At-Risk

Up to now, I have implicitly assumed that firms place equal weight to each contact it has with competitors in other markets. However, it is also plausible that firms weight their contacts differently depending on how important other markets besides market m are to firm i. The more contact a firm has with competitors in other markets, the more its sales in other markets are at risk if it decides to behave aggressively by slashing prices (Feinberg (2015)).[38]

Referencing Table 11, **Model 1** shows a 1% increase in XAR for firm i in market m corresponds with a 1.5% increase in firm i's export price to market m. In **Model 2**, a 1% increase in XAR_{ctry} associates with a 2.5% decrease in price, but a 2.3% increase in price for XAR_{prod} and a .6% increase in XAR_{cross}. Coefficient signs are similar to those found for specifications using non-weighted measures of MMC (Tables 8 and 10). These results are consistent in magnitude and direction to those reported in Feinberg (2015) (**Model 1** only) and to the main results above (both **Model 1** and **Model 2**).

5.3 External Competition

As mentioned in Section 4.4, interacting foreign competition on MMC sheds light on the ability of U.S. firms to maintain above equilibrium prices when faced with competition from non-U.S. exporters.**Model 1** interacts the share of foreign party trade with MMC and **Model**

[38] See the appendix in Chapter 1 for details on the computation of XAR.

2 the average share of foreign party faced in all of firm i's export markets ($\overline{impShare_{it}}$) with MMC. To compute MMC for firm i in market m, one needs information on market structure for all markets where firm i is present. As $\overline{impShare_{it}}$ approaches unity, the coefficient of MMC increases from .005 to .01. As stated in Section 12, one reason the coefficient effect is positive could be that foreign competitors themselves have MMC with firms in the sample (i.e. downward bias in MMC measurement.)

Furthermore, in **Model 2** the coefficient on MMC slightly decreases from roughly .1 when the firm faces mostly foreign competition in it's export markets compared to .05 indicating that MMC has a weaker effect on price when foreign rivals are not present. This is an interesting result that deserves further exploration, but one theory could be that U.S. firms band together with well-known competitors to combat foreign competition. However, a perhaps more likely theory is that major exporters in the battery industry are exporting from foreign destinations and also have MMC with U.S. exporters.

I replicate the above approach in **Model 3** and **Model 4** except I substitute the count of out-of-sample non-manufacturing battery exporters for share of trade from foreign parties. The interaction effects were either insignificant (**Model 3**) or marginal (**Model 4**) suggesting that unobserved MMC due to the presence of non-manufacturing exporters matters little (and is perhaps independent from observed MMC) to estimating the coefficient on MMC.

In **Model 5** and **Model 6**, I include the interaction of the share of firm i's non-battery exports (**Model 5**) and the average share of non-battery exports for rivals in market m (**Model 6**) with MMC. MMC has a larger effect for firms that mostly export batteries and/or markets whose rivals mostly export batteries. Looking at **Model 6**, when the average share of total exports in non-batteries is close to 0 for all firms in the market, then meeting a competitor in one more market is linked to more than a 1.5% increase in price. That being said, in **Model 6**, even in markets where incumbents mostly export non-battery products, the net effect of MMC on price still remains positive ($0.177 - 0.139 = .038$). Both coefficients are negative and significant indicating that the downward bias introduced from potential

MMC across battery and non-battery markets is a source of inflated coefficient estimates for MMC.

In **Model 7**, I combine all the interaction terms into one model to more completely control for the extent of downward bias in the model. Generally, in markets where firms do not face much foreign competition and also mostly export products other than batteries, MMC could negatively effect prices.[39] However, MMC has the anticipated positive effect on price for more prominent battery exporters and the effect is stronger if the firm regularly faces foreign competition.

6 Conclusion

I find that battery exporters tend to charge higher prices when faced with MMC using a combination of confidential international trade transaction and establishment level data provided by the U.S. Census Bureau. However, contrary to the literature, I find that there also exist pro-competitive MMC effects when firms meet across markets defined by different products, but within the same country. The main result also does not change when assuming different fixed-effects specifications, implemented different measures of MMC commonly considered in the literature while controlling for a myriad of firm, market and firm-market level control variables. I find a one standard deviation increase in the degree of MMC significantly corresponds to over a 1% increase in market price. This result is consistent with other empirical results spanning across the literature.

