Common-Ownership *vs.* Cross-Ownership: Evidence from the Automobile Industry*

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Abstract

Overlapping ownership has gained considerable momentum in the last decades, yet little is known about the role of its sources. We quantify the relative importance of common-ownership, by shareholders external to an industry, and cross-ownership, by firms within the industry. We focus on the global automobile industry, over the period 2007-2021, and document that common-ownership links amount to 31–40%, while cross-ownership links amount to 5–9% of automobile manufacturers' stock. We show that not accounting for these relatively modest cross-ownership links has important implications: it underestimates the average weight assigned by managers to the profit of competitors by between 41–105%.

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1 Introduction

The unprecedented growth and concentration of the asset management industry over recent decades (McIntyre et al., 2022) has led major asset managers to hold significant stakes in almost all the major firms of a multitude of industries. These common-ownership links may lead to a failure of Hart (1979)'s competitiveness condition, according to which shareholders unanimously agree on own-profit maximization, regardless of their preferences.[1] As such, the managers of firms with common shareholders may not maximize own profit, but, instead, weigh the (potential) conflicting preferences of their shareholders and (partially) internalize the externalities their strategies impose on the profits of other firms (Rotemberg, 1984; Hansen and Lott, 1996). This internalization can lessen product market competition,[2,3] a concern that spurred increasing research to quantify the prevalence of common-ownership.

Backus et al. (2021) and Amel-Zadeh et al. (2022) examine this question for the set of S&P 500 firms. The former consider the holdings of S&P 500 firms by large institutional shareholders and show that the average weight assigned by the managers of S&P 500 firms to the profit of the remaining S&P 500 firms has increased from 0.2 in 1980 to almost 0.7 in 2017. The latter consider the holdings not only of institutional shareholders, but also of corporate insiders and blockholders. They show that once we account for these holdings, the weight assigned by the managers of S&P 500 firms to the profit of the remaining S&P 500 firms is, in fact, lower, with most profit weights decreasing by between 5–25%.

Boot et al. (2022) examine the same question for the set of S&P Europe 350 firms. They show that the average weight assigned by the managers of S&P Europe 350 firms to the profit of the remaining S&P Europe 350 firms has increased from 0.08 in 2004 to 0.21 in 2015. This implies that while the average weight is lower than for the set of S&P 500 firms, the increase has been steeper in Europe than in the United States.

In some industries, however, in addition to common-ownership links, by shareholders external to the industry, there are also (for a variety of reasons) cross-ownership links, by shareholders that are internal to the industry, i.e., firms within an industry are themselves shareholders of other firms in the industry. Examples include various industries, such as

[1] To see why, note, for example, that if firm A imposes a negative externality on firm B, a shareholder of firm A who also holds shares in firm B typically wants the manager of firm A to pursue a less aggressive strategy than the strategy desired by a shareholder with no holdings in firm B.

[2] For example, Brito et al. (2019) show that the internalization induced by common shareholders among firms with horizontal relationships (and which thereby are likely to impose a negative externality on each other) can directly lead to higher product prices and lower output levels

[3] Although non-common shareholders may favor a different firm-specific strategy, that does not mean they are harmed by common shareholding because these links may, for example, reduce the competitiveness of rival firms, and non-common shareholders benefit from a reduction of competition between the firm and its rivals (see Schmalz, 2018 for a formal model).

automobiles (Neto et al., 2020), banking (Termushoev and Stakhovych, 2019), media (Ferguson, 1983), electric power (Amundsen and Bergman, 2002) and insurance (La Porta et al., 1999). Cross-ownership in itself can also decrease the incentives to compete and, naturally, lessen product market competition.[4] Moreover, it has also the potential to increase the extent of common-ownership. The reason is that cross-ownership links change the distribution of ultimate holdings among external shareholders (see, for example, Ellerman, 1991; and Brito et al., 2018). To see why, consider, for example, an industry with three firms: firms A, B and C. To begin with, consider a shareholder structure with solely common-ownership links. In particular, consider that firm A has two shareholders: shareholders 1 and 2, with shareholder 1 being an external non-common shareholder with holdings solely in firm A and shareholder 2 being an external common shareholder with holdings in firms A and B. This shareholder structure implies, as discussed above, that the manager of firm A may not maximize own profit. Instead, she may weigh also the profit of firm B (as shareholder 2 has a direct interest in the profit of firm B), although not the profit of firm C (as no shareholder has a direct interest in the profit of firm C).

Consider now a shareholder structure with (additionally) cross-ownership links among the firms in the industry. In particular, consider that firm A has holdings in firm B and that firm B has holdings in firm C. These cross-ownership links have several qualitative implications. First, the ultimate interest of shareholder 2 in firm B is greater than her direct holdings in the firm, because she now also has an indirect interest in the profit of firm B (via the profit of firm A). Second, although shareholder 1 has holdings solely in firm A, the cross-ownership link between firms A and B turns her ultimately into a common shareholder of firm B, because she now has an indirect interest in the profit of this firm (via the profit of firm A). Third, although none of the shareholders of firm A have direct holdings in firm C, the cross-ownership links between the three firms turn these shareholders ultimately into common shareholders of firm C, because they now have an indirect interest in the profit of this firm (via the profit of firms A and B). In other words, cross-ownership links have the potential to increase the extent of common-ownership in two dimensions: (a) increase the positive weight that, due to common ownership, is assigned by managers to the profit of rivals; and (b) increase the number of firms considered in the weighted average of the manager.

To the best of our knowledge, this potential reinforcing role of cross-ownership links has

[4]For example,Reynolds and Snapp (1986) and Shelegia and Spiegel (2012) show that cross-ownership links can increase prices while Bresnahan and Salop (1986) and Dietzenbacher et al. (2000) show that they can increase price-cost margins. Farrell and Shapiro (1990) show, on the other hand, that even if at the cost of higher prices, cross-ownership links can increase welfare, due to improved industry performance, while Gilo et al. (2006) show that they may not necessarily facilitate tacit collusion.

not been examined empirically in the literature. We propose to address this gap by examining the relative roles of common- and cross-ownership in the global automobile industry. This industry is ideally suited for such a study for two reasons. First, automobile manufacturers command a substantial share of the global GDP. Thus, it is not surprising that major asset managers have holdings in the major manufacturers. In 2021, for example, the Big Three asset managers (BlackRock, Vanguard and State Street) held significant stakes in literally all the major manufacturers.[5] Second, automobile manufacturers engage in different types of partnerships to share high development costs, reduce sourcing costs, gain access to new markets, establish economies of scale or gain access to complementary resources (Robertson and Karl, 1998). These types of partnerships include (among others) cross-ownership links.[6] In fact, cross-ownership links have a long tradition in the automobile industry. Alley (1997) documents cross-ownership links between U.S. and Japanese manufacturers as early as 1979. Examples of long-term partnerships include the holdings among Mercedes, Nissan and Renault, between Ford and Mazda (ended in 2014), between Nissan and Renault, between Volkswagen and Suzuki, and among Toyota and a number of other Asian manufacturers (see Neto et al., 2020 for a thorough account).

