Common Ownership and Collusion*

Vincent Abraham† Florian Ederer‡ Catarina Marvão§

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Abstract

We provide the first empirical evidence that common ownership can facilitate explicit collusion. Our unique setting, the population of legal cartels in Sweden, lets us observe cartel formation, duration, and dissolution without the sample-selection bias that plagues studies of detected cartels. Combining hand-collected ownership data with the universe of registered cartels, we compute firm-pair profit weights (κ) that measure how much one firm internalizes a rival's profits. Higher profit weights are associated with a greater likelihood of cartel participation, predict future cartel involvement, and are linked to longer cartel duration. Firms also reduce their profit weights immediately after a cartel dissolves. However, this relationship is concentrated among pairs in which the firm that internalizes the rival firm's profits colludes while the rival does not. Common ownership therefore complements a firm's own participation in explicit collusion but substitutes for cartel participation by the rival whose profits it internalizes.

JEL Codes: D43, G32, L21, L41, L43

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†FIDERES, vincent.abraham@fideres.com

‡Boston University, CEPR, ECGI, and NBER, ederer@bu.edu

§University College Dublin (Smurfit) and Stockholm School of Economics (SITE), catarina.marvao@ucd.ie (corresponding author)

1 Introduction

In June 2025, the European Commission (EC) issued its first cartel fine involving minority shareholding, penalizing Delivery Hero for using its minority stake in Glovo to facilitate collusive behavior.[1] In announcing the fine, the EC explicitly warned that it would scrutinize similar arrangements across sectors, signaling a broader concern over how partial common ownership might contribute to anticompetitive coordination. Similar concerns have recently emerged in the United States, where the Federal Trade Commission (FTC) and the Department of Justice (DOJ) jointly filed a Statement of Interest regarding an antitrust lawsuit against BlackRock, Vanguard, and State Street.[2] The case alleges that these asset managers used their overlapping equity stakes in coal companies to facilitate coordinated production cuts, thereby reducing output and raising prices. This marks the first time that U.S. enforcement agencies have explicitly supported a legal theory of collusion based on common ownership. Together, these developments highlight the growing intersection between two previously distinct domains of antitrust scrutiny: common ownership and explicit collusion.

While common ownership, the practice of investors holding stakes in multiple competing firms, has attracted increasing attention from scholars and regulators due to its potential to dampen competitive incentives (e.g., Azar, Schmalz and Tecu, 2018; Backus, Conlon and Sinkinson, 2021; Koch, Panayides and Thomas, 2021; Lewellen and Lowry, 2021), most of the empirical literature has focused on unilateral pricing incentives. Meanwhile, cartel enforcement has traditionally been centered on direct evidence of coordination and communication (Marvão, 2015; Harrington and Wei, 2017). However, emerging theoretical work suggests that common ownership may also affect the stability and formation of cartels by aligning firms' incentives or facilitating network ties (Pawliczek, Skinner and Zechman, 2022; Charistos and Papadopoulos, 2022), while other models highlight potential destabilizing effects if firms internalize competition within a shared portfolio (De Haas and Paha, 2021). Whether and in which direction common ownership shapes cartel behavior remains an open empirical question.

This paper provides the first empirical investigation of the relationship between common ownership and cartel participation. Leveraging a unique institutional setting in Sweden where cartels were legal until 1993 and disclosure was relatively complete, we examine whether common owners increase the likelihood and duration of cartel formation among

[1]See https://ec.europa.eu/commission/presscorner/detail/en/ip_25_1356 for the EC press release of the announcement of this fine.

[2]The joint FTC-DOJ Statement of Interest addressing the potential for anticompetitive coordination arising from common ownership is available at https://www.ftc.gov/news-events/news/press-releases/2025/05/ftc-doj-file-statement-interest-energy-collusion-case-against-blackrock-state-street-vanguard.

competing firms. We combine detailed ownership data with a comprehensive registry of cartel agreements from 1985 to 1993 and use network analysis to track evolving ownership links between firms. To quantify the strength of shared financial interests between firms, we compute a contemporaneous measure of profit internalization called κ, which captures the degree to which profit of one firm enters the objective function of another.

Our primary contribution is to establish a robust empirical link between common ownership and cartel participation. We find that higher κ weights between rivals are strongly associated with an increased probability that firm f participates in a cartel. This relationship is concentrated in firm pairs where firm f is a cartel participant while firm g, whose profits firm f internalizes, is not. This pattern is consistent with common ownership complementing firm f's own cartel participation while substituting for direct cartel participation by the commonly linked rival. Moreover, temporal tests of lagged and future values of common ownership and cartel participation show that κ weights predict future cartel membership, while cartel dissolution is followed by a measurable decline in common ownership ties. Thus, there is evidence for a two-way interaction between ownership structure and collusive activity.[3]

Second, we show that common ownership is positively associated with cartel duration, consistent with the idea that aligned financial interests stabilize collusive arrangements. At the sector level, by contrast, we find only limited evidence linking aggregate common ownership to cartel prevalence. The relationship appears to operate primarily through specific firm-pair ownership links rather than broad sector-wide patterns.

Third, we use network measures to document a substantial reorganization of the Swedish ownership network between 1985 and 1993. Although the number of firms and ownership links declined, the network became denser and more locally clustered among the firms that remained. The network connecting cartel firms to non-cartel firms evolved differently: it became considerably thinner but more centralized, with its remaining links carrying larger profit weights on average. These patterns indicate a restructuring, rather than an expansion, of ownership relationships during the period in which cartel legality was being phased out. This timing is consistent with ownership ties potentially becoming relatively more important as explicit cartel arrangements declined, as posited by Pawliczek et al. (2022). Thus, in addition to affecting unilateral incentives common ownership also shapes coordinated outcomes in markets.

Our paper contributes to a growing literature at the intersection of common ownership and product market outcomes. Several studies document that common owners may influence pricing, output, or compensation strategies in ways that prioritize portfolio-level returns over firm-level competition (Azar et al., 2018; Backus et al., 2021; Antón, Ederer, Giné and

[3] Throughout the paper we use the terms cartel membership and collusion interchangeably.

Schmalz, 2023). However, other empirical work does not find evidence of such anticompetitive effects (Kennedy, O'Brien, Song and Waehrer, 2017; Koch et al., 2021; Lewellen and Lowry, 2021). The relationship thus appears context-dependent and may hinge on enforcement environments and institutional structures.

A smaller but growing strand of the literature has begun to explore how common ownership might interact with explicit collusion. Theoretically, partial cross-ownership can facilitate collusion by aligning incentives and enhancing punishment credibility (Spagnolo, 1999; Gilo, Moshe and Spiegel, 2006; De Haas and Paha, 2016). Recent models suggest that passive common ownership can also reduce firms' incentives to report cartels under leniency programs (Charistos and Papadopoulos, 2022). Empirically, several studies link minority shareholdings to the persistence or formation of cartel agreements, particularly in settings where enforcement is weak or ownership ties are opaque (Heim, Hüschelrath, Laitenberger and Spiegel, 2022; Pawliczek et al., 2022; Adler and Mitkov, 2023). At the same time, other work points to potential disciplining or destabilizing effects of common ownership on collusion, particularly when antitrust institutions are strong (De Haas and Paha, 2021; Yao, Guo, Sensoy, Goodell and Cheng, 2024).[4]

Our paper also builds on research that uses network-based measures to study ownership structures and competitive behavior and emphasizes that firms' strategic positioning within inter-firm networks can amplify or mitigate anticompetitive outcomes (Ballester, Calvó-Armengol and Zenou, 2006; Galeotti, Golub and Goyal, 2020; Pellegrino, 2025). In particular, Ederer and Pellegrino (2025) show that the overlap between product market rivalry and common ownership networks lessens unilateral incentives to compete and is a key driver of deadweight loss in the U.S. economy. We extend this research by examining how the structure and dynamics of ownership networks influence coordinated effects and relate to cartel formation and stability over time.

The rest of the paper proceeds as follows. Section 2 proposes a simple theoretical framework for common ownership and collusion. Section 3 describes the data and construction of the common ownership and cartel variables. Section 4 presents our empirical strategy and main results while in Section 5 we provide additional robustness checks. Section 6 concludes with implications for antitrust enforcement and directions for future research.

[4]Recent evidence shows that shared leadership, such as common executives or board members, increases collusion in labor markets (Herrera-Caicedo, Jeffers and Prager, 2025), while the prohibition of interlocking directorates in banking reduces corporate loan rates, consistent with diminished collusion (Barone, Schivardi and Sette, 2025).

2 Theoretical Framework

To formalize the intuition behind our empirical analysis, we sketch a simple model of profit interdependence and cartel formation under common ownership. The goal is to capture how common ownership alters firms' incentives to collude and how these incentives change after cartel dissolution. The framework extends standard repeated-game models of collusion by incorporating portfolio-weighted firm objectives as posited by Rotemberg (1984) and Backus et al. (2021), and is intended as a reduced-form representation of profit internalization arising from ownership links. Such links may emerge through direct cross-ownership or through common ownership by overlapping shareholders. In both cases, firms behave as if they place positive weight, denoted by κ, on rivals' profits.

2.1 Firms, Market, and Ownership Structure

Consider a sector with n firms indexed by $f = 1, \ldots, n$. Each firm competes in a differentiated product market and chooses a strategic action q_f which could represent price or quantity, depending on the mode of competition. The vector of actions across all firms is $\mathbf{q} = (q_1, \ldots, q_n)$.

Each firm f earns a profit $\pi_f(\mathbf{q})$ that depends on the full action profile of all firms. Assume that own profit π_f is strictly concave in q_f and, in the Cournot case developed below, decreasing in each rival's quantity q_g (strategic substitutes). Under differentiated Bertrand the corresponding condition runs through prices (strategic complements).