Motivated by evidence of collusion between battery manufacturers in the U.S. and elsewhere, the broad objective of this paper is to use simple econometric methodology to show the existence of a robust relationship between MMC and export prices in an international trade setting. From here, there are many paths of future research that can be taken to show how MMC impacts firm export decisions. Besides studying this question using a different

[39]It should be noted that such cases should be more thoroughly examined by including potential omitted variable bias not used in this analysis.

industry, it would be beneficial to implement a more structural model that captures the dynamic interplay between price and MMC that is more in line with the theoretical literature. Parallel to this point, one could use the granular nature of shipment level data to observe whether and exactly how firms retaliate when faced with an aggressive competitor. However, leading into that, one must first think about how firm's entry into global markets is impacted by MMC. Finally, the majority of existing theory assumes two-firm, two-market models but in reality there are many firms competing in many, but not all markets. Such rich market structure could have network type effects on firm behavior. Finally, more exploration of the mechanisms driving the competitive effects of MMC could convey that certain types of MMC can actually be welfare enhancing as opposed to universally detrimental.

References

Alcantara, L. L. and Mitsuhashi, H. (2015). Too many to handle? Two types of multimarket contacts and entry decisions. *Management Decision*, 53(2):354–374.

Alvarez, R., Faruq, H., and López, R. A. (2013). Is previous export experience important for new exports? *The Journal of Development Studies*, 49(3):426–441.

Arie, G., Markovich, S., and Varela, M. (2017). On the competitive effects of multimarket contact. *European Economic Review*, 100:116–142.

Baum, J. A. and Korn, H. J. (1999). Dynamics of dyadic competitive interaction. *Strategic Management Journal*, 20.3:251–278.

Bellemare, M. F., Masaki, T., and Pepinsky, T. B. (2017). Lagged explanatory variables and the estimation of causal effect. *The Journal of Politics*, 79(3):949–963.

Bernard, A. B., Jensen, J. B., Redding, S. J., and Schott, P. K. (2007). Firms in international trade. *Journal of Economic perspectives*, 21(3):105–130.

Bernheim, B. D. and Whinston, M. D. (1990). Multimarket contact and collusive behavior. *The RAND Journal of Economics*, 1:1–26.

Bond, E. W. and Syropoulos, C. (2008). Trade costs and multimarket collusion. *The RAND Journal of Economics*, 39.4:1080–1104.

Choi, J. P. and Gerlach, H. (2012). Global cartels, leniency programs and international antitrust cooperation. *International Journal of Industrial Organization*, 30(6):528–540.

Ciliberto, F. and Williams, J. W. (2014). Does multimarket contact facilitate tacit collusion? inference on conduct parameters in the airline industry. *The RAND Journal of Economics*, 45.4:764–791.

Council of European Union (2009). Council regulation (EU) no 139/2004.

Cristea, A. D. and Nguyen, D. X. (2016). Transfer pricing by multinational firms: New evidence from foreign firm ownerships. *American Economic Journal: Economic Policy*, 8(3):170–202.

Edwards, C. D. (1955). Conglomerate bigness as a source of power. *Princeton University Press*, 1:331–359.

Evans, W. N. and Kessides, I. N. (1994). Living by the "golden rule": Multimarket contact in the US airline industry. *The Quarterly Journal of Economics*, 1:341–366.

Feinberg, R. M. (1984). Mutual forbearance as an extension of oligopoly theory. *Journal of Economics and Business*, 36(2):243–249.

Feinberg, R. M. (1985). " sales-at-risk": A test of the mutual forbearance theory of conglomerate behavior. *Journal of Business*, pages 225–241.

Feinberg, R. M. (2013). Multimarket contact and export entry. *Economics Letters*, 121(1):82–84.

Feinberg, R. M. (2014). Price effects of multimarket contact among movie chains in small US metropolitan areas. *Economics Letters*, 123(1):6–8.

Feinberg, R. M. (2015). "exports-at-risk": The effect of multimarket contact in international trade. *Southern Economic Journal*, 81(3):769–781.

Feinberg, R. M. (2018). A note on market definition and the measurement of multimarket contact.

Flaaen, A. (2017). The role of transfer prices in profit-shifting by US multinational firms: Evidence from the 2004 homeland investment act.

Gimeno, J. and Woo, C. Y. (1999). Multimarket contact, economies of scope, and firm performance. *Academy of Management Journal*, 42(3):239–259.

Görg, H., Halpern, L., and Murakozy, B. (2010). Why do within firm-product export prices differ across markets?

Greve, H. R. (2006). The intent and extent of multimarket contact. *Strategic organization*, 4.3:249–274.

Hanlon vs. LG Chem (2013). In re lithium ion batteries antitrust litig., class action no. 413md02420ygrdmr.

Hanlon vs. LG Chem (2017). In re lithium ion batteries antitrust litig., mdl no. 2420 no. 413md02420ygrdmr.