We focus on the ownership patterns in the global automobile industry for the period 2007-2021. We document that common-ownership links amount to 31–40%, while cross-ownership links amount to 5–9% of automobile manufacturers' stock. We show that not accounting for these relatively modest cross-ownership links has important implications: it underestimates the average weight assigned by managers to the profit of competitors by between 41–105%, depending on the years and on the measure of corporate control used.

The remainder of the paper is organized as follows. Section 2 describes the theoretical framework used to compute the profit weights. Section 3 applies the profit weights to the global automobile industry. Section 4 concludes and discusses policy implications of the results.

[5]This includes BAIC, BMW, Changan, Dongfeng, FAW, Ford, GM, Geely, Great Wall, Honda, Hyundai, Mazda, Mitsubishi, Nissan, Renault, SAIC, Subaru, Suzuki, Stellantis, Tata, Toyota, and Volkswagen.

[6]Other types of partnerships include joint ventures, where companies join their forces to establish a child company, and non-equity strategic alliances, where companies agree to pool their resources and capabilities together. Examples of horizontal joint ventures are partnerships between Western car makers and their Chinese counterparts, in order to access the Chinese market (Hu et al., 2014). Vertical joint ventures comprise firms of different industries, such as in efforts to produce batteries, develop autonomous driving technology, build charging infrastructure, and introduce car-sharing services (Automotive News Europe, 2018). A leading example of strategic alliance is the joint development of car platforms, whereby companies share design, engineering, and production efforts, leading to different models sharing the same components (Autoblog, 2022). Recent cases include the joint development of the Toyota GR86 and the Subaru GTR and Volkswagen's MQB platform, whose first version was introduced in 2012, which has been used by different products of the brands Audi, Seat, Skoda, and Volkswagen itself.

2 Theoretical Framework

There are N multi-product firms, indexed by $f \in \Im \equiv \{1, \ldots, F\}$, whose total stock is composed of voting stock and non-voting (preferred) stock. Both stocks give the holder the right to a share of the firm's profits, but only the former gives the holder the right to vote in the firm's general assembly.

There are also K shareholders, indexed by $k \in \Theta \equiv \{1, \ldots, F, \ldots, K\}$, who may engage in overlapping ownership. The set of shareholders can include not just shareholders $\Theta \setminus \Im$ that are external to the industry (and can engage in common-ownership), but also shareholders from the subset of firms that are internal to the industry (and can engage in cross-ownership).

The holdings $\phi_{kf} \in [0, 1]$ of total stock of shareholder k in firm f, regardless of whether it be voting or non-voting stock, capture her *financial rights* to the firm's profits. The holdings $\upsilon_{kf} \in [0, 1]$ of voting stock of shareholder k in firm f, capture her *voting rights* in the firm. These voting rights may not necessarily coincide with her *control rights* in the firm, $\gamma_{kf} \in [0, 1]$, which refer to her rights to influence the decisions of firm f and depend, in general, not only on her voting rights, but also on the distribution of voting rights in the firm: $\gamma_{kf} = \mathcal{F}(\upsilon_{kf} | \upsilon_{1f}, ..., \upsilon_{kf}, \ldots, \upsilon_{Kf})$.[7] For instance, shareholder k may have no control over the decision-making within firm f, i.e. $\gamma_{kf} = 0$, even while holding 49% of the voting rights in the firm, if one other shareholder holds 51%. In contrast, shareholder k may have effective control over the decision-making within firm f, i.e. $\gamma_{kf} = 1$, even while holding 10% of the voting rights in the firm, if each of the remaining shareholders is atomistic.

We assume that external shareholders hold voting rights in at least one firm of the industry. This implies that the firms in the industry are not entirely held by the firms themselves.[8] As such, we have that $\sum_{k \in \Theta \setminus \Im} \upsilon_{kf} > 0$ for at least one firm f. Because the financial rights of a shareholder in a firm denotes the owner's holdings of total stock in the firm, regardless of whether it be voting or non-voting stock, it implies we also have that $\sum_{k \in \Theta \setminus \Im} \phi_{kf} > 0$ for at least one firm f.

2.1 Ultimate Financial, Voting and Control Rights

The automobile industry is characterized by a multitude of cross-ownership links. We follow Ellerman (1991) and Brito et al. (2018) in computing the ultimate rights of external shareholders on the different firms that result from the existing cross-ownership links. We begin this analysis by focusing on the financial rights.

[7] Short-sales are not allowed and so financial, voting and control rights are non-negative.

[8] Furthermore, it implies also that we can cope with settings in which a firm can hold 100% of the financial rights of a rival firm.

2.1.1 Financial Rights

The ultimate financial rights of external shareholder k in firm f, ϕ^u_{kf}, includes not just her direct financial rights in the firm, ϕ_{kf}, but also the indirect financial rights that may arise from having ultimate financial rights in a rival $g \in \Im \backslash f$ that holds, in turn, financial rights in firm f. This implies that for all $k \in \Theta \backslash \Im$ and $f, g \in \Im$, we have:

$$\phi^u_{kf} = \phi_{kf} + \sum\nolimits_{g \in \Im \backslash f} \phi^u_{kg} \phi_{gf}, \tag{1}$$

where $\Im \backslash f$ denotes the set $\Im$ not including firm f. The set of equations (1) implicitly determines the ultimate financial rights of each external shareholder as a function of the direct financial rights of all shareholders (internal and external).[9] Please see Appendix A for the computation details. We now address the voting and control rights.