Firms are owned by a common set of shareholders, indexed by s, who hold equity stakes in multiple firms. Because these shareholders are diversified across competing firms, each firm f maximizes not its own profit alone but the Pareto-weighted profits of its shareholders. As posited by Rotemberg (1984) and Backus et al. (2021), this objective can be written as

$$\phi_f(\mathbf{q}) = \pi_f(\mathbf{q}) + \sum_{g \neq f} \kappa_{fg} \, \pi_g(\mathbf{q}), \tag{1}$$

where the profit weight $\kappa_{fg} \geq 0$ measures the extent to which firm f internalizes the profit of rival g. These weights depend on the matrix of ownership stakes and the weights that firms assign to their shareholders. We describe their construction in Section 3.2 and derive them formally in Appendix C. Because κ_{fg} is built from the matrix of investor holdings, it does not distinguish between common ownership (shared owners) and cross-ownership (direct stakes).

When $\kappa_{fg} = 0$, firm f acts independently. When $\kappa_{fg} > 0$, it partially internalizes rival payoffs, reducing its incentive to compete aggressively. The matrix $\boldsymbol{\kappa}$ summarizes the structure of common ownership in the industry.

2.2 Cartel Formation and Incentives

Firms may engage in explicit collusion through cartel agreements. Let $C \subseteq \{1, \ldots, n\}$ denote the set of firms forming a cartel. Members of the cartel coordinate actions to jointly maximize total internalized profit

$$\max_{\{q_f\}_{f \in C}} \sum_{f \in C} \phi_f(\mathbf{q}), \tag{2}$$

subject to the best-response behavior of non-cartel firms. Cartel firms internalize both direct profit effects and those weighted by κ_{fg} terms. Non-cartel firms choose q_g to maximize $\phi_g(\mathbf{q})$, taking cartel behavior as given.

Let π_f^C denote firm f's profit under cartel coordination and π_f^{NC} the profit in the absence of a cartel. A firm f prefers to be in the cartel if

$$\phi_f^C \equiv \pi_f^C + \sum_{g \neq f} \kappa_{fg} \pi_g^C > \pi_f^{\mathrm{NC}} + \sum_{g \neq f} \kappa_{fg} \pi_g^{\mathrm{NC}} \equiv \phi_f^{\mathrm{NC}}. \tag{3}$$

Equation (3) hints at a key complementarity. The gain from participation, $\phi_f^C - \phi_f^{\mathrm{NC}} = (\pi_f^C - \pi_f^{\mathrm{NC}}) + \sum_{g \neq f} \kappa_{fg}(\pi_g^C - \pi_g^{\mathrm{NC}})$, is increasing in κ_{fg} whenever the relevant rival earns more under the cartel than without it, $\pi_g^C > \pi_g^{\mathrm{NC}}$, as holds for cartel members in the symmetric Cournot model below. Cartel participation thus becomes more attractive when the firm places positive weight on rival profits, which captures the main prediction of our empirical analysis: firms with higher κ_{fg} values are more likely to participate in cartels.

2.3 Cartel Dissolution and Adjustment in Ownership Links

Suppose a cartel is dissolved due to legal enforcement or instability. In the post-dissolution phase, firms revert to non-cooperative behavior. The incentives for maintaining common ownership links may then diminish.

$\phi_f^C - \phi_f^{\mathrm{NC}}$ are the gains from coordination. When $\phi_f^C > \phi_f^{\mathrm{NC}}$, firm f values coordination. But if coordination is no longer feasible, firms may reduce or eliminate ownership links that served primarily to support collusion. Since firms do not directly choose κ in our model, ownership links may weaken following cartel dissolution as investors rebalance portfolios, ownership structures evolve, or firms unwind cross-ownership positions. That is, we may observe:

$$\frac{d\kappa_{fg}}{dt} < 0 \quad \text{after cartel dissolution.} \tag{4}$$

This dynamic adjustment in κ is in line with our empirical findings where we show that firms reduce their profit weights after cartel dissolution.

2.4 Illustrative Example: Linear Demand Curve

To derive explicit comparative statics, consider a standard linear demand system with n symmetric firms, where the inverse demand curve is given by

$$P(Q) = a - bQ, \qquad Q = \sum_{f=1}^{n} q_f, \tag{5}$$

where q_f is firm f's output and $c < a$ is the constant marginal cost of production.

Firm f's product market profit is

$$\pi_f(q_f, q_{-f}) = (P(Q) - c)q_f \tag{6}$$

and thus the per-period portfolio-weighted objective of firm f at time t is

$$\phi_{f,t} = \pi_{f,t} + \sum_{g \neq f} \kappa_{fg,t}\, \pi_{g,t} - \lambda_t F_t, \tag{7}$$

where F_t is the expected penalty for collusion (i.e., the probability of detection multiplied by the expected fine) and $\lambda_t \in \{0, 1\}$ indicates whether firms are colluding in period t. This is the objective ϕ_f from equation (1), now time-indexed and net of the expected collusion penalty.

2.4.1 One-period Outcomes

In the static Cournot game, we obtain the following standard benchmark outcomes:

$$\pi^C = \frac{(a-c)^2}{4bn} \qquad \text{(profit per firm under collusion)} \tag{8}$$

$$\pi^{\mathrm{NC}} = \frac{(a-c)^2}{b(n+1)^2} \qquad \text{(profit per firm under Cournot-Nash)} \tag{9}$$

$$\pi^D = \frac{(a-c)^2(n+1)^2}{16\, b\, n^2} \qquad \text{(profit of a deviator when others cooperate)} \tag{10}$$

$$\pi^{D,-} = \frac{(a-c)^2(n+1)}{8\, b\, n^2} \qquad \text{(profit of non-deviators when one deviates)} \tag{11}$$

2.4.2 Repeated Interaction

The cartel game repeats infinitely with a common discount factor $\delta \in (0, 1)$. Firms use a grim-trigger strategy and maximize their discounted portfolio-weighted profits ϕ_f. They cooperate by producing q^C if no one has deviated in the past. Otherwise, they forever revert to Cournot output q^{NC}.

The net (portfolio-weighted) gain from deviating for firm f is

$$\Delta^{\text{dev}} = (\pi^D - \pi^C) + (n-1)\kappa(\pi^{D,-} - \pi^C). \tag{12}$$

The first term captures the standard temptation to deviate (own profit gain); the second captures how common ownership offsets this incentive by valuing rivals' losses from deviation.

The continuation gain from cooperation is

$$\Delta^{\text{coop}} = (1 + (n-1)\kappa)(\pi^C - \pi^{\text{NC}}) - F, \tag{13}$$

representing the discounted value of future collusive gains (i.e. the difference between collusive and competitive weighted profits) net of expected fine F.

The one-shot deviation incentive constraint is

$$\Delta^{\text{dev}} \leq \frac{\delta}{1-\delta}\Delta^{\text{coop}}. \tag{14}$$

Rearranging this ICC yields the critical discount factor:

$$\delta^*(\kappa, F) = \frac{\Delta^{\text{dev}}}{\Delta^{\text{dev}} + \Delta^{\text{coop}}}. \tag{15}$$

A lower δ^* implies that collusion is easier to sustain.

2.4.3 Comparative Statics

From equation (15), we obtain the following comparative statics:[5]

- $\partial\delta^*/\partial\kappa < 0$: greater profit weights from common ownership stabilize collusion (*complementarity effect*).
- $\partial\delta^*/\partial F > 0$: higher expected penalties destabilize collusion (*substitution effect*).

[5]Section B includes more detailed calculations. Both signs are established under the maintained assumption $\kappa < \frac{1}{2}$, which holds throughout our data and ensures that deviation remains tempting ($A(\kappa) > 0$); the sign of $\partial\delta^*/\partial\kappa$ then follows for any viable cartel.

These results yield our first key prediction: firms with higher κ are more likely to form and sustain cartels. They also motivate a second, empirical hypothesis. Because κ is not a choice variable in the model, we do not derive it directly; but dissolution or enforcement shocks that reduce collusive feasibility may lead firms and investors to unwind ownership links that had supported collusion, weakening κ. These predictions motivate the empirical analyses in Sections 4 and 5.

3 Data and Variables

We use three different datasets in the analysis. First, we hand-collected data on stock ownership in Sweden (1985-1993). Second, we merged it with the *Swedish Cartel Register* from Forsbacka, Le Coq and Marvão (2023), which includes the cartel population of Sweden (1946-1993). Third, we use firm-level financial data from *Statistics Sweden*. The variables used in the analysis are shown in Table 1.

3.1 Data Sources

3.1.1 Ownership Data

Common ownership data was hand-collected from the book *Ägarna och Makten i Sveriges Börsföretag* (Owners and Power in Sweden's Listed Companies), published annually by SIS Ägarservice AB between 1985 and 2015. It includes information on the ownership structure and voting rights of investors for all listed firms in Sweden. On average, there are 230 listed companies per year, as depicted in Figure A1 in the appendix.

Swedish firms are often characterized by concentrated family ownership, pyramidal control structures, and a separation between cash flow rights and voting power (Henrekson and Jakobsson, 2005; Hogfeldt, 2005). In particular, Sweden has the largest share of firms with differentiated voting rights, meaning that certain shares grant owners more voting power than others. It also has the second highest share of pyramidal structures globally, where a controlling entity holds stakes through layers of ownership, allowing a small group to control multiple firms with relatively limited capital investment (Faccio and Lang, 2002; ISS, 2007). These features have important implications for the theory of common ownership. The combination of pyramidal structures and differentiated voting rights allows controlling shareholders to influence several firms simultaneously, even with modest cash flow rights. This may intensify the mechanisms proposed by the common ownership hypothesis, as overlapping control between firms can strengthen the coordination of strategic behavior, including collusion, particularly compared to settings with more dispersed ownership (e.g., Gilje, Gormley and

Levit (2020)). These institutional features make Sweden a particularly informative setting for studying how overlapping ownership structures interact with collusive behavior.[6]

In Sweden, there are also several prominent investor spheres, as illustrated in Figure A2 in the Appendix. These spheres operate similarly to institutional investors in the US, but are characterized by long-standing controlling networks, such as those of the *Handelsbanken* and the *Wallenberg* family. Whereas in the US, executives and CEOs often play a dominant role in shaping firm strategies, in Sweden, it is typically the controlling shareholders who hold this authority, appointing boards that are frequently composed of non-executive directors (Swedish Corporate Governance Board, 2016). In the Swedish context, the separation between voting and cash flow rights may weaken the link between common ownership and incentives to maximize portfolio-wide profits. Alternatively, it may lead controlling shareholders to prioritize strategic control over financial returns. These characteristics create a distinct environment for examining the relationship between common ownership and collusive behavior, where control is highly concentrated and ownership structures are stable over time.