Harrigan, J., Ma, X., and Shlychkov, V. (2015). Export prices of US firms. *Journal of International Economics*, 97(1):100–111.

Haveman, H. A. and Nonnemaker, L. (2000). Competition in multiple geographic markets: The impact on growth and market entry. *Administrative Science Quarterly*, 45(2):232–267.

Helpman, E., Melitz, M. J., and Yeaple, S. R. (2004). Export versus FDI with heterogeneous firms. *American economic review*, 94(1):300–316.

Hoover's (2017). Battery manufacturing: Industry report. Technical report, Hoover's.

IBISWorld (2017). Ibisworld industry report 33591: Battery manufacturing in the U.S. Technical report, IBISWorld.

Jans, I. and Rosenbaum, D. I. (1997). Multimarket contact and pricing: Evidence from the US cement industry. *International Journal of Industrial Organization*, 15.3:391–412.

Jarmin, R. S. and Miranda, J. (2002). The Longitudinal Business Database. Technical report, Center of Economic Studies.

Jayachandran, Satish, J. G. and Varadarajan, P. R. (1999). The theory of multimarket competition: A synthesis and implications for marketing strategy. *The Journal of Marketing*, 1:49–66.

Khandelwal, A. (2010). The long and short (of) quality ladders. *The Review of Economic Studies*, 77(4):1450–1476.

Lin, H. and McCarthy, I. M. (2018). Multimarket contact in health insurance: Evidence from medicare advantage. Technical report, National Bureau of Economic Research.

Ma, H. (1998). Mutual forbearance in international business. *Journal of International Management*, 4(2):129–147.

Manova, K. and Zhang, Z. (2012). Export prices across firms and destinations. *The Quarterly Journal of Economics*, 127(1):379–436.

Melitz, M. J. (2003). The impact of trade on intra-industry reallocations and aggregate industry productivity. *Econometrica*, 71.6:1695–1725.

Parker, P. M. and Röller, L.-H. (1997). Collusive conduct in duopolies: multimarket contact and cross-ownership in the mobile telephone industry. *The RAND Journal of Economics*, pages 304–322.

Scott, J. T. (1991). Multimarket contact among diversified oligopolists. *International Journal of Industrial Organization*, 9(2):225–238.

Thomas, C. J. and Willig, R. D. (2006). The risk of contagion from multimarket contact. *International Journal of Industrial Organization*, 24.6:1157–1184.

Tieying, Y., Subramaniam, M., and Cannella, A. A. (2009). Rivalry deterrence in international markets: Contingencies governing the mutual forbearance hypothesis. *Academy of Management Journal*, 52(1):127–147.

Yu, T. and Cannella, A. A. (2013). A comprehensive review of multimarket competition research. *Journal of Management*, 39.1:76–109.

Zhou, J. (2016). The rise and fall of cartels with multi-market colluders. *Review of Industrial Organization*, 48(4):381–403.

U.S. Exports in Batteries from 1992 - 2016

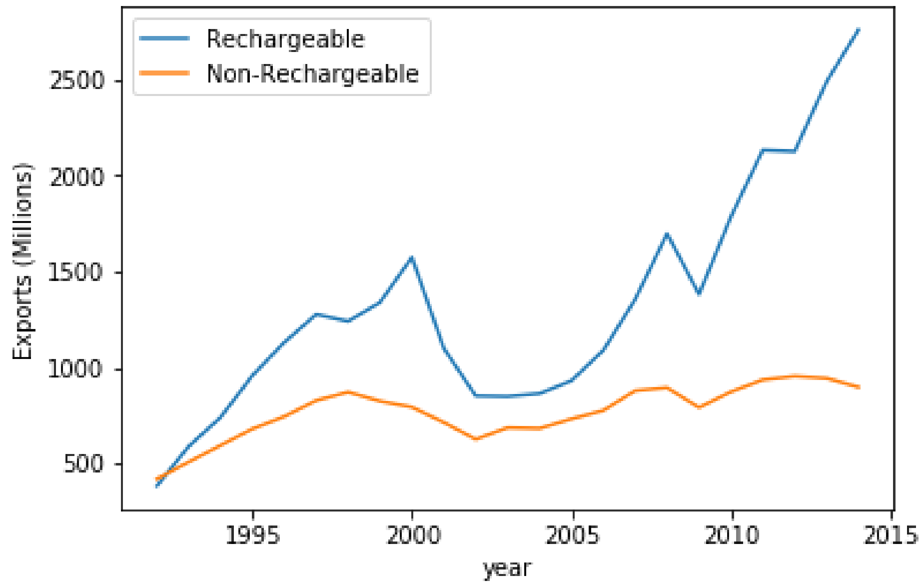

Figure 1: Source: UN Comtrade Database.