2.1.2 Voting and Control Rights

The ultimate voting rights of external shareholder k in firm f, υ^u_{kf}, includes not just her direct voting rights in the firm, υ_{kf}, but also the indirect voting rights that may arise from having ultimate control rights in a rival $g \in \Im \backslash f$ that holds, in turn, voting rights in firm f. To see why, consider the following example, borrowed from Levy (2011). If an external shareholder fully controls firms A and B and each of the firms holds in turn 30% of the voting rights in firm C, then the external shareholder ultimately holds 60% of the voting rights in firm C. This implies that for all $k \in \Theta \backslash \Im$ and $f, g \in \Im$, we have:

$$\begin{aligned} \upsilon^u_{kf} &= \upsilon_{kf} + \sum\nolimits_{g \in \Im \backslash f} \gamma^u_{kg} \upsilon_{gf} \\ &= \upsilon_{kf} + \sum\nolimits_{g \in \Im \backslash f} \mathcal{F}\left(\upsilon^u_{kg} | \upsilon^u_{F+1g}, ..., \upsilon^u_{kg}, \ldots, \upsilon^u_{Kg}\right) \upsilon_{gf}. \end{aligned} \tag{2}$$

If the ultimate control rights of external shareholders in any given firm (implied by the vector of their ultimate voting rights) are non-negative and sum up to one, the set of equations (2) implicitly determines the ultimate voting rights of each external shareholder as a function of the direct voting rights of all shareholders (internal and external).[10] Please see Appendix

[9] Brito et al. (2018) show that the ultimate financial rights of external shareholders implied by the set of equations (1) are non-negative and sum up to one for any given firm f, making clear that a cross-ownership of financial rights changes the distribution of those rights among external shareholders, as the *ultimate* financial rights of external shareholder k in firm f, ϕ^u_{kf}, is not necessarily equal to the *direct* financial rights of external shareholder k in that firm, ϕ_{kf}, but the sum of all financial interests in the firm, is: $\sum_{k \in \Theta} \phi_{kf} = \sum_{k \in \Theta \backslash \Im} \phi^u_{kf} = 1$.

[10] Brito et al. (2018) show that the ultimate voting rights of external shareholders implied by the set of equations (2) are non-negative and sum up to one for any given firm f, making clear that a cross-ownership of voting rights changes the distribution of those rights among external shareholders, as the *ultimate* voting

A for the computation details.

2.2 Profit Weights

The managers of firms with overlapping shareholders may weigh the eventual conflicting objectives of their shareholders, rather than maximizing own profits. This implies that they may internalize (to some degree) the externalities their strategies impose on other firms (Rotemberg, 1984; Hansen and Lott, 1996). The quantification of this induced internalization is paramount to empirically quantify the prevalence of overlapping ownership.[11] To do so, the formulation of the weight that the manager of a firm assigns to the profit of other firms is key. This formulation is, however, non-trivial. To see why, consider, for example, that firm A has four shareholders, each holding 25% of the firm, and that one of those shareholders also holds 20% of firm B. If firm A imposes an externality on firm B, what weight would the manager of firm A assign to the profit of firm B?

The dominant formulation of these profit weights in the presence of overlapping shareholders is due to O'Brien and Salop (2000). Incorporating features from both Rotemberg (1984) and Bresnahan and Salop (1986), they assume that *the manager of each firm f with overlapping shareholders would maximize a control-weighted sum of the returns of the firm's shareholders*. In the presence of both cross- and common-ownership, this implies maximizing $\sum_{k\in\Theta\setminus\Im}\gamma^u_{kf}R_k$, where $R_k=\sum_{g\in\Im}\phi^u_{kg}\pi_g$ denotes the return of shareholder k's ultimate financial rights holdings in all the firms in the industry, and π_g denotes the profit of firm g. Naturally, this is entirely equivalent to *maximizing a weighted sum of the profits of (potentially) all the firms in the industry*, where the (normalized) weight that the manager assigns to the profit of firm g for any $f,g\in\Im$ is given by:[12]

$$w_{fg} \;=\; \frac{\sum_{k\in\Theta\setminus\Im}\gamma^u_{kf}\phi^u_{kg}}{\sum_{k\in\Theta\setminus\Im}\gamma^u_{kf}\phi^u_{kf}}. \tag{3}$$

Azar (2012, 2016, 2017), Brito et al. (2018) and Moskalev (2019) microfound the dominant formulation of these profit weights through a voting model in which shareholders vote to elect the manager from two potential candidates, an incumbent and a challenger, with conceivably differing strategy proposals to the firm. Candidates are assumed to care about

rights of external shareholder k in firm f, υ^u_{kf}, is not necessarily equal to the *direct* voting rights of external shareholder k in that firm, υ_{kf}, but the sum of all voting rights in the firm, is: $\sum_{k\in\Theta}\upsilon_{kf}=\sum_{k\in\Theta\setminus\Im}\upsilon^u_{kf}=1$.

[11] See Brito et al. (2022) for a review of the proposals available in the literature for this quantification.

[12] This dominant formulation has been critiqued for yielding counter-intuitive profit weights when the ownership of non-overlapping shareholders is highly dispersed. Brito et al. (2022) propose an alternative formulation of the objective function of managers, which solves this criticism.

holding office.[13] In turn, shareholders are assumed to care about the returns that result from the different strategy proposals and to have an additive profit-irrelevant bias for (or against) the challenger.[14,15] Voting is probabilistic in the sense that the bias, while known to voters, is unobserved by candidates, who treat it as random. This microfoundation is consistent with empirical evidence establishing that shareholders' voting impacts the objective function of managers (Aggarwal et al., 2019). Moreover, it provides an endogenous measure of shareholders corporate control within the firm. Azar (2012, 2017) shows that the corporate control of shareholders can be microfounded to be endogenously measured by their voting rights (proportional control) while Azar (2016), Brito et al. (2018) and Moskalev (2019) show it can be microfounded to be endogenously measured by the normalized Banzhaf power indices that result from their voting rights.

3 Empirical Application

3.1 Data Description

We examine the ownership patterns in the global automobile industry for the period 2007-2021. We focus on the following automobile manufacturers: BAIC, BMW, Changan, Chrysler, Daihatsu, Dongfeng, FAW, Fiat, Ford, Geely, GM, Great Wall, Honda, Hyundai, Mazda, Mercedes, Mitsubishi, Nissan, PSA, Renault, SAIC, Subaru, Suzuki, Tata, Toyota, and Volkswagen.[16] According to the International Organization of Motor Vehicle Manufacturers, these manufacturers cover around 90% of the yearly world motor vehicle production.[17]

For each manufacturer and year, we obtain ownership information from Refinitiv Eikon, which we combine when appropriate with ownership information from annual reports and Troubled Asset Relief Program (TARP) assistance reports prepared by the Congressional

[13] Azar (2012, 2017) considers the case in which candidates choose strategy proposals to maximize their *vote share* while Azar (2016), Brito et al. (2018) and Moskalev (2019) consider the case in which candidates choose strategy proposals to maximize their *expected utility from corporate office*.