3.1.2 The Swedish Cartel Register

The Swedish Cartel Register (SCR) provides a unique record of cartels in Sweden in the 20th century, between 1946 and 1993. Upon request from the authorities, firms were required to register any agreements that restricted price, output, or turnover, of which they were a part. Failure to register an agreement was punishable by pecuniary fines or imprisonment of up to six months. Following the identification of a cartel, the SCR sent a standardized form to its members, which contained questions about the agreement, price lists, meetings, minutes, and members. Any changes to the agreement had to be reported to the SCR. Authorities also regularly followed up with cartels that had been registered and not reported as terminated to maintain accurate information about the cartels. The SCR was thus informed if a cartel had died or if its agreement had been revised (Sandberg, 2016).

The SCR data, from Forsbacka et al. (2023), include 4,777 agreements registered between 1947 and 1993. The legislation governing the register was not specific about what constituted a potential anticompetitive agreement, resulting in the registration of a variety of agreements. Although the structure of the files in the register was mostly similar, the registration practices were very imprecise. Some agreements were withdrawn, some were replaced by new ones, some included a "cartel" composed of a group of local "cartels," and some were bilateral contracts with individuals. Forsbacka et al. (2023) identify 2,440 unique cartel agreements

[6]Moreover, state ownership remains substantial in key industries, with implications for tax behavior and firm objectives (Hilling, Lundtofte, Sandell, Sonnerfeldt and Vilhelmsson, 2021).

that include at least two firms, covering the majority of sectors. Figure A3 in the Appendix includes an example of a cartel contract in the provision of services.

While the cartel contracts were legal, we are not aware of any instances where such contracts were actually enforced in courts, through litigation, and there is some anecdotal evidence that courts typically refused to enforce them. In practice, these contracts may thus not have been legally binding. As a result, cartels had to rely on internal enforcement mechanisms to deter deviations. In our data, most cartels included a dispute resolution mechanism and 23% of cartels imposed one or more types of internal penalties, highlighting the practical need for stabilization mechanisms regardless of formal legality. Figure A4 depicts the type of punishment for cartel deviations. In many cases, it stipulated a fixed (8.6%) or a minimum or maximum fee (8.8%) that the deviating members had to pay, but it also included suspensions and cartel termination (7.9%) for the deviating members. In a few cases, the contract stipulated that it was up to the dispute resolution body to decide the penalty (1.9%). The threat of such internal penalties likely played a key role in sustaining collusion in the absence of credible legal enforcement.

Thus, Sweden is particularly attractive because it combines (i) mandatory cartel registration, (ii) detailed ownership records, and (iii) concentrated ownership structures.

3.1.3 Macroeconomic Variables

To control for business cycles, we include GDP shocks that capture short-term fluctuations in output. The Swedish economy went through significant changes over the lifetime of the cartel register and, in particular, during our period of study from 1985 to 1993. We, therefore, control for the long-term trend and include a quadratic term to allow for nonlinear relationships between the long-run growth trend and cartels' birth and death.

The GDP data is taken from Edvinsson (2014). We measure GDP in real terms, using a deflation index from Edvinsson and Söderberg (2014). Following Forsbacka et al. (2023), we separate GDP into its long-term trend (*GDP trend*) and its cyclical components, but include both in the regression analysis. Specifically, we include the GDP trend and its squared term, along with positive (*GDP positive shocks*) and negative (*GDP negative shocks*) deviations from the trend. This allows us to capture both the structural and the cyclical components of economic activity, allowing us to test whether cartels behave differently in booms and recessions, in line with the theoretical predictions of Rotemberg and Saloner (1986) and Haltiwanger and Harrington (1991). As Forsbacka, Le Coq and Marvão (2025) show, positive and negative GDP shocks can affect cartels differently. Figure A5 illustrates the trend (*GDP trend*) and GDP shocks in the study period (1985-1993).[7]

Finally, we merge these three datasets. Because cartels were only legal until 1993 and stock ownership data are only available from 1985, we focus on the period 1985 to 1993.

3.2 Computation of Profit Weights

We construct the profit weights κ (also referred to as kappa or k-weights in the literature) following Rotemberg (1984) and Backus et al. (2021), where firms maximize the weighted sum of the portfolio profits of their shareholders. As introduced in Section 2, the weight $\kappa_{fg}(\gamma_f, \beta)$ that firm f places on the profit of rival g in the objective (1) is a function of the vector of Pareto weights γ_f that firm f assigns to its shareholders s and the matrix of cash-flow rights β, where β_{fs} is the ownership share of shareholder s in firm f. Under the neoclassical benchmark of individual profit maximization $\kappa_{fg} = 0$, whereas the common ownership hypothesis rationalizes $\kappa_{fg} > 0$.

The Pareto weights γ_{fs} capture the control that shareholder s exerts over firm f and are often treated as synonymous with the shareholder's voting share, since control over the firm is exercised through voting rights. In line with Rotemberg (1984) and as adopted by Backus et al. (2021), we assume that these control weights γ_{fs} are proportional to the ownership stakes β_{fs} of shareholders. This assumption simplifies the model by equating the influence a shareholder has over firm profits to their ownership share. Since shareholders typically have a proportional stake in the profits of the firms they invest in, this assumption allows us to model the firm's decision-making in a way that reflects both its own profits and the profits of its competitors, shaped by the overlapping ownership structure.

Under this assumption, the profit weight that firm f places on rival g is given by

$$\kappa_{fg} = \frac{\sum_s \beta_{fs}\beta_{gs}}{\sum_s \beta_{fs}^2}. \tag{16}$$

This equation captures the extent to which firm f internalizes firm g's profits, based on the overlapping ownership between the firms. The numerator sums, across shareholders, the product of each shareholder's stakes in firms f and g, capturing overlapping ownership. The denominator $\sum_s \beta_{fs}^2$ is a squared-ownership (concentration) term that normalizes the weight placed on firm g's profits relative to the shareholder-weighted value of firm f's own

[7]The decline in the GDP trend between 1990 and 1993 reflects the Swedish banking and financial crisis, which led to a recession, hence affecting the output levels. The Hodrick-Prescott filter captures this by adjusting the trend downward in response to sustained negative shocks, as is typical in relatively short samples.

profit, rather than the total ownership in firm f. We further describe the decomposition of κ weights in Appendix C.[8]

Higher κ weights reflect a greater degree of profit internalization between firms, indicating that a firm takes into account not only its own profits but also those of its rivals when making strategic decisions. Such ownership structures can dampen competitive incentives. For instance, if an investor holds substantial stakes in both firm f and firm g, firm f may refrain from aggressive competition in order to preserve the profitability of firm g. This mechanism reduces the pressure to undercut rivals and can soften product market competition. The pattern is consistent with the common ownership hypothesis, which posits that overlapping ownership can induce lower competition without explicit collusion.

While our κ matrix captures overlapping ownership stakes between firms, it does not distinguish between common ownership (where institutional investors hold stakes in multiple competing firms) and cross-ownership (where firms directly hold shares in their rivals). As such, our measure of κ reflects both types of ownership links. Conceptually, effects of κ weights derived from cross-ownership may be larger in magnitude because cross-ownership involves direct financial stakes and strategic influence. In contrast, κ weights from common ownership often arise from portfolio diversification and may represent more diffuse incentives. This limitation should be borne in mind when interpreting our results.

One additional limitation concerns measurement. Our ownership data cover only publicly listed Swedish firms and therefore do not capture ownership links involving private firms or unlisted entities. Moreover, the Swedish corporate sector is characterized by pyramidal ownership structures and differentiated voting rights, implying that observed cash-flow rights may not fully reflect the underlying control relationships between firms. In constructing κ, we adopt the proportional-control convention of Rotemberg (1984) and Backus et al. (2021), setting voting rights equal to cash-flow rights ($\gamma_{fs} = \beta_{fs}$), which keeps our measure directly comparable to the common ownership literature. This convention does not exploit the wedge between control and cash-flow rights that dual-class shares and pyramidal holdings create. Because controlling owners in such structures typically hold voting rights in excess of their cash-flow rights, proportional control understates the weight of precisely the blockholders best positioned to coordinate firm conduct. The assumption therefore works against the associations we document rather than generating them; a measure based on realized voting rights would, if anything, reinforce them. Unobserved ownership links, indirect control structures, and timing mismatches may introduce measurement error into our measure of

[8] In most cases, κ ranges from 0 to 1, but it can exceed 1 which leads to tunneling incentives (Backus et al., 2021). As argued in Chiappinelli, Xefteris and Papadopoulos (2023), the collective control exerted by institutional investors has a significant influence on firm decision making, as firms prioritize the overall profitability of their shareholders' portfolios rather than maximize their own profits.

κ. To the extent that these omissions cause us to understate the true extent of profit internalization between firms, the estimated relationship between κ and cartel participation is likely to be attenuated. Under this interpretation, our estimates provide a conservative indication of the relationship between ownership-based profit weights and cartel participation within the listed-firm sample.

We merge the common ownership data with the SCR cartel data to further explore the relationship between common ownership and collusion. Figure 1 reports the distribution of κ across all firms in our sample and also depending on whether a given firm is in a cartel or not. Figure A6 in the appendix reports the average κ across different sectors.

3.3 Sector-level Common Ownership Measures

Common ownership measures at the sector level allow us to assess how concentrated ownership affects competition and corporate behavior. When multiple firms in the same sector are owned by common blockholders, it can reduce the incentive to compete and create a conflict of interest within companies, as common owners may prioritize the growth of their overall portfolio over individual firms.