Number of U.S. Battery Importing Countries from 1992 - 2016

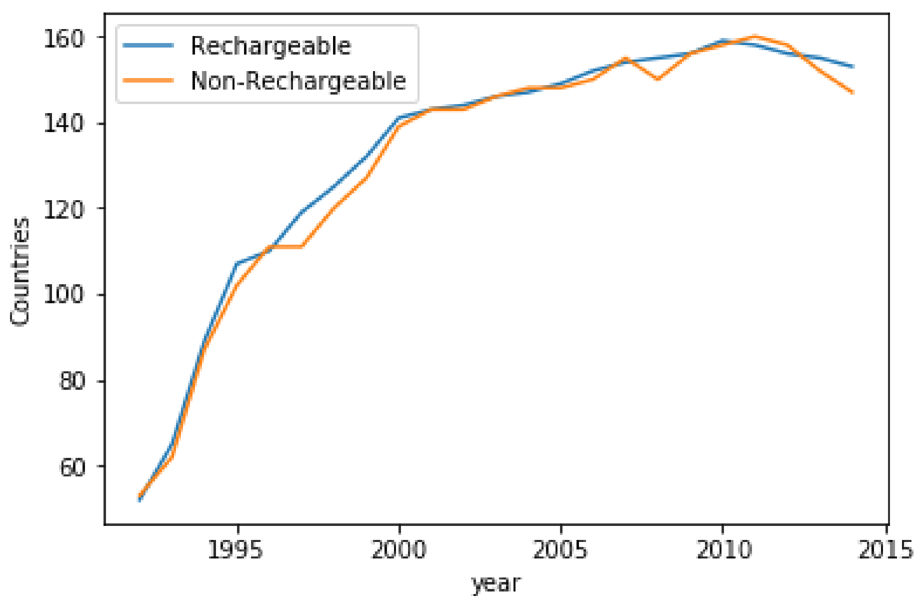

Figure 2: Source: UN Comtrade Database.

Product Segmentation in Battery Industry

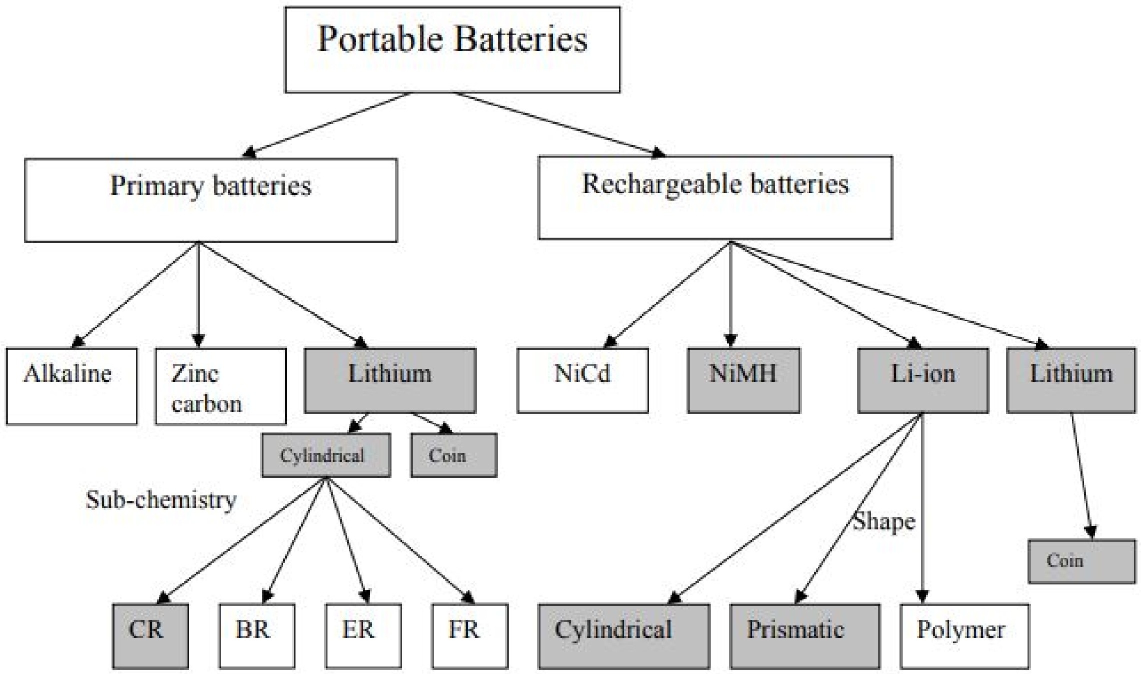

Figure 3: Battery Market Segmentation suggested by the EC. The EC finds that market segmentation occurs at the sub-chemistry level. Shaded areas show the overlap between Panasonic and Sanyo. CR means Lithium manganese dioxide, BR means Lithium poly-carbon monofluoride, ER means Lithium thionyl chloride and FR means Lithium-Iron Disulfide (Council of European Union (2009)).