[14] Azar (2012, 2016, 2017) and Brito et al. (2018) consider the case in which this bias is *independent* (and identically) distributed across shareholders while Moskalev (2019) considers the case in which the bias can be *correlated* across shareholders.

[15] In line with Azar (2017), one may also microfound the dominant formulation through a voting model in which shareholders vote whether to approve a managerial change in the firm's status quo strategic plan and have an additive profit-irrelevant bias for (or against) this change.

[16] We do not include Kia as a stand-alone manufacturer because Kia and Hyundai are members of the Hyundai Motor Group, a South Korean chaebol, with Hyundai regarded as the *de facto* representative of the group.

[17] The International Organization of Motor Vehicle Manufacturers provides statistics, by manufacturer, on the world motor vehicle production until 2017. For the period 2007-2017, these manufacturers account for between 87.9–93.1% of the yearly world production.

Research Service for the U.S. Congress. Please see Appendix B for additional details (including the Reuters instrument codes used). Refinitiv Eikon has a number of advantages compared to other data sources. First, in addition to 13F filings, which are only filed by large shareholders in the US, it also includes both institutional and non-institutional shareholders. Amel-Zadeh et al. (2022) show that including solely institutional shareholders when calculating measures of overlapping ownership "can bias the measured level and mask the true variation of overlapping ownership of firms, whether in the same industry, or across industries".

Second, the ownership information in Refinitiv Eikon is to a large extent aggregated by asset manager and therefore requires less processing than the 13-F fillings. Notwithstanding this aggregation, it still has several separate entries for the Big Three asset managers (BlackRock, Vanguard and State Street), which report some of their subsidiary holdings separately. We consolidate those entries, since Fichtner et al. (2017) show that the Big Three do utilize coordinated voting strategies and hence follow a centralized corporate governance strategy. We also consolidate the holdings of the following shareholders of BAIC, Changan, Dongfend, FAW, and SAIC, respectively: Beijing Automotive Group Co, China Changan Automobile Group Co, Dongfeng Motor Corporation, China FAW Co, and Shanghai Automotive Industry (Group), as they are wholly owned subsidiaries of the Government of the People's Republic of China, the Municipality of Beijing or the municipality of Shanghai.[18]

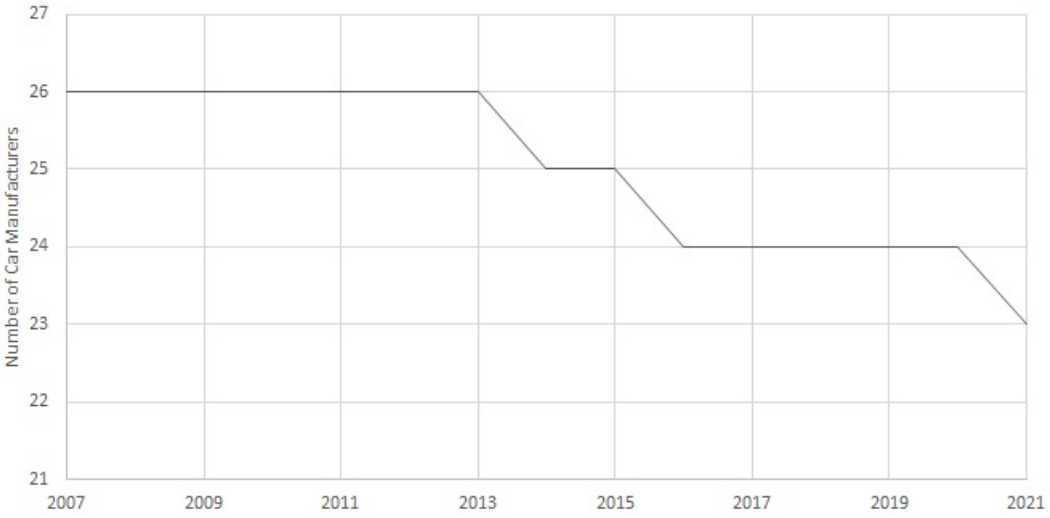
Third, Refinitiv Eikon has historical data on delisted companies, which is key because of the recent consolidation of the automobile industry. Figure 1 reports the number of automobile manufacturers in the sample over time, illustrating this consolidation: in October 2014, Chrysler and Fiat merge (giving rise to FCA); in August 2016, Daihatsu became a wholly owned subsidiary of Toyota; and in January 2021, FCA and PSA merge (giving rise to Stellantis).

We classify a shareholder of a firm as an internal shareholder (i.e., a rival automobile manufacturer) if the name of the shareholder coincides exactly with the name of the manufacturer from Refinitiv Eikon, with two exceptions: (a) for GM, we also consider the holdings of GM Asset Management; and (b) for Nissan, we also consider the holdings of Nissan Finance Co., Ltd. Both are wholly owned subsidiaries of GM and Nissan, respectively. We do not classify as internal shareholders, affiliated firms of the manufacturer and subsidiaries of external shareholders.[19] Figure 2 reports the (arithmetic) average of the financial rights held

[18] We also consolidate the holdings of Li Shufu, Geely's founder, which are reported by Refinitiv Eikon under two different headings: Li (Shu Fu) and Li (Shufu).

[19] In particular, we do not consider, for Toyota, the holdings of affiliates Toyota Asset Management Co., Ltd. (before the merger in 2013 with Sumitomo Mitsui Asset Management Co Ltd) and Toyota Tsusho Corp, as Toyota stakes on both firms is only partial. Further, we also do not consider, for BAIC, the holdings