In contrast to common ownership at the firm level where κ has emerged as the standard metric, there is a lack of consensus in the literature on what measure best reflects the degree of common ownership in an entire sector. We follow Koch et al. (2021) and compute four commonly used measures. Including these alternative measures also allows us to make the analysis more comparable with the existing common ownership literature, where such metrics are widely used. These are the percentage of common funds (PCF), the percentage of common stock (PCS), the density of common ownership (*Density*), and the common ownership incentive term (COI). We compute these at the sector level using NACE one-digit codes. We describe each of these measures below.

For the four measures, two firms are considered connected whenever there is a blockholder (institutional investor) who owns at least 5% of each of the two firms. The COI measure differs from these connection-based measures because it uses the continuous ownership and voting shares of all relevant owners and does not impose a (5%) threshold.

The first measure, the percentage of common funds (PCF), quantifies the propensity of the blockholders to maintain investments in multiple firms in the same sector (Cohen and Frazzini, 2008; Antón and Polk, 2014). It is defined as follows:

$$PCF_{sector} = \frac{\text{blockholders owning at least two firms in a given sector}}{\text{total blockholders in that sector}}$$

If no blockholders own two or more firms, PCF is equal to zero. Second, the percentage of common stocks (PCS) measures the extent to which firms in a sector are connected through the blockholder with the widest presence in that sector. It is defined as:

$$PCS_{sector} = \frac{\max_i \{\text{number of firms in the sector in which blockholder } i \text{ owns at least 5\%}\}}{\text{total number of firms in that sector}}.$$

Third, the density of common ownership measures the strength of firm-pair connections in the sector (Azar, 2012). It is computed as follows:

$$Density_{sector} = \frac{\text{firm-pairs connected in a given sector}}{\text{maximum firm-pairs in that sector}}.$$

Finally, the common ownership incentive term COI measures the extent to which owners with voting control in one firm also hold ownership stakes in other firms in the same sector. Let β_{ij} denote owner i's ownership share in firm j, and let γ_{ij} denote owner i's voting share in firm j. The sector-level measure is defined as:

$$COI_{sector} = \text{Average}_{j \neq k} \left(\frac{\sum_i \gamma_{ij} \beta_{ik}}{\sum_i \gamma_{ij} \beta_{ij}} \right),$$

where the average is taken across all firm-pairs j and k within the same sector. Unlike $MHHI\Delta$, COI does not weight firm-pairs by their market shares, and therefore captures common ownership incentives independently of firms' relative market positions (Kennedy et al., 2017).

4 Empirical Analysis

4.1 Descriptives and Network Analysis

We begin our analysis by investigating the distributions of common ownership and cartel membership.

Figure 1 shows the density of firm-pair profit weights κ_{fg} for all firm pairs with positive profit weights (i.e., $\kappa_{fg} > 0$). Panel (a) displays the overall distribution of κ_{fg}, plotted on a logarithmic scale to capture the wide variation in values. The distribution is strongly right-skewed, with the majority of firm pairs exhibiting relatively small κ_{fg} values and a long tail of larger weights. Overall, 50% of firm pairs have $\kappa_{fg} = 0$, and an additional 43% of pairs have $0 < \kappa_{fg} < 0.1$. Large profit weights between firm pairs are rare, as 93% of firm pairs have κ_{fg} values below 0.1.

We further decompose the distribution of profit weights by cartel membership. In our sample, cartel participation accounts for 7.64% of firm pairs. Among firm pairs where firm f participates in a cartel, 63% have positive κ_{fg} values, compared to 49% among pairs where firm f does not participate in a cartel. Panel (b) of Figure 1 decomposes the distribution of positive profit weights by cartel membership, distinguishing between firm pairs based on whether firm f assigning the positive κ_{fg} weight to firm g's profit is part of a cartel (orange) or not (green). The density curves show that firm pairs involving cartel members tend to have higher κ_{fg} weights on average compared to non-cartel pairs. These patterns for both zero and strictly positive profit weights suggest that common ownership is more pronounced among firms engaged in collusive agreements and are consistent with the hypothesis that common ownership may facilitate or complement cartel activity.

We now describe some of the features of common ownership and collusive agreements by visualizing common ownership network structures. The connections between firms can be highlighted by mapping the ownership structures. This approach is useful for identifying central nodes (firms) that are highly connected, often having significant influence on market dynamics, and potentially facilitating coordinated actions among firms.

To visualize the networks, we use two commonly adopted tools for large scale networks: the 'OpenOrd' algorithm from Martin, Brown, Klavans and Boyack (2011) and the 'FR gravity' algorithm from Fruchterman and Reingold (1991). The former is used to prearrange the nodes, enhancing the visualization of the network's community structure, while the latter creates a two-dimensional structure to interpret the connections. Each node represents a firm in the dataset and the network connections (edges) are weighted by κ_{fg} profit weights, such that the thickness of the lines corresponds to the κ_{fg} weight that a firm f places on the profits of firm g, indicating a stronger profit-weight relationship in the common ownership analysis.

In examining the network dynamics between 1985 and 1993, the data reveal a significant reorganization in the structure of firm connections during the period in which the legality of cartels was changing in Sweden. In 1985, the ownership network contained a relatively high number of nodes, but the firms were connected less densely, as shown in Panel (a) of Figure 2. Average eigenvector and betweenness centrality were also relatively low, consistent with a more dispersed ownership structure.

By 1993, the network had undergone a significant transformation. The number of firms and ownership links declined, while the density of the remaining connections increased, as shown in Panel (b) of Figure 2. A large number of firms underwent mergers and acquisitions which is likely the reason for a decline in the number of nodes. Among the firms that remained in the network, ownership relationships became more tightly interconnected. This pattern indicates contraction accompanied by densification and reorganization, rather than a straightforward expansion of the ownership network.

The evolution of the cartel-owner network differs from that of the full ownership network. The number of cartel firms declined considerably between 1985 and 1993, together with the number of ownership links from cartel firms to non-cartel firms, as shown in Figure 3. Thus, the descriptive evidence suggests that, as the explicit cartel network weakened, the remaining ownership relationships involving cartel firms became fewer but more concentrated and stronger on average. Although this pattern is consistent with ownership links potentially becoming relatively more important as explicit cartel participation declined, the network evidence alone cannot establish that firms substituted common ownership for explicit collusion.

Table 9 formalizes these visual impressions. In the full ownership network, the number of firms falls from 250 to 182 and the number of ownership links falls from around 30 thousand to 19 thousand. Average degree also declines from 237.5 to 213.2, while the average profit weight, κ, remains unchanged at 0.053. Despite this contraction, network density rises from 0.477 to 0.589 and the average local clustering coefficient increases from 0.769 to 0.812 (Watts and Strogatz, 1998). Because density is measured relative to the number of possible links, part of this increase reflects the decline in the number of firms: the number of possible ownership links falls more rapidly than the number of observed links. The increase in density should therefore be interpreted as relative densification among the firms remaining in the network, rather than as an increase in the absolute number of ownership relationships. The rise in clustering similarly indicates that the remaining firms became more locally interconnected, consistent with the structure shown in Panel (b) of Figure 2. Network centralization, measured using the normalized out-degree index of Freeman (1978), falls from 0.336 to 0.280; outgoing ownership links thus became less concentrated around a small number of dominant owner firms. Average eigenvector and betweenness centrality increase modestly, indicating that the remaining firms occupied somewhat more interconnected positions within the network.

The cartel-owner network evolves differently. The number of ownership links falls sharply, from 4,127 to 1,097, while density declines from 0.071 to 0.038 and average degree drops from 34.1 to 12.8. This is consistent with the thinner ownership structure visible in Figure 3. However, this thinning does not imply fragmentation: in both years, the largest connected component contains all the firms in the network. Instead, the remaining links become more concentrated around particular owner nodes. Network centralization rises from 0.646 to 0.814, indicating that ownership ties involving cartel firms became increasingly organized around a smaller set of central owners. At the same time, the average profit weight, κ, rises from 0.067 to 0.102; the remaining ownership links thus carried larger profit weights on average (Carrington, Scott and Wasserman, 2005).

The zero clustering coefficient in the cartel-owner network follows from its bipartite construction, which precludes triangles under the standard local clustering definition. Average betweenness centrality is also zero because the directed two-layer structure contains no intermediary nodes on directed paths between other firms (Freeman, 1977). Eigenvector centrality (Bonacich, 1972) is therefore not reported for this network, because its acyclic two-layer structure gives the adjacency matrix a zero leading eigenvalue, making the conventional directed eigenvector-centrality measure uninformative. The statistics confirm a pattern of contraction and structural reorganization. The full ownership network becomes relatively denser and more locally interconnected among fewer firms, while the cartel-owner network becomes thinner but more centralized, with fewer ownership links carrying larger average profit weights. These patterns are consistent with a changing role for ownership relationships as registered cartel activity declined.

4.2 Cartel Membership

We now formally test how common ownership is related to cartel membership. We estimate a series of regressions that examine whether a higher κ_{fg} that firm f places on the rival firm g is associated with a higher likelihood of cartel involvement. To disentangle the relationship between common ownership and collusion, we consider five distinct cases: (1) whether firm f is in a cartel, regardless of g's status; (2) whether both f and g are in the same cartel; (3) whether only f is in a cartel; (4) whether g is in a cartel, regardless of f's status; and (5) whether only g is in a cartel. This breakdown allows us to test whether common ownership predicts cartel formation, and whether its effects depend on ownership ties spanning across cartel and non-cartel firms.

Specifically, we investigate the relationship between common ownership and cartel membership using variants of the following regression specification:

$$Cartel_t(x) = \beta_1 \kappa_{fg,t} + \beta_2 \text{Macro}_t + \tau_{s,t} + \theta_{fg} + \varepsilon_{fg,t} \tag{17}$$

where $Cartel_t(x)$ is a dummy variable equal to one if one or both firms are in a cartel, in year t, with the variable x indicating the cartel membership. Specifically, we examine $x \in \{f, f\_and\_g, f\_not\_g, g, g\_not\_f\}$, depending on whether f is collusive (regardless of whether g is in the cartel or not), both are collusive, only f is collusive, g is collusive (regardless of whether f is or not) and only g is collusive, respectively.