Example of MMC Computation

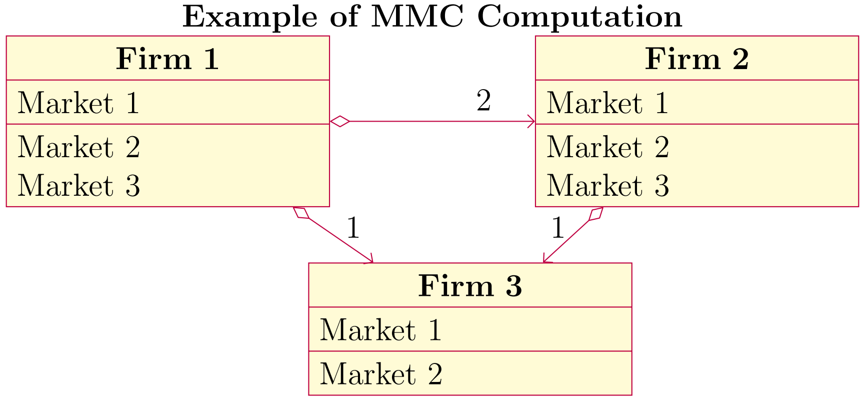

Figure 4: MMC faces firm 2 in 2 other markets besides market 1 and firm 3 in one other market. Hence, MMC for firm 1 in market 1 is 2 + 1 = 3.

Table 1: Portrait of Firms in the Sample

Variable	Avg.	Std. Dev.	Firm-Years
Total Firm Battery Exports (USD) (i,t)	3,582,000	16,550,000	5,500
Number of Manuf. Estabs. (i,t)	12.7	27.2	5,500
Firm Employment (i,t)	12,160	46,530	5,500
Number of Other Export Markets (i,t)	5.39	13.77	5,500
% Total Exp. in Batt (i,t)	.21	0.35	5,500
Total Non-Batt. Exports (i,t)	4,176,000	19,800,000	5,500
Avg. % Imports from FPT (i,t)	.66	.24	5,500

Table 1: These are firm-level control variables. "Number of other exports markets" counts the total number of alternative export markets for a firm. For instance, if the a firm has 3 export markets, then it will have 2 other markets relative to any one export market. "% Total Exp. in Batt" is firm i's total share of export revenue earned from battery sales. "Total Non-Batt. Exports" is firm i's export revenue earned in the sale of electronics that use batteries (e.g. laptops, automobiles). "Avg. % Imports from FPT" is the average share of imports from non-U.S. countries in firm i's export markets. In the average year there are $\frac{5500}{16} = 350$ battery exporters that own a manufacturing establishment. A firm is a battery exporter if it sends at least one battery shipment to a foreign market.

Table 2: Non-Manufacturing Battery Exporters

Variable	Avg.	Std. Dev.	Firm-Years
Battery Export sales	800,100	8,104,000	30,000
Firm Employment	4,394	29,780	30,000

Table 2: Description of battery exporters that do not have a manufacturing establishment. In the average year there are $\frac{30000}{16} = 1875$ battery exporters that do not own a manufacturing establishment.

Table 3: Descriptives on MMC

Market Definition	Stat	MMC	Mkt. Competitors	Obs.
Ctry-HS4	Avg.	103.80	6.42	25,000
	Std. Dev.	125.50	10.19	25,000
Ctry-HS6	Avg.	35.23	2.51	29,500
	Std. Dev.	49.10	4.67	29,500

Table 3: MMC is a pooled average from panel data unique at the year-firm-market level. In this table and all others below, observations are rounded and all values have at most 4 significant digits in accordance with U.S. Census Bureau disclosure policy.

Table 4: Disaggregated Measures of MMC

Type of MMC	Description	Avg.	Std. Dev.
MMC_{ctry}	MMC Within Country and Across Product (i,m,t)	2.80	8.03
MMC_{prod}	Within Product and Across Country (i,m,t)	14.94	27.22
MMC_{cross}	Across Country and Product (i,m,t)	11.07	20.40

Table 4: Decomposition measures of MMC that exploit the similarities and differences between markets where firms could have MMC with competitors.