Figure 1: *Number of Car Manufacturers in the Sample*

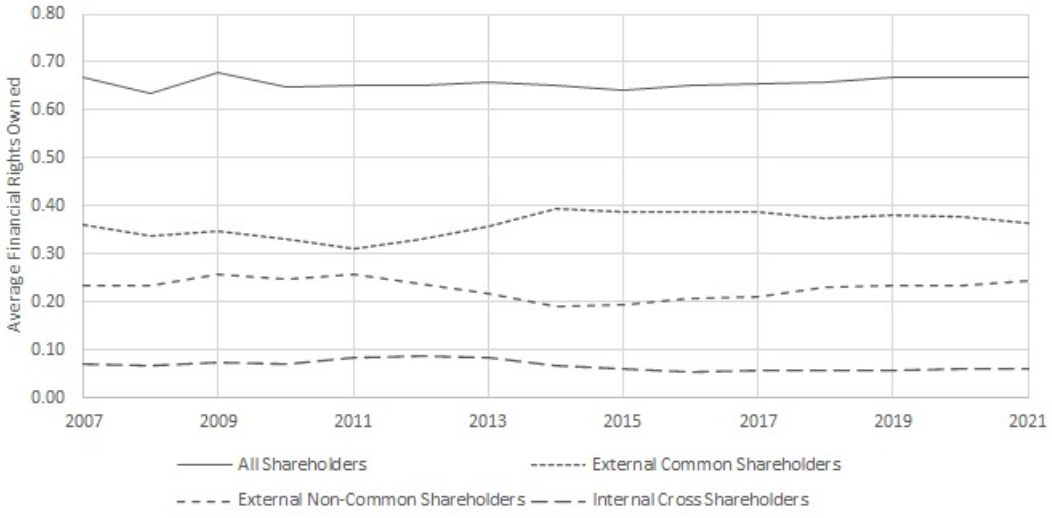


by the shareholders collected by Refinitiv Eikon for the different automobile manufacturers in each year, discriminated across the different shareholder types. The plot shows that the shareholders collected by Refinitiv Eikon hold between 64–68% of the financial rights in the average automobile manufacturer in the sample, discriminated as follows. Between 19–26% are held by external non-common shareholders (with holdings in a single manufacturer in a given year), between 31–40% are held by external common shareholders (with holdings in at least two manufacturers in a given year, reflecting common ownership), and between 5–9% are held by internal shareholders (reflecting cross-ownership).

Figure 3 examines the holdings of internal shareholders in more detail. Figure 3, Panel A reports the number of pairwise cross-ownership links over time. The plot shows that, in each year, we have between 8 and 14 direct pairwise cross-ownership links in the sample. The increase in the number of cross-ownership links in the first part of the sample stems from a combination of an increase of alliances aiming to emulate the successful Renault-Nissan partnership and a response to the challenges posed by the financial crisis, e.g., the quest for cost reductions and production efficiencies through technology sharing and joint development of product lines (BBC, 2012). Following a decrease in the number of links with the recovery of the global economy, the increase in the number of cross-ownership links in the final part of the sample may be attributed to the new challenges facing the industry, such as the development of electric mobility, autonomous driving, and mobility as a service

of BAIC Group Industrial Investment Co Ltd, a wholly owned subsidiary of BAIC's external shareholder Beijing Automotive Group co. Ltd. Finally, we do not consider, for Mitsubishi, the holdings of other firms of the Mitsubishi Group as each firm of the group is independent.

Figure 2: *Average Financial Rights in the Sample*



(Automotive News Europe, 2018).[20]

Figure 3, Panel B reports the (arithmetic) average of the financial rights associated to those pairwise cross-ownership links. The plot shows that the average direct pairwise cross-ownership links involves between 12–17% of the financial rights, and has decreased slightly from 2016 onwards.[21]

3.2 Profit Weights

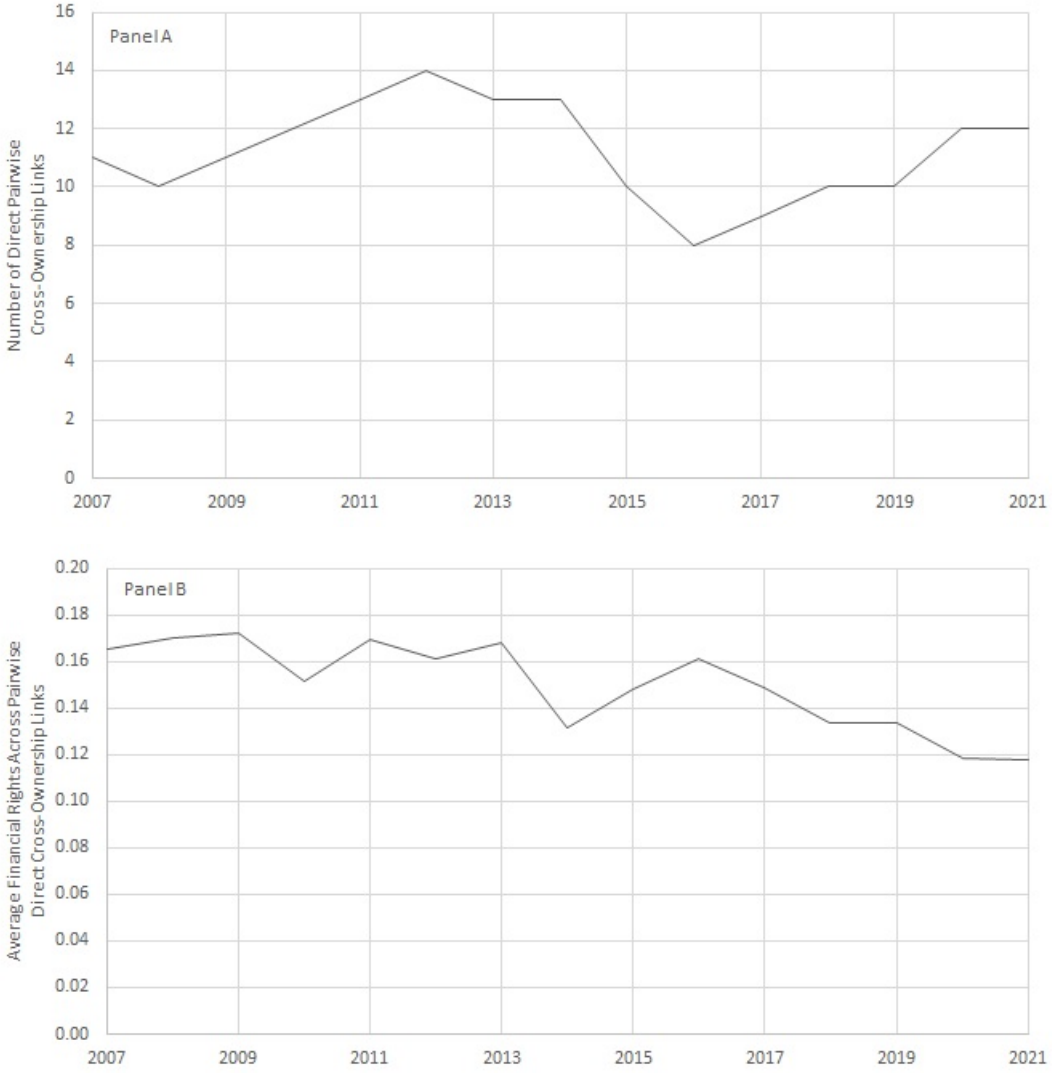
At first sight, the above findings suggest that cross-ownership links are relatively unimportant compared with common-ownership links. To evaluate this, we use the ownership data to compute the profit weight for each manufacturer pair in each year. We follow the literature in assuming a one-share-one-vote rule. Further, as retail shareholders are not observed in the data, we assume, also following the practice in the literature, that the (remaining) retail share of each firm is made up of an infinity of atomist shareholders.