$\kappa_{fg,t}$ is the weight that firm f places on rival g's profit in period t, as shown in equation (1). $Macro_t$ is a vector of macroeconomic controls which includes detrended real GDP and its squared term (*GDP_trend* and *GDP_trend2*), and positive and negative deviations from the trend (*GDP_pos* and *GDP_neg*). τ and θ denote year-sector and firm-pair fixed effects.

Table 2 presents panel regressions examining the relationship between firm-level κ weights and cartel participation. Each panel corresponds to a different configuration of cartel involvement across the firm pair (f, g). The dependent variable in each case is a binary indicator of whether firm f, firm g, or both are participants in a cartel in year t. The regressions use firm-pair fixed effects and macro controls throughout all specifications, but differ in their use of year, sector, and year-sector controls.

Panel A examines whether firm f is in a cartel, regardless of the cartel status of firm g. Across all specifications, we find a robust and statistically significant positive association between the κ_{fg} that firm f places on a rival firm g and the likelihood that firm f participates in a cartel.

The magnitude of the coefficient, which ranges from 0.035 to 0.042 across specifications, implies that a one-unit increase in κ is associated with a 3.5 to 4.2 percentage point increase in cartel participation. Given that the unconditional probability of cartel involvement is 7.64%, this corresponds to a relative increase of approximately 46–55%. While a full-unit increase in κ is uncommon in practice, the results remain meaningful even at more typical levels of variation.

For instance, using the specification in Column (3), a one-standard-deviation increase in κ (about 0.1058) corresponds to a 0.44 percentage point increase in cartel participation, or approximately a 5.8% increase relative to the baseline participation rate.[9] Even moderate changes in ownership-induced profit internalization thus have economically meaningful effects on cartel participation, evidence of a *complementarity effect* between ownership links and cartel formation.

To unpack this relationship, Panels B through E of Table 2 disaggregate the firm-pair cartel participation structure. Panel B focuses on the case where both firms f and g are cartel members in year t. The coefficient on κ here is small and statistically insignificant across all specifications. The absence of a statistically significant relationship between κ and joint cartel participation is notable because it suggests that ownership links do not simply encourage commonly owned firms to collude directly with one another.

Panel C isolates the case where only firm f is in a cartel while firm g is not. Here, the κ coefficient remains positive and statistically significant, with estimates very similar in magnitude to those in Panel A. This indicates that the observed complementarity between

[9] Calculated as: $0.0419(0.1058)=0.00443$; $0.00443/0.076=0.0583 \approx 5.8\%$

κ weights and cartel membership is not primarily about co-membership between commonly owned firms. Rather, it reflects a tendency for firms that internalize rival profits due to common ownership to belong to cartels independently of those rivals. This pattern is consistent with a substitution effect: common ownership reduces the need for both firms to participate in the same cartel, as one firm's participation benefits the shared owners regardless of whether the rival joins. We refer to this as the *substitution effect* in cartel partner selection.

Panel D examines whether firm g's cartel membership is predicted by the κ_{fg} placed on it by firm f, irrespective of whether f is in the cartel. The coefficients are negative but small and statistically insignificant, implying that firm f's profit internalization of g does not increase the likelihood that g joins a cartel. Panel E further narrows the case to instances where g is in a cartel and f is not. Again, the κ_{fg} coefficient is negative and statistically insignificant, consistent with the notion that common ownership does not promote joint cartelization. In fact, this finding reinforces the interpretation that common ownership may serve as an alternative mechanism for internalizing coordination benefits, reducing the need for explicit collusion involving both firms.

The results in Table 2 suggest that common ownership is associated with a higher likelihood of cartel participation, but not necessarily between co-owned firms. Instead, it appears that firms with stronger ownership links to rivals are more likely to join cartels themselves, while allowing rivals to stay out, thereby achieving partial coordination through a combination of explicit collusion and indirect alignment via ownership. Common ownership thus acts as both a complement to and a substitute for direct collusive arrangements.

To ensure that the results are not driven by the use of relatively broad sector classifications, Appendix Table A1 replaces the sector (NACE-letter) controls with NACE-2 sector fixed effects and NACE-2 sector-year fixed effects. The estimated coefficients are virtually unchanged. For example, the coefficient on κ in Panel A is essentially identical under sector fixed effects (0.0348 with both the baseline NACE-letter and the NACE-2 controls) and rises only slightly, from 0.0419 to 0.0430, under sector-year fixed effects. Similar patterns emerge across the remaining specifications. The positive association between ownership links and cartel participation is therefore not explained by narrowly defined sector characteristics.

4.2.1 Common Ownership versus Cross-ownership

In this subsection, we split the baseline κ measure into two distinct components: common ownership and cross-ownership. This distinction is important because the two channels capture economically different mechanisms through which ownership structures may affect collusion. While common ownership reflects passive overlapping holdings by diversified investors, cross-ownership captures direct equity stakes in another firm. Separating the two therefore allows us to examine whether cartel participation is primarily associated with indirect incentive alignment through shared investors or with more direct strategic ownership between competitors.[10]

We decompose the baseline profit weight by partitioning investors into listed-company owners and non-company owners while retaining the same denominator, $\sum_i \beta_{if}^2$, used in the full κ_{fg} measure. Specifically, κ^{CO} sums the numerator contributions of non-company investors, whereas κ^{CrO} sums those of listed companies; the two components are therefore additive by construction, so that $\kappa_{fg} = \kappa_{fg}^{CO} + \kappa_{fg}^{CrO}$.

We classify an investor as a cross-owner when it is itself a listed company in the ownership dataset; all other investors, including funds, pension funds, individuals, families, foundations, and non-listed investment or holding vehicles, are classified as non-company common owners.

However, recall that our ownership dataset only includes publicly listed Swedish firms. Therefore, the ownership links we observe likely represent only a subset of the complete ownership structure in the economy.

In table 3, κ^{CO}, captures common ownership links arising from passive diversified investors such as pension funds, investment funds, or individual shareholders simultaneously holding stakes in multiple competitors. This is the mechanism emphasized in the standard common ownership literature, where overlapping investors soften firms' competitive incentives through portfolio-level profit internalization.

In table 4, κ^{CrO}, captures cross-ownership ties in which firms directly own shares in rival firms. Cross-ownership creates direct financial exposure, potential control rights, board influence, and stronger opportunities for explicit coordination.

Tables 3 and 4 report the results for common ownership excluding cross-ownership and for cross-ownership excluding common ownership, respectively. The results are largely unchanged in Panels A to C relative to the baseline, but the effects are significantly smaller for common ownership than for cross-ownership. Direct ownership stakes thus appear more strongly associated with cartel participation than passive overlapping ownership.

However, Panels D and E, across the two tables, reveal an important asymmetry. Unlike the baseline specification, κ^{CO} is now negative and statistically significant when explaining cartel participation by firm g. Passive common ownership may thus act as a substitute for joint cartel participation: once one firm internalizes rival profits through overlapping investors, there is less need for both firms to explicitly collude simultaneously.[11]

[10] In our data, cross-ownership links account for 34% of observed ownership relationships, while common-ownership links account for the remaining 66%.

[11] This cross-firm substitution, whereby common ownership stands in for explicit joint collusion, is an empirical finding rather than a model prediction, and is distinct from the enforcement *substitution effect* of fines in Section 2.4.3. Our model is silent on which firms collude with which, and so does not generate it.

Instead, for cross-ownership, the coefficients in Panels D and E are positive and statistically significant. This implies that when firm f directly owns shares in rival firm g, both firms become more likely to participate in collusion (although not together). Cross-ownership therefore appears to complement rather than substitute for cartel participation, consistent with the idea that direct equity ties create stronger coordination incentives through financial exposure, influence, and control rights.

4.3 Direction and Timing of Relationship

The previous section established that firms with higher common ownership are more likely to participate in cartels. However, this association is silent on the temporal ordering of the two: whether common ownership tends to precede cartel participation, or whether investors instead adjust their ownership stakes in response to cartel activity. We examine this ordering using a lead–lag (Granger-type) approach, which speaks to temporal precedence and predictive content rather than to a causal effect that our setting does not allow us to identify.

Several mechanisms may explain why common ownership is associated with a higher likelihood of cartel participation. First, managers may recognize the importance of maximizing industry-wide profits rather than focusing solely on their own firm's bottom line. This broader perspective reduces incentives to aggressively undercut rivals, which in turn softens competition and may lead to collusive outcomes, either tacit or explicit. Second, common owners might influence executive compensation structures to reward performance at the industry level. As shown by Bloomfield, Marvão and Spagnolo (2023), such arrangements can align managerial incentives across competing firms, reinforcing cooperative behavior. Third, common owners may exercise their voting power or leverage board representation to encourage firms to adopt more cooperative market strategies. Finally, because common owners have access to strategic information from multiple firms in the same sector, they may, either inadvertently or intentionally, transmit signals that help coordinate behavior and facilitate collusive agreements.

However, it is also possible that the observed relationship runs in the opposite direction, namely that colluding firms are more likely to have higher κ weights. In this case, several alternative mechanisms could be at work. Investors may be more likely to concentrate their holdings in industries with high profit margins, which often reflect reduced competition and the presence of cartel activity. Additionally, investors might strategically hold stakes in multiple cartel members as a form of risk management, hedging against the possibility that one firm deviates from the collusive agreement. Cartels themselves may also encourage or facilitate investment by common owners in order to stabilize the arrangement, reduce incentives to defect, and increase the cost of deviation. Moreover, the higher profitability typically associated with successful collusion may attract investors seeking superior returns. Finally, well-informed investors may simply be better at identifying colluding firms and may allocate capital accordingly.