Table 5: Manufacturing Battery Exporters from 1997 - 2013

Variable	Avg.	Std. Dev.	Med.
Intra-Firm Exports (USD) (i,m,t)	204,300	2,119,000	1,139
Arm-Length Exports (USD) (i,m,t)	357,500	2,585,000	44,300
Total Exports (USD) (i,m,t)	561,800	3,727,000	54,890
Quantity (units) (i,m,t)	168,700	2,106,000	847.70
Price (AL Revenue/Qty.) (i,m,t)	**906.40**	**8,405.00**	**53.33**

Table 5: Trade activity for firm (i) in the average export market (m) in the average year (t). Medians are interpolated by averaging some values above and below the true median in accordance with Census Bureau Disclosure Policy.

Table 6: Extent of Access to Foreign Markets

Variable	Avg.	Std. Dev.
Shr. of intra-firm export value	0.11	0.26
Experience In Market (years)	3.78	3.36

Table 6: "Pct. of intra-firm export value" is the share of intra-firm shipments by firm i to market m. "Experience In Market" is the number of past years firm i was exporting to market m.

Table 7: Characteristics of Export Markets

Variable	Avg.	Std. Dev.	Market-Years
Total U.S. Exports to a Market (m,t)	3,385,000	15,630,000	8,000
Total Exports by Non-Manufacturers (m, t)	2,421,000	13,150,000	8,000
Number of Non-manuf exporters in market (m,t)	9.21	18.02	8,000
gdp per capita	21,780.00	2,071.00	8,000
Imports from FPT (m,t)	33,090,000	156,700,000	8,000
Share of imports from FPT (m,t)	0.70	.35	8,000
Product Exports from Dest. Country (m,t)	35,160,000	205,700,000	8,000
Mkt. Avg. % of Non-Batt Exp. (m,t)	.61	.33	8,000

Table 7: Markets are defined as country-HS6 pairs. "Number of Non-manuf exporters in market" is the number of non-manufacturers that export to market m and "Total Exports by Non-Manufacturers" is the value they export to market m. " Share of imports from FPT" is the share of imports from firms located in non-U.S. countries and "Imports from FPT" is the amount they export. "Product Exports from Dest. Country" is the value of exports from potential competitors in the foreign market itself. "Mkt. Avg. % of Non-Batt Exp." is the share of revenue earned in non-battery markets among U.S. firms in export market m.

Table 8: The Effect of MMC on Log Battery Export Prices

Covariates	Model 1	Model 2	Model 3	Model 4
$MMC * 10^{-1}(i,m,t)$	*0.078****	*0.029****	*0.039****	*0.018****
	[0.003]	*[0.003]*	*[0.003]*	*[0.003]*
Shr. of Shipments to RP (i,m,t)	-2.949***	-2.576***	-2.410***	-2.349***
	[0.045]	[0.040]	[0.043]	[0.040]
Experience In Market	-0.028***	-0.016***	-0.034***	-0.031***
	[0.003]	[0.003]	[0.003]	[0.003]
Log GDP per capita (m,t)	-0.097***	-0.05	-0.087***	-0.084
	[0.011]	[0.110]	[0.010]	[0.095]
Log Imports from Third-Party Countries (m,t)	-0.072***	-0.013	-0.048***	-0.006
	[0.006]	[0.008]	[0.006]	[0.006]
Log Product Exports from Dest. Country (m,t)	0.015***	-0.005	-0.005	-0.001
	[0.003]	[0.006]	[0.003]	[0.004]
Number of Other U.S. Exporters (m,t)	0.014***	-0.001	0.013***	-0.008**
	[0.003]	[0.003]	[0.003]	[0.003]
Number of Non-manuf exporters in market (m,t)	-0.004***	0.005***	-0.004***	0.003**
	[0.001]	[0.001]	[0.001]	[0.001]
Log Avg. Non-battery Exp. (m,t)	0.096***	0.022**	0.027***	0.007
	[0.007]	[0.007]	[0.006]	[0.006]
Avg. % Exp in non-Batteries (m,t)	-0.225**	-0.127+	-0.043	-0.148*
	[0.071]	[0.077]	[0.064]	[0.065]
Log Total Exports (m,t)	-0.038**	0.031+	0.011	0.019
	[0.012]	[0.017]	[0.010]	[0.012]
Share of imports from FPT (m,t)	0.858***	-0.119	0.782***	-0.021
	[0.085]	[0.126]	[0.074]	[0.080]
Number of Other Markets Services (i,t)	-0.002***	0	-0.001	-0.002**
	[0.001]	[0.000]	[0.001]	[0.001]
Log Firm employment (i,t)	0.065***	0.068***	0.109**	0.072*
	[0.008]	[0.007]	[0.034]	[0.031]
Log Non-Battery Exports (i,t)	-0.029***	-0.012*	-0.017+	-0.012
	[0.006]	[0.005]	[0.009]	[0.008]
% Export Value in Batteries (i,t)	-0.486***	-0.309***	0.059	-0.01
	[0.071]	[0.062]	[0.141]	[0.130]
Log Firm Exports (i,t)	-0.143***	-0.130***	-0.105***	-0.098***
	[0.009]	[0.008]	[0.017]	[0.015]
Avg. FPT Imp Share faced by firm (i,t)	0.864***	0.465***	0.230*	0.316**
	[0.085]	[0.076]	[0.109]	[0.101]
R-Sq. Overall	0.223	0.174	0.2	0.401
Obs.	29500	29500	29500	29500
Year Effects	FIXED	FIXED	FIXED	FIXED
Firm Effects	NONE	NONE	FIXED	FIXED
Country Effects	NONE	NONE	NONE	FIXED
Product Effects	NONE	NONE	NONE	FIXED
Market Effects	NONE	FIXED	NONE	NONE
Clustering By	Market-Year	Market-Year	Market-Year	Market-Year