Figure 4 reports the (arithmetic) average profit weight of all cross-pairs of car manufac-

[20] Important new cross-ownership links in the early part of the sample include the Fiat-Chrysler partnership (2009) and the then Daimler Group partnership with the Renault-Nissan alliance (2010). The decrease in cross-ownership links mid-sample occurs due to a variety of reasons such as the Fiat-Chrysler merger (2014) and the Daihatsu acquisition by Toyota (2016); the end of the Volkswagen-Suzuki (2014), Ford-Mazda (2015), and Subaru-Suzuki (2016) partnerships. These were not counteracted by the creation of the Daimler-BAIC partnership (2014), which introduced a new cross-ownership link with the aim of increasing the foothold of the German carmaker in the Chinese market and sharing development costs (CNN, 2019). Finally, partnerships which increased the number of cross-ownership links towards the end of the sample include Toyota's partnerships with Mazda (2017) and Suzuki (2020).

[21] This reduction reflects the fact that the new cross-ownership links created from 2017 are of smaller magnitude than the pre-existing ones.

Figure 3: *Cross-Ownership Links in the Sample*



turers in each year. We report the formulation of the profit weight established in equation (3), which accounts for the cross-ownership links in the industry, by distinguishing between internal and external shareholders and considering the ultimate rights of external shareholders. For comparison purposes, we also report a formulation of the profit weight which does not account for the cross-ownership links in the industry. To do so, we do not distinguish between internal and external shareholders and consider solely the direct rights of shareholders, as if all shareholders (internal and external) were external to the industry. This mimics the formulation in Backus et al. (2021), Amel-Zadeh et al. (2022), and Boot et al. (2022).

Figure 4, Panel A considers the case in which the control rights of shareholders are measured by their voting rights (which are assumed to coincide with their financial rights, also following the practice in the literature). This measure of control rights may have two unappealing properties: (a) it does not converge to 100% as the voting rights of a shareholder approach 50%; and (b) it does not depend on the voting rights of the firm's all other shareholders.[22] Figure 4, Panel B therefore considers the case in which the control rights of shareholders are measured by the normalized Banzhaf power indices that result from their voting rights, which addresses the two unappealing properties described above.[23]

The plots of both panels suggest that the average profit weight has increased steadily over time until 2017 and has decreased slightly since then. Further, the plots also suggest that the average profit weight is lower when compared to the set of S&P 500 firms (as reviewed in the introduction). This is consistent with the evidence in Boot et al. (2022), as U.S. asset managers typically hold smaller stakes in non-U.S. firms. Finally, the plots also suggest that accounting for the cross-ownership links in the industry is important. Not doing so, i.e., computing profit weights as if all shareholders (internal and external) were external to the industry, underestimates the average profit weight downwards by between 41% and 105%, depending on the years and on whether control rights are measured by voting rights or the normalized Banzhaf power indices that result from voting rights.

To examine this bias in more detail, Figure 4, Panels C and D report the distribution of the percentage change in the profit weights due to accounting for cross-ownership links, for all individual firm-pairs across all years.[24] Figure 4, Panel C considers the case in which control rights are measured by voting rights. The results confirm that cross-ownership links have the potential to increase the extent of common-ownership in two dimensions: (a) increase

[22] As we may expect a shareholder who holds, for example, 10% of the voting rights in a firm to have effective control if each of the remaining shareholders hold a tiny amount of the firm's voting rights.

[23] To do so, we compute, following Dubey and Shapley (1979), the normalized Banzhaf power indices using the set of observed shareholders.

[24] The percentage change associated to individual firm-pairs for which profit weights are null regardless of whether we account or not for cross-ownership links, is depicted as zero in Figure 4, Panels C and D.

the positive weight that due to common-ownership is assigned by managers to the profit of rivals; and (b) increase the number of firms considered in the weighted average of the manager. In fact, when we account for cross-ownership links, the profit weights of most individual firm-pairs (54%) do change, with the overwhelming changes being concentrated in increases between 1–25% (22%) and increases above 100% (20% of which finite and 4% of which infinite, denoting profit weights that in the absence of cross-ownership links are null, but become positive when those links are accounted for). These results are robust to measuring control rights by the normalized Banzhaf power indices that result from voting rights, as depicted in Figure 4, Panel D. Overall, this suggests that overlapping ownership in the global automobile industry is a relevant empirical issue and that empirical quantifications of its impact on market outcomes should take cross-ownership links into consideration.