To distinguish these possibilities, we use the lead–lag relationship between cartel firms and κ weights. We do this for the case in which firm f is in a cartel, regardless of whether or not g is collusive. The specifications are as follows:

$$Cartel_{t+1}(f) = \beta_1 \kappa_{fg,t} + \beta_2 Cartel_t(f) + \tau_{s,t} + \theta_{fg} + \varepsilon_{fg,t} \tag{18}$$

$$Cartel_{t-1}(f) = \beta_1 \kappa_{fg,t} + \beta_2 Cartel_t(f) + \tau_{s,t} + \theta_{fg} + \varepsilon_{fg,t} \tag{19}$$

where $Cartel_f$ is the dependent variable indicating whether firm f is part of a cartel at time t, following $t+1$ or previous $t-1$ periods. $\kappa_{f,t}$ is the weight that firm f places on its rival's profit in period t. The specifications also include year-sector and firm-pair fixed effects which are denoted by τ and θ, respectively. Table 5 examines the temporal ordering of the relationship between profit weights and cartel participation. Column (1) tests whether current $\kappa_{fg,t}$ predicts firm f's cartel participation in period $t+1$, conditional on its current cartel status. The positive and statistically significant coefficient indicates that current profit weights contain predictive information about future cartel participation.

Column (2) instead relates current $\kappa_{fg,t}$ to firm f's cartel status in period $t-1$, conditional on current cartel participation. The small and statistically insignificant coefficient suggests that current profit weights contain little additional information about past cartel status once current participation is taken into account. This specification should thus be interpreted as a conditional lagged-association.

Current κ predicts future cartel participation, while it is not significantly associated with lagged cartel status conditional on current participation. The estimates support a predictive timing relationship from ownership structure to future cartel membership.

Thus, κ weights reflect structural incentives that help predict which firms collude, rather than being a byproduct of cartel involvement. This pattern is consistent with the view that common ownership may facilitate anticompetitive behavior (Azar et al., 2018; Antón, Azar, Giné and Lin, 2022), though it reflects predictive rather than causal evidence.

4.4 Cartel Duration

Having shown that firms with stronger common ownership ties are more likely to participate in cartels, we now turn to the question of whether common ownership also affects the stability of those collusive agreements. In particular, we examine whether firms with higher κ weights tend to participate in cartels that last longer. That is, whether common ownership helps sustain cartels, not just form them.

Two distinct selection issues arise in studies of cartel duration. The first is detection-based sample selection: studies of illegal cartels generally observe only agreements that are discovered or prosecuted, and detected cartels may differ systematically from the underlying cartel population in terms of their duration or severity (Harrington and Wei, 2017). Our Swedish setting substantially mitigates this problem. Because cartel registration was mandatory while cartels were legal, the Swedish Cartel Register provides unusually comprehensive information on registered agreements and their reported start and end dates. Our duration sample is therefore not restricted to cartels selected through antitrust detection or conviction.

A separate participation-selection issue nevertheless remains. Cartel duration is observed only for firms that participate in a cartel. Firms that enter cartels may differ systematically from firms that do not, and the same unobserved factors that influence participation may also be related to the duration of the agreements they enter.

To account for this participation selection, we estimate a two-step Heckman selection model. The selection equation models whether the relevant firm or firm-pair configuration participates in a cartel. Conditional on participation, the outcome equation models the duration of the associated cartel agreement. Thus, the first stage does not model whether an existing cartel is detected or observed by the authorities; rather, it models selection into the subsample for which cartel duration is defined.

For identification beyond the nonlinearity of the model, we include the Swedish inflation rate in the selection equation but exclude it from the duration equation. The identifying assumption is that inflation may affect firms' incentives to enter cartel agreements through changes in nominal conditions, demand, costs, or the transparency of price adjustments, but does not directly affect cartel duration once the other macroeconomic controls are included. This should be interpreted as a maintained identifying assumption rather than as an empirically established fact. Figure A7 documents the evolution of inflation over the sample period, but does not by itself validate the exclusion restriction.

As before, we examine five scenarios depending on the cartel-participation status of firms f and g. Table 6 reports the results from the Heckman two-stage selection model. Consistent with the results in Section 4.2, the selection equation shows that higher profit weights are associated with a significantly greater likelihood of cartel participation across all specifications. The outcome equations then estimate the relationship between κ and cartel duration conditional on this participation.

In the outcome equation, the relationship between κ and cartel duration is more nuanced. In Columns (1) and (3), where firm f participates in the cartel, higher profit weights are associated with significantly longer cartel duration. Using Column (3), a one-standard-deviation increase in κ (0.1058) corresponds to approximately 1.78 additional years of cartel duration (16.8125×0.1058). Given an average cartel duration of 34.88 years[12], this represents an increase of approximately 5.10%. Ownership links may thus help sustain collusive agreements by reducing incentives to deviate and facilitating coordination among firms.

In contrast, Column (2), where both firms f and g participate in the same cartel, yields a negative and statistically significant coefficient. Ownership links and explicit collusion may thus act as partial substitutes once both firms are already coordinating through the same cartel agreement. Then, in these cases, stronger ownership links may reduce the additional value of sticking to longer-lasting cartels. In contrast, the coefficients in Columns (4) and (5) are statistically insignificant, indicating that ownership links have no significant effect on cartel duration when only firm g participates in the cartel.

The inverse Mills ratio is positive and statistically significant in several columns, indicating that the unobserved determinants of cartel participation and duration are correlated under the maintained Heckman specification. This is consistent with the relevance of accounting for participation selection. As a robustness check, Appendix Table A2 replaces inflation with nominal interest rates as the exclusion restriction. The positive duration effects observed in columns (1) and (3) remain statistically significant and economically meaningful. This exercise shows that the results are robust to an alternative exclusion variable, although nominal interest rates may also plausibly affect cartel duration directly.

Overall, common ownership not only raises cartel participation but also affects cartel stability, with the effect depending on the structure of collusion. Ownership links complement collusion when only one firm in the pair is in the cartel, but act as a partial substitute when both are.

[12] Duration measures the total length of each registered cartel agreement over the 1946–1993 life of the register, not the portion falling within our 1985–1993 ownership window. Many Swedish cartels were long-established, and some remained active for nearly the entire register period, which accounts for the high average.

4.5 Cartel Termination

To further explore the relationship between common ownership and collusion, we now turn to the dynamics of cartel termination. Specifically, we examine whether firms adjust their common ownership structures when a cartel ends.

To this end we construct an indicator variable, END, which takes the value of one in the year a firm exits a cartel agreement and zero otherwise. This allows us to test whether firms respond to the end of explicit collusion by altering their κ weights (i.e., whether they increase or decrease their ownership influence over rivals once formal coordination ceases). This analysis provides additional insight into whether common ownership is a substitute for, or a complement to, explicit cartel agreements over time.

We test for the impact of cartel termination using variants of the following regression specification

$$\Delta\kappa_{fg,t} = \beta_1 END_{f,t-1} + \theta_{fg} + \varepsilon_{fg,t}, \tag{20}$$

where $\Delta\kappa_{fg,t}$ is the change in κ weights. That is to say, for an (f, g) firm-pair, it is the change in the profit weight that firm f places on the rival firm g (i.e., within the same sector) in year t. $END_{f,t-1}$ is an indicator variable equal to one if firm f was a member of a cartel that ended in year $t-1$ (i.e., $CARTEL_{f,t-1} = 1$ and $CARTEL_{f,t} = 0$).

As in Section 4.2, we present the results for each of the five subcases in Panels A through E of Table 7. In all panels, the dependent variable is the change in κ_{fg} between years $t-1$ and t, and the main explanatory variable is the indicator END.

In Panel A, where the outcome variable captures the change in the κ_{fg} for firm f, we find that cartel termination is associated with a statistically significant decrease in κ weights across all specifications. Ending a cartel is associated with a reduction in the firm's ownership influence, in the year following cartel dissolution, of approximately 0.0075 units. While this average shift is modest in absolute terms, it corresponds to roughly 4.8% of one standard deviation of the year-to-year changes in κ among cartel firms (0.155). This result reinforces the idea that common ownership and explicit collusion operate as complements: when formal collusion ends, the incentive to maintain ownership ties to rivals also diminishes.

Panel C examines changes in κ for firm f when the corresponding rival firm g is not in the cartel. As in Panel A, we find a robust and significant decline in κ weights following cartel dissolution. Even when ownership ties are not directly reciprocal within the cartel, firms strategically reduce their influence over non-cartel rivals once coordination ceases.

The remaining panels show a different and less robust pattern. Panel B, where both f and g participate in the cartel, yields no statistically significant change in κ. In contrast, Panels D and E produce positive coefficients in some specifications: the estimates are statistically significant in Columns (2) and (3) of Panel D and at the (10%) level in the corresponding columns of Panel E. These positive effects are not robust across all specifications and are weaker than the consistent negative estimates in Panels A and C. The evidence points to a decline in κ when the firm imposing the profit weight exits a cartel, particularly when the linked rival is not a cartel member, while the reverse firm-pair configurations show more limited and less robust increases. The strategic reconfiguration of common ownership is primarily concentrated among cartel participants that held asymmetric ties to non-cartel firms.

Common ownership structures are not fixed but adapt to firms' competitive environments. The reductions in κ following cartel dissolution point to a dynamic complementarity: common ownership is more valuable during collusion and is more likely to be unwound once coordination breaks down.

5 Robustness

5.1 Sector-level Analysis

While our firm-level analysis highlights how ownership links influence cartel participation at the firm-pair level, it is also useful to examine whether similar patterns emerge at a more aggregated level. To this end, we turn to a sector-level analysis that considers how common ownership patterns correlate with the prevalence of cartels across entire industries. This approach allows us to investigate whether sectors characterized by higher levels of overlapping ownership among firms tend to exhibit different patterns of collusive behavior. Specifically, we relate the share of firms participating in cartels within each sector to the common ownership measures introduced in Section 3.3.

Table 8 presents the results for four commonly used sector-level measures of common ownership: the percentage of common stock (PCS), the percentage of common funds (PCF), ownership density, and the common ownership incentive term (COI). Across the specifications, only PCS is positively associated with cartel prevalence, with the coefficient being statistically significant at the 10% level both with and without year fixed effects. The estimated coefficients imply that cartel participation tends to be slightly higher in sectors where the most widespread blockholder is present in a larger fraction of firms.