Table 8: (i, m, t) refers to a covariate that varies by the firm, market and year, (m, t) refers to a covariate that varies by market and year and (i, t) refers to a covariate that varies by firm and year. Coefficient standard errors are in brackets. $***p < .001$, $**p < .01$, $*p < .05$, $+p < .10$

Table 9: Robust Relationship between MMC and Log Battery Export Prices

Covariates	Model 1 (GLS)	**Model 2 (Main Result)**	Model 3 (GLS)	Model 4	Model 5 (Lagged MMC)
MMC * 10^{-1} (i,m,t)	0.031***	**0.019*** **	0.035***	0.039***	0.01**
	[0.003]	**[0.003]**	[0.004]	[0.004]	[0.00]
R-Sq. Overall	0.212	**0.192**	0.164	0.156	0.372
Obs.	29,500	**29,500**	29,500	29,500	29,500
Market * Year Effects	RANDOM	**FIXED**	NONE	NONE	NONE
Firm * Year Effects	NONE	**NONE**	RANDOM	FIXED	NONE
Clustering By	MARKET-YEAR	**MARKET-YEAR**	FIRM-YEAR	FIRM-YEAR	MARKET-YEAR

Table 9: Model 2 shows my main result. Model 5 shows results using a lagged measure of MMC. Coefficients on controls shown in Table 8 were included in implementation, but are suppressed from the output. Coefficient standard errors are in brackets. $***p < .001$, $**p < .01$, $*p < .05$, $+p < .10$

Table 10: Evidence of Competitive Effects from MMC

Covariates	Model 1	Model 2 (Main)	Model 3	Model 4
$MMC_{ctry} * 10^{-1}$ (i,m,t)	-0.136***	-0.027	-0.064**	-0.058**
	[0.021]	[0.024]	[0.022]	[0.019]
$MMC_{prod} * 10^{-1}$ (i,m,t)	0.127***	0.111***	0.067***	0.017***
	[0.006]	[0.007]	[0.011]	[0.004]
$MMC_{cross} * 10^{-1}$ (i,m,t)	0.030***	0.040***	0.013	0.042***
	[0.007]	[0.008]	[0.009]	[0.006]
Other Markets Within Ctry (i,c,t)		-0.142***	-0.078***	
		[0.014]	[0.016]	
Other Markets Within Prod (i,p,t)		0.003	-0.002	
		[0.002]	[0.005]	
Other Markets Outside Both (i,t)		-0.002*		
		[0.001]		
R-Sq. Overall	0.24	0.24	0.182	0.196
Obs.	29500	29500	29500	29500
Year Effects	FIXED	FIXED	NONE	NONE
Market * Year Effects	NONE	NONE	FIXED	FIXED
Clustering By	MARKET-YEAR	MARKET-YEAR	MARKET-YEAR	MARKET-YEAR

Table 10: Disaggregated MMC measures that emphasize MMC across different products within a country (MMC_{ctry}), MMC across different countries within the same product (MMC_{prod}) and MMC across markets that differ by both country and product (MMC_{cross}). "Other Markets Within Ctry" are the number of other products firm i sells in country c, "Other Markets Within Prod" are the other countries where firm i sells product p and " Other Markets Outside Both" are the rest of the other markets. Coefficient standard errors are in brackets. $* * *p < .001$, $* * p < .01$, $*p < .05$, $+p < .10$