4 Conclusions

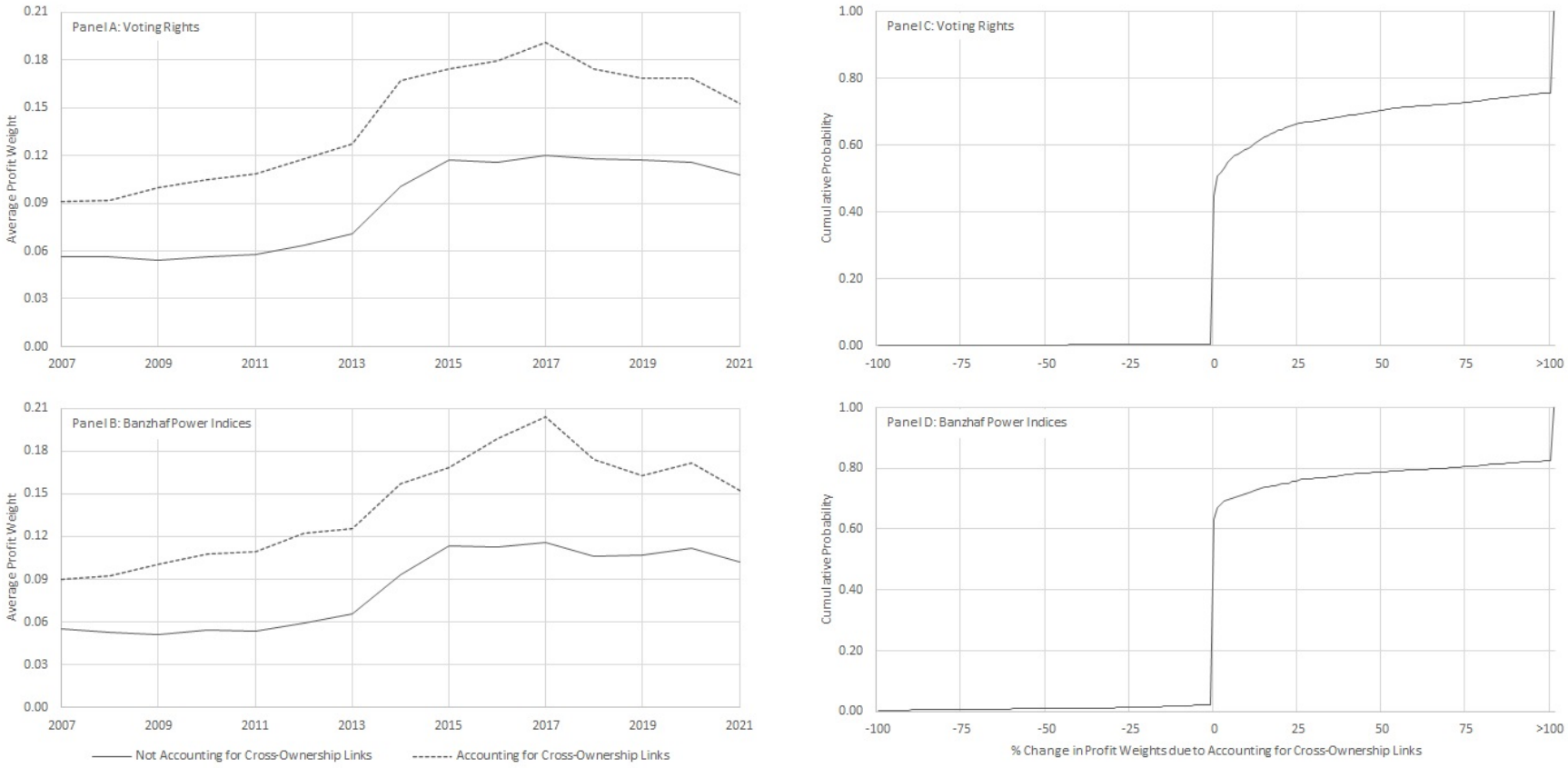
We examine the evolution of overlapping ownership in the global automobile industry over the period 2007-2021. As the industry is very much characterized by both common- and cross-ownership links, it is important to quantify the relative importance of these two sources of overlapping ownership.

We document that common-ownership links amount to 31–40%, while cross-ownership links amount to 5–9% of automobile manufacturers' stock. We also show that not accounting for these relatively modest cross-ownership links has important implications. It results in an underestimation of the average weight assigned by managers to the profit of competitors by between 41–105%, depending on the years and on the measure of corporate control used.

This finding has important policy implications. First, competition agencies ought to account for cross-ownership when calculating the traditional indicators used to screen unilateral anti-competitive effects. Second, and more generally, cross-ownership ought to play a potentially important role in the major rethinking of antitrust enforcement stimulated by the rise in overlapping ownership (Elhauge, 2016; Scott Morton and Hovenkamp, 2018; Hemphill and Kahan, 2020), which must make the best possible use of the existing empirical evidence.

This article leaves a number of open questions. For instance, what is the impact of the different sources of overlapping ownership on market outcomes? It would be interesting to address this in future research.

Figure 4: *Profit Weights in the Sample*



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Appendices

A Ultimate Rights

Ultimate Financial Rights

In order to see why the set of equations (1) implicitly determines the ultimate financial rights of each external shareholder as a function of the direct financial rights of all shareholders (internal and external), let $\mathbf{F}$ and $\mathbf{F}^u$ denote the $(K-F)\times F$ matrices capturing the direct and ultimate financial rights, respectively, of external shareholders, with typical elements ϕ_{kf} and ϕ^u_{kf} representing the direct and ultimate financial rights, respectively, of external shareholder k in firm f. Let also $\mathbf{F}^*$ denote the $F\times F$ matrix capturing the direct financial rights of internal shareholders, with zero diagonal elements, $\phi_{ff}=0$, and off-diagonal elements, $0\leq\phi_{fg}\leq 1$ (if $f\neq g\in\Im$), representing the direct financial rights of firm f in firm g. We can then use matrices $\mathbf{F}$, $\mathbf{F}^u$ and $\mathbf{F}^*$ to write the set of equations (1) in vector notation, as follows:

$$\mathbf{F}^u \quad = \quad \mathbf{F}+\mathbf{F}^u\mathbf{F}^*. \tag{4}$$

In order to solve for $\mathbf{F}^u$ explicitly we can rewrite it as:

$$\mathbf{F}^u\left(\mathbf{I}_F-\mathbf{F}^*\right) \quad = \quad \mathbf{F}, \tag{5}$$

where $\mathbf{I}_F$ denotes a $F \times F$ identity matrix.

The assumption that external shareholders hold voting rights in at least one firm of the industry implies that $\sum_{k \in \Im} \phi_{kf} \leq 1$ for all firms f with strict inequality for at least one firm. This constitutes a sufficient condition for the Frobenius root of the non-negative square matrix $\mathbf{F}^*$ to be less than unit (see Theorem 12, Chapter 4, in Murata, 1977). As a consequence, the absolute value of any eigenvalue of $\mathbf{F}^*$ is less than unit and, thus, its spectral radius, which implies, in turn, that $(\mathbf{I}_N - \mathbf{F}^*)^{-1}$ exists, with typical element ϕ^*_{fg} representing the ultimate financial rights of firm f in firm g. We can, thereby, solve for $\mathbf{F}^u$ explicitly as follows:

$$\mathbf{F}^u = \mathbf{F}\left(\mathbf{I}_N - \mathbf{F}^*\right)^{-1}, \tag{6}$$

which establishes, as postulated, that the ultimate financial rights of each external shareholder can, in fact, be written as a function of the direct financial rights of all shareholders.