By contrast, the coefficients on PCF, density, and COI are statistically insignificant. The relationship between common ownership and collusion is considerably weaker at the sector level than at the firm-pair level. One possible explanation is that sector-level ownership measures aggregate across a large number of heterogeneous firms and ownership relationships, thereby masking specific ownership links that may be most relevant for cartel participation. In contrast, the profit-weight measure κ used throughout the paper captures the direct degree of profit internalization between individual firms and therefore aligns more closely with the theoretical mechanism linking ownership structures to collusion.

The sector-level evidence provides only limited support for a relationship between common ownership and cartel prevalence. The stronger, more consistent firm-pair results point to ownership-induced profit internalization operating primarily through specific ownership connections between firms rather than broad sector-wide patterns.

5.2 Logit Analysis

In most of our regression specifications, the dependent variable is a binary variable. We used linear probability models, instead of logit (or probit) models, for two main reasons. First, linear models tend to perform more reliably when using dense fixed-effect structures, thus avoiding the incidental parameters problem (Neyman and Scott, 1948; Lancaster, 2000). Second, logit models rely on variation in the outcome to estimate the effects of covariates. In our case, there are several firm pairs that always take the value of one across all years. Therefore, the inclusion of firm controls leads to these observations being dropped, as they do not contribute to the model estimation.

As a robustness check, Table A3 reports conditional fixed-effects logit estimates. These specifications condition out firm-pair fixed effects and cluster standard errors at the firm-pair level, thereby matching the fixed-effect and clustering structure of the linear probability models closely. Given that the conditional logit estimation is identified only from firm pairs whose cartel-participation status changes during the sample period, the estimation sample is substantially smaller than in the main analysis. Nevertheless, the estimated coefficient on κ remains positive and statistically significant both with macroeconomic controls and with year fixed effects. We interpret this as evidence that the qualitative relationship between profit weights and cartel participation is not specific to the linear probability specification.

5.3 Heterogeneity Across Industries

To further assess the robustness of our findings, Appendix Tables A4 and A5 split the sample by product differentiation and sector type, respectively. The results show a consistent pattern. The coefficient on κ remains positive and statistically significant across differentiated and undifferentiated product markets, as well as across manufacturing and non-manufacturing sectors. Thus, the positive relationship between ownership-induced profit internalization and cartel participation is not confined to a particular type of industry.

However, the magnitude of the effect varies substantially across subsamples. The estimated coefficients are considerably larger in differentiated-product industries and in manufacturing sectors, where ownership links appear to be more strongly associated with cartel participation. Nevertheless, the qualitative pattern remains unchanged across all specifications. In each subsample, the positive association is concentrated in Panels A and C, while the coefficients in Panels B, D, and E remain largely insignificant. Ownership links thus influence cartel participation across a broad range of industries, while their economic importance is greatest in sectors where firms compete through differentiated products and in manufacturing activities, where cartel activity has historically been more prevalent.

6 Conclusion

Using a unique dataset from Sweden, where cartels were legal until 1993, we show that profit weights κ are associated with, and temporally precede, cartel participation. Overlapping ownership may thus help stabilize collusive agreements.

Our analysis shows that firms with a higher profit weight κ on their rival's profits are more likely to participate in a cartel. This supports the idea that common owners align the interests of competing firms, reducing competition as suggested in Azar et al. (2018). Furthermore, a higher κ is associated with longer cartel duration. Cartelists may thus be able to lower the costs of collusion through overlapping ownership. This is in line with the findings in Backus et al. (2021), who highlight the role of common ownership in potentially fostering cooperation among competitors in concentrated markets. However, firms tend to reduce their κ profit weights immediately after the termination of a cartel, indicating a shift in competitive strategies after explicit collusion ceases. We find a complementarity effect between common ownership and collusion, but a substitution effect in the choice of cartel partners.

The network analysis further indicates substantial restructuring of ownership relationships between 1985 and 1993. The full network contracted in terms of firms and links, but became denser and more locally interconnected among the firms that remained. At the same time, ownership links from cartel firms to non-cartel firms became fewer and more centralized, with larger average profit weights on the remaining links. These patterns coincide with the phasing out of legal cartel agreements, and suggest that firms may have used common ownership as a substitute for explicit collusion when cartels became illegal. This complements the findings in Ederer and Pellegrino (2025), which highlight the welfare costs associated with common ownership. To the extent that this shift from explicit to tacit coordination dampens competition, it may generate welfare losses (through higher prices and reduced innovation) that mirror those of traditional cartels.

At the sector level, by contrast, we find only limited support for a link between aggregate common ownership and cartel prevalence, reinforcing that the relationship operates mainly through specific firm-pair ownership links rather than broad sector-wide patterns.

These findings have important implications for competition policy. While traditional antitrust enforcement has focused on detecting and prosecuting explicit collusion, the results suggest that common ownership may serve as a structural enabler of (tacit) coordination, especially in the aftermath of cartel prohibition. This is also highlighted in the recent cartel conviction by the European Commission (June 2025), wherein Delivery Hero and Glovo were in a cartel which was facilitated by a minority shareholding of Delivery Hero in Glovo. This also raises concerns that standard legal tools may underestimate the anti-competitive risks posed by overlapping ownership structures, particularly when ownership links are diffuse and involve passive institutional investors.

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Figures and Tables

This section contains the most important figures and tables referenced in the main text.

Table 1: Variable Description

Variable	Description	Obs.	Mean	Std. dev.	Min	Max
Firm level:						
$\text{Cartel}_t(f)$	Dummy(=1) if the firm f is part of a cartel	480304	0.0764	0.2656	0	1
$\text{Cartel}_t(f\_and\_g)$	Dummy(=1) if both the firms f and g are part of the same cartel	480304	0.0011	0.0338	0	1
$\text{Cartel}_t(f\_NOT\_g)$	Dummy(=1) if the firm f is part of a cartel and the firm g is not.	480304	0.0703	0.2556	0	1
$\kappa_{fg,t}$	Profit weight imposed on rival firms within the same sector	480304	0.0269	0.1058	0	13.8702
END	Dummy(=1) if firm f was in a cartel that ended in year (t-1)	480304	0.0052	0.0721	0	1
Cartel level:						
Duration	Years covered by Firm f's active cartel	36679	34.8843	11.8446	8	44
Macroeconomic level:						
GDP_pos	GDP vol.-HP trend in year t, if this is > 0	480304	49.3492	93.887	0	274.0219
GDP_neg	GDP vol.-HP trend in year t, if this is < 0	480304	46.6427	64.339	0	229.6228
GDP_trend	Real GDP by expenditure (original series 100=1946)	480304	5408.1437	957.0985	3965.6033	6911.6187
Inflation	Inflation rate	480304	6.2442	2.4112	2.3	10.5
Sector level:						
Cartel_share	Share of firms participating in at least one cartel within the sector	143	0.4429	0.3418	0	1
PCS	% of common stock	143	0.2484	0.2271	0	1
PCF	% of common funds	143	0.0942	0.0770	0	0.3125
Density	Ratio of firm-pairs connected in a sector	143	0.1390	0.1747	0	1
COI	Common ownership incentive term	143	0.0517	0.0587	0	0.5085

Notes: The table contains description of firm-, cartel-, macro-, and sector-level variables we use in the empirical analysis.

Table 2: Panel Regressions for κ

	(1)	(2)	(3)	(4)
PANEL A		$\boldsymbol{Cartel}_t(f)$		
κ	0.0348***	0.0342***	0.0419***	0.0348***
	(0.0058)	(0.0057)	(0.0055)	(0.0058)
R^2	0.0274	0.0303	0.1902	0.0274
PANEL B		$\boldsymbol{Cartel}_t(f\_and\_g)$		
κ	0.0005	0.0005	0.0006	0.0005
	(0.0006)	(0.0006)	(0.0006)	(0.0006)
R^2	0.0004	0.0004	0.0018	0.0004
PANEL C		$\boldsymbol{Cartel}_t(f\_not\_g)$		
κ	0.0351***	0.0346***	0.0416***	0.0351***
	(0.0058)	(0.0057)	(0.0056)	(0.0058)
R^2	0.0194	0.0212	0.1527	0.0194
PANEL D		$\boldsymbol{Cartel}_t(g)$		
κ	-0.0011	-0.0018	-0.0018	-0.0011
	(0.0030)	(0.0030)	(0.0030)	(0.0030)
R^2	0.0266	0.0295	0.0296	0.0266
PANEL E		$\boldsymbol{Cartel}_t(g\_not\_f)$		
κ	-0.0009	-0.0014	-0.0021	-0.0009
	(0.0027)	(0.0027)	(0.0028)	(0.0027)
R^2	0.0185	0.0204	0.0231	0.0185
In all panels:				
Macro controls	Y	N	N	Y
Year FEs	N	Y	N	N
Year-sector FEs	N	N	Y	N
Sector FEs	N	N	N	Y
Firm-pair FEs	Y	Y	Y	Y
N	480,304	480,304	480,304	480,304

Notes: Significance levels are denoted by * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. The clustered standard errors (by firm pairs) are shown in brackets. The macroeconomic controls include GDP_pos, GDP_neg, GDP_trend and GDP_trend2.

Table 3: Common Ownership (Excluding Cross-Ownership)

	(1)	(2)	(3)	(4)
PANEL A		$\boldsymbol{Cartel}_t(f)$		
κ^{CO}	0.0130*	0.0132*	0.0312***	0.0130*
	(0.0077)	(0.0077)	(0.0068)	(0.0077)
R^2	0.0266	0.0296	0.1892	0.0266
PANEL B		$\boldsymbol{Cartel}_t(f\_and\_g)$		
κ^{CO}	-0.0005	-0.0005	-0.0004	-0.0005
	(0.0006)	(0.0006)	(0.0006)	(0.0006)
R^2	0.0004	0.0004	0.0018	0.0004
PANEL C		$\boldsymbol{Cartel}_t(f\_not\_g)$		
κ^{CO}	0.0269***	0.0270***	0.0434***	0.0269***
	(0.0076)	(0.0077)	(0.0070)	(0.0076)
R^2	0.0187	0.0206	0.1519	0.0187
PANEL D		$\boldsymbol{Cartel}_t(g)$		
κ^{CO}	-0.0331***	-0.0330***	-0.0335***	-0.0331***
	(0.0060)	(0.0060)	(0.0060)	(0.0060)
R^2	0.0268	0.0298	0.0298	0.0268
PANEL E		$\boldsymbol{Cartel}_t(g\_not\_f)$		
κ^{CO}	-0.0193***	-0.0192***	-0.0213***	-0.0193***
	(0.0057)	(0.0057)	(0.0057)	(0.0057)
R^2	0.0186	0.0205	0.0232	0.0186
In all panels:				
Macro controls	Y	N	N	Y
Year FEs	N	Y	N	N
Year-sector FEs	N	N	Y	N
Sector FEs	N	N	N	Y
Firm-pair FEs	Y	Y	Y	Y
N	480,304	480,304	480,304	480,304

Notes: Significance levels are denoted by * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. The clustered standard errors are shown in brackets. The macroeconomic controls include GDP_pos, GDP_neg, GDP_trend and GDP_trend2.

Table 4: Cross-Ownership (Excluding Common Ownership)

	(1)	(2)	(3)	(4)
PANEL A		$\boldsymbol{Cartel}_t(f)$		
κ^{CrO}	0.0497***	0.0486***	0.0509***	0.0497***
	(0.0104)	(0.0102)	(0.0090)	(0.0104)
R^2	0.0276	0.0305	0.1901	0.0276
PANEL B		$\boldsymbol{Cartel}_t(f\_and\_g)$		
κ^{CrO}	0.0012	0.0012	0.0012	0.0012
	(0.0009)	(0.0009)	(0.0009)	(0.0009)
R^2	0.0005	0.0005	0.0018	0.0005
PANEL C		$\boldsymbol{Cartel}_t(f\_not\_g)$		
κ^{CrO}	0.0425***	0.0416***	0.0438***	0.0425***
	(0.0092)	(0.0090)	(0.0079)	(0.0092)
R^2	0.0193	0.0211	0.1523	0.0193
PANEL D		$\boldsymbol{Cartel}_t(g)$		
κ^{CrO}	0.0166***	0.0154***	0.0155***	0.0166***
	(0.0042)	(0.0040)	(0.0040)	(0.0042)
R^2	0.0267	0.0296	0.0297	0.0267
PANEL E		$\boldsymbol{Cartel}_t(g\_not\_f)$		
κ^{CrO}	0.0093***	0.0084***	0.0084***	0.0093***
	(0.0033)	(0.0032)	(0.0032)	(0.0033)
R^2	0.0186	0.0204	0.0231	0.0186
In all panels:				
Macro controls	Y	N	N	Y
Year FEs	N	Y	N	N
Year-sector FEs	N	N	Y	N
Sector FEs	N	N	N	Y
Firm-pair FEs	Y	Y	Y	Y
N	480,304	480,304	480,304	480,304

Notes: Significance levels are denoted by * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. The clustered standard errors are shown in brackets. The macroeconomic controls include GDP_pos, GDP_neg, GDP_trend and GDP_trend2.

Table 5: Tests for the Timing of the Relationship between Cartel Membership and κ

	(1)	(2)
	$\textbf{Cartel}_{t+1}(f)$	$\textbf{Cartel}_{t-1}(f)$
κ_t	0.0241***	0.0010
	(0.0042)	(0.0035)
$\text{Cartel}_t(f)$	0.5112***	0.5273***
	(0.0067)	(0.0058)
Year-sector FEs	Y	Y
Firm-pair FEs	Y	Y
R^2	0.3148	0.3220
N	468,240	468,240

Notes: Significance levels are denoted by * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. The clustered standard errors (by firm pairs) are shown in brackets. The dependent variable is a dummy variable equal to one if the firm f is in a cartel (similar to Panel A, in Table 2).

Table 6: Heckman Two-Stage Models for Cartel Duration

	(1)	(2)	(3)	(4)	(5)
Selection Stage:					
	Cartel_t(f)	Cartel_t(f and g)	Cartel_t(f not g)	Cartel_t(g)	Cartel_t(g not f)
κ	0.9112***	0.2252***	0.8259***	0.5626***	0.2199***
	(0.0185)	(0.0532)	(0.0188)	(0.0297)	(0.0226)
Inflation	-0.0136***	-0.0298***	-0.0136***	-0.0136***	-0.0143***
	(0.0020)	(0.0093)	(0.0020)	(0.0050)	(0.0020)
Constant	1.2534***	-1.1760**	0.8788***	1.2535***	0.8874***
	(0.0996)	(0.4851)	(0.1020)	(0.2587)	(0.1017)
N (non-selected)	443,625	479,754	446,561	443,625	446,561
Outcome Stage:					
	Duration	Duration	Duration	Duration	Duration
κ	17.2972***	-9.2706***	16.8125***	-1.1746	-1.3895
	(4.2174)	(2.4802)	(4.2570)	(7.4200)	(1.3542)
IMR	32.1678***	2.9817	33.5598***	17.1053	29.2141***
	(5.7296)	(6.6630)	(6.2916)	(14.3002)	(5.4758)
Constant	8.0385**	17.5225	-1.6206	6.6056	-0.9193
	(3.8705)	(15.5783)	(3.8790)	(10.1574)	(3.3628)
Macro controls	yes	yes	yes	yes	yes
N (selected)	36,679	550	33,743	36,679	33,743

Notes: Significance levels are denoted by * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. The inverse Mills ratio (IMR) is an indicator of selection bias.

Table 7: Cartel End Regressions

	(1)	(2)	(3)	(4)
PANEL A	$\Delta\kappa$ [$\mathbf{Cartel}_t(f)$]			
END	-0.0077***	-0.0054**	-0.0253***	-0.0077***
	(0.0023)	(0.0023)	(0.0049)	(0.0023)
R^2	0.0012	0.0017	0.0216	0.0012
PANEL B	$\Delta\kappa$ [$\mathbf{Cartel}_t(f\_and\_g)$]			
END	0.0142	0.0170	0.0212	0.0142
	(0.0219)	(0.0220)	(0.0229)	(0.0219)
R^2	0.0011	0.0017	0.0213	0.0011
PANEL C	$\Delta\kappa$ [$\mathbf{Cartel}_t(f\_not\_g)$]			
END	-0.0071***	-0.0048*	-0.0247***	-0.0071***
	(0.0025)	(0.0025)	(0.0050)	(0.0025)
R^2	0.0012	0.0017	0.0215	0.0012
PANEL D	$\Delta\kappa$ [$\mathbf{Cartel}_t(g)$]			
END	0.0033	0.0058**	0.0058**	0.0033
	(0.0024)	(0.0024)	(0.0024)	(0.0024)
R^2	0.0011	0.0017	0.0213	0.0011
PANEL E	$\Delta\kappa$ [$\mathbf{Cartel}_t(g\_not\_f)$]			
END	0.0021	0.0045*	0.0044*	0.0021
	(0.0023)	(0.0023)	(0.0023)	(0.0023)
R^2	0.0011	0.0017	0.0213	0.0011
In all panels:				
Macro controls	Y	N	N	Y
Year FEs	N	Y	N	N
Year-sector FEs	N	N	Y	N
Sector FEs	N	N	N	Y
Firm-pair FEs	Y	Y	Y	Y
N	343,298	343,298	343,298	343,298

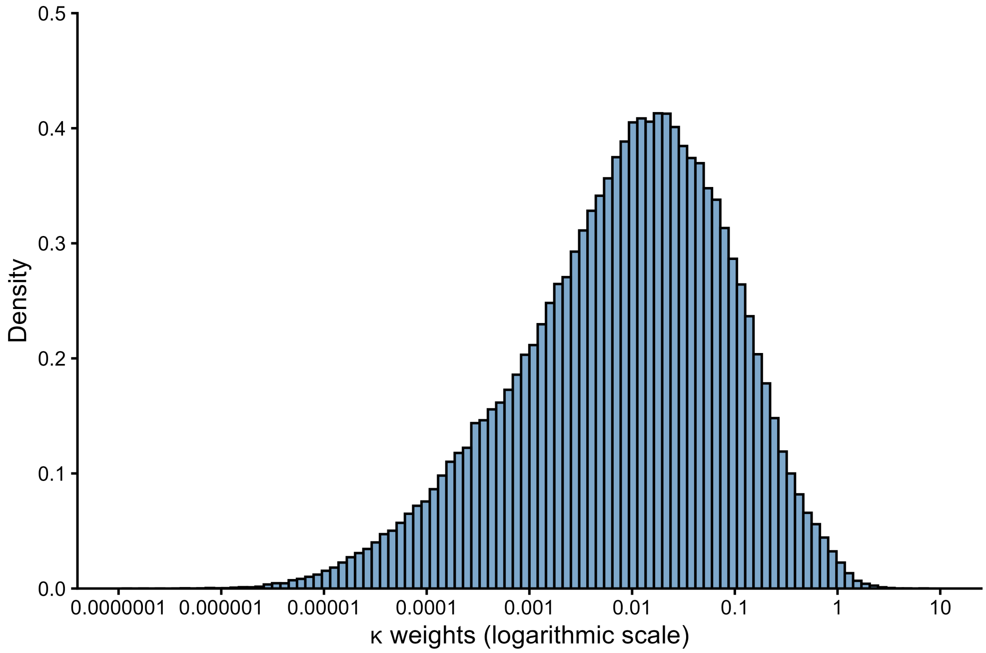
Notes: Significance levels are denoted by * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. The clustered standard errors by firm pairs are shown in parentheses.

Table 8: Panel Regressions for Sector-Level Common Ownership Measures