Table 11: Exports-At-Risk

Covariates	Model 1	Model 2
Log(XAR) (i,m,t)	0.015***	
	[0.003]	
Log(XAR_{ctry}) (i,m,t)		-0.028***
		[0.002]
Log(XAR_{hs}) (i,m,t)		0.023***
		[0.003]
Log(XAR_{cross}) (i,m,t)		0.006*
		[0.003]
Year Effects	FIXED	FIXED
Clustering By	MARKET-YEAR	MARKET-YEAR

Table 11: Model 1 has XAR is a weighted alternative to MMC used in Table 8. Model 2 decomposes XAR to emphasize XAR across different product markets within a country (XAR_{ctry}), different country markets within product (XAR_{prod}) and different country and product markets (XAR_{cross}). For reference, average XAR is $\$47,450,000$ with a standard deviation of $\$152,800,000$. Coefficient standard errors are in brackets. $***p < .001$, $**p < .01$, $*p < .05$, $+p < .10$

Table 12: Effects of External Competition

Covariates	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7
MMC * 10^{-1} (i,m,t)	0.066***	0.050**	0.102***	0.081***	0.090***	0.177***	0.103***
	[0.007]	[0.017]	[0.005]	[0.005]	[0.005]	[0.012]	[0.022]
Number of Non-manuf. exporters in market (m,t)	-0.004*	-0.005**	-0.003	-0.005**	-0.005**	-0.005**	-0.003+
	[0.002]	[0.002]	[0.002]	[0.002]	[0.002]	[0.002]	[0.002]
Average % of Non-Battery Exports by rivals (m,t)	-0.206*	-0.189*	-0.210*	-0.193*	-0.220*	0.096	0.123
	[0.094]	[0.094]	[0.094]	[0.094]	[0.094]	[0.097]	[0.101]
Share of imports from FPT (m,t)	0.661***	0.787***	0.758***	0.786***	0.792***	0.848***	0.744***
	[0.138]	[0.129]	[0.129]	[0.129]	[0.129]	[0.128]	[0.138]
Avg. FPT Imp Share faced by firm (i,t)	1.164***	1.029***	1.106***	1.099***	1.112***	1.089***	1.001***
	[0.112]	[0.117]	[0.109]	[0.109]	[0.109]	[0.109]	[0.124]
Avg. Non-Manuf Exp. (i,t)	0.004***	0.004***	0.003***	0.004***	0.004***	0.004***	0.003***
	[0.001]	[0.001]	[0.001]	[0.001]	[0.001]	[0.001]	[0.001]
% Export Value in Non-Batteries (i,t)	0.464***	0.460***	0.472***	0.469***	0.529***	0.501***	0.487***
	[0.069]	[0.069]	[0.069]	[0.069]	[0.077]	[0.069]	[0.077]
MMC * FPT IMP. SHR * 10^{-1}	0.029**						0.022+
	[0.009]						[0.011]
MMC * Avg. FPT IMP. SHR * 10^{-1}		0.048*					0.087***
		[0.023]					[0.024]
MMC * Num. Non-Manuf Exporters * 10^{-1}			-0.000***				-0.000*
			[0.000]				[0.000]
MMC * Avg. Non-Manuf Exp. * 10^{-1}				0			0.000**
				[0.000]			[0.000]
MMC * % NonBatt Exp. * 10^{-1}					-0.010+		-0.002
					[0.005]		[0.006]
MMC * Avg. % Non-Batt Exp * 10^{-1}						-0.139***	-0.153***
						[0.016]	[0.018]
R-Sq. Overall	0.23	0.23	0.23	0.23	0.23	0.23	0.24
Obs.	29500	29500	29500	29500	29500	29500	29500
Year Effects	FIXED	FIXED	FIXED	FIXED	FIXED	FIXED	FIXED
Clustering By	MARKET-YEAR	MARKET-YEAR	MARKET-YEAR	MARKET-YEAR	MARKET-YEAR	MARKET-YEAR	MARKET-YEAR

Table 12: Models 1 through 7 control for the extent of external competition on the ability of firms to use MMC to maintain high export prices. Controls in Table 8 are not included in this analysis in order to more fully understand the relationships seen in the data. Models 1 and 2 are concerned with competitors from foreign countries. Models 3 and 4 test the extent of downward bias emanating from out of sample non-manufacturing exporters. Models 5 and 6 examine the possibility of MMC occurring across battery and non-battery markets. Model 7 runs all the interactions in one specification. Coefficient standard errors are in brackets. $***p < .001$, $**p < .01$, $*p < .05$, $+p < .10$