Ultimate Voting and Control Rights

In order to see why that the set of equations (2) implicitly determines the ultimate voting rights of each external shareholder as a function of the direct voting rights of all shareholders (internal and external), let $\mathbf{V}$, $\mathbf{V}^u$ and $\mathbf{C}^u$ denote the $(K-F) \times F$ matrices capturing the direct voting rights, ultimate voting rights and ultimate control, respectively, of external shareholders, with typical elements υ_{kf}, υ^u_{kf} and γ^u_{kf} representing the direct voting rights, ultimate voting rights and ultimate control rights, respectively, of external shareholder k in firm f. Let also $\mathbf{V}^*$ denote the $F \times F$ matrix capturing the direct voting rights of internal shareholders, with zero diagonal elements, $\upsilon_{ff} = 0$, and off-diagonal elements, $0 \leq \upsilon_{fg} \leq 1$ (if $f \neq g \in \Im$), representing the direct voting rights of firm f in firm g. We can use matrices $\mathbf{V}$, $\mathbf{V}^u$, $\mathbf{C}^u$ and $\mathbf{V}^*$ to write the set of equations (2) in vector notation, as follows:

$$\begin{aligned} \mathbf{V}^u &= \mathbf{V} + \mathbf{C}^u\mathbf{V}^* \\ &= \mathbf{V} + \mathcal{F}\left(\mathbf{V}^u\right)\mathbf{V}^*, \end{aligned} \tag{7}$$

where $\mathcal{F}(\cdot)$ denotes the function which maps the ultimate voting rights of external shareholders implied by matrix $\mathbf{V}^u$ into the corresponding ultimate control rights established in matrix $\mathbf{C}^u$. Brito et al. (2018) show that if there exists a unique matrix $\mathbf{V}^u$ that solves $\mathbf{V}^u = \mathbf{V} + \mathcal{F}\left(\mathbf{V}^u\right)\mathbf{V}^*$, the fixed point iterates given by $\mathbf{V}^{u(i+1)} = \mathbf{V} + \mathcal{F}\left(\mathbf{V}^{u(i)}\right)\mathbf{V}^*$ converges to $\mathbf{V}^u$ as $i \to \infty$ from *any* initial condition $\mathbf{V}^{u(0)}$, as under the assumption that external shareholders hold voting rights in at least one firm of the industry $\mathbf{V}$ is not a null matrix. In the particular case of proportional corporate control, where the corporate control rights of the different shareholders are captured by their corresponding voting rights, we have that $\mathbf{C}^u = \mathcal{F}\left(\mathbf{V}^u\right) = \mathbf{V}^u$. This implies that $\mathbf{V}^u = \mathbf{V} + \mathbf{V^u}\mathbf{V}^*$, which - under the assumption that external shareholders hold voting rights in at least one firm of the industry - yields $\mathbf{V}^u = \mathbf{V}\left(\mathbf{I}_N - \mathbf{V}^*\right)^{-1}$.

B Ownership Data Sources

We obtain ownership information from Refinitiv, which we combine when appropriate with ownership information from annual reports and TARP assistance reports prepared by the Congressional Research Service for Congress. The details are as follows.

For BMW, Changan, Daihatsu, FAW, Fiat, Ford, Geely, Honda, Hyundai, Mazda, Mercedes, Mitsubishi, Nissan, PSA, Renault, SAIC, Subaru, Suzuki, Tata, Toyota, and Volkswagen, as well as for the merged entities FCA and Stellantis, ownership information is obtained solely from Refinitiv. The Reuters instrument codes used and periods considered for each of these manufacturers are the following: BMW (RIC: BMWG.DE; Period: 2007-2021), Changan (RIC: 000625.SZ; Period: 2007-2021), Daihatsu (RIC: 7262.T^G16; Period: 2007-2015), FAW (RIC: 000800.SZ; Period: 2007-2021), FCA (RIC: STLA.MI; Period: 2014-2020), Fiat (RIC: STLA.MI; Period: 2007-2013), Ford (RIC: F; Period: 2007-2021), Geely (RIC: 0175.HK; Period: 2007-2021), Honda (RIC: 7267.T; Period: 2007-2021), Hyundai (RIC: 005380.KS; Period: 2007-2021), Mazda (RIC: 7261.T; Period: 2007-2021), Mercedes (RIC: MBGn.DE; Period: 2007-2021), Mitsubishi (RIC: 7211.T; Period: 2007-2021), Nissan (RIC: 7201.T; Period: 2007-2021), PSA (RIC: PEUP.PA^A21; Period: 2007-2020), Renault (RIC: RENA.PA; Period: 2007-2021), SAIC (RIC: 600104.SS; Period: 2007-2021), Stellantis (RIC: STLA.MI; Period: 2021), Subaru (RIC: 7270.T; Period: 2007-2021), Suzuki (RIC: 7269.T; Period: 2007-2021), Tata (RIC: TAMO.NS; Period: 2007-2021), Toyota (RIC: 7203.T; Period: 2007-2021), and Volkswagen (RIC: VOWG.DE; Period: 2007-2021).

For BAIC, Dongfeng, and Great Wall, ownership information is obtained from Refinitiv as well as from annual reports. The reason is as follows. The aggregate share capital of BAIC, Dongfeng, and Great Wall is divided into A-shares and H-shares. A-shares are domestic shares which can be traded (or not) on Chinese stock exchanges while H-shares are overseas-listed foreign shares. As a consequence of this capital structure, the ownership of these three automobile manufacturers combines the two shares types. The A-shares of BAIC and Dongfeng are not traded and, as such, the information regarding shareholders is obtained from their annual reports.[25] The A-shares of Great Wall are traded on the Shanghai Stock Exchange and, as such, the information regarding shareholders is obtained from Refinitiv. The Reuters instrument code used is 601633.SS, for the period 2007-2021. The H-shares of the three automobile manufacturers are traded on the Hong Kong Stock Exchange and, as such, the information regarding shareholders is also obtained from Refinitiv. The Reuters instrument codes used and periods considered for each of these manufacturers are the following: BAIC (RIC: 1958.HK; Period: 2014-2021), Dongfeng (RIC: 0489.HK; Period: 2007-2021), and Great Wall (2333.HK; Period: 2007-2021). The combination of the two shares types makes use of the corresponding total number of shares, obtained from the firms annual reports.

For Chrysler (both Chrysler LLC, for the period 2007-2008, and Chrysler Group LLC, for the period 2009-2013), the ownership of is obtained from the Chrysler's TARP assistance report prepared by the Congressional Research Service for the U.S. Congress (Webel and Canis, 2012).

Finally, for GM, the ownership of GM for the periods 2007-2008 and 2010-2021 is obtained from Refinitiv. The Reuters instrument code used is MTLQQ.PK^D11 for the period 2007-2008 and GM for the period 2010-2021. The ownership of GM for 2009 is obtained from the GM's TARP assistance report prepared by the Congressional Research Service for the U.S. Congress (Canis and Webel, 2013).

[25] For BAIC, annual reports are only publicly available from 2014 onwards (inclusive), when the (H-shares of the) firm became listed on the Hong Kong Stock Exchange. We assumed the holders of A-shares between 2007 and 2013 are the same as those reported in the 2014 annual report. This seems a reasonable assumption as the holders of A-shares have remained relatively constant from 2014 to 2021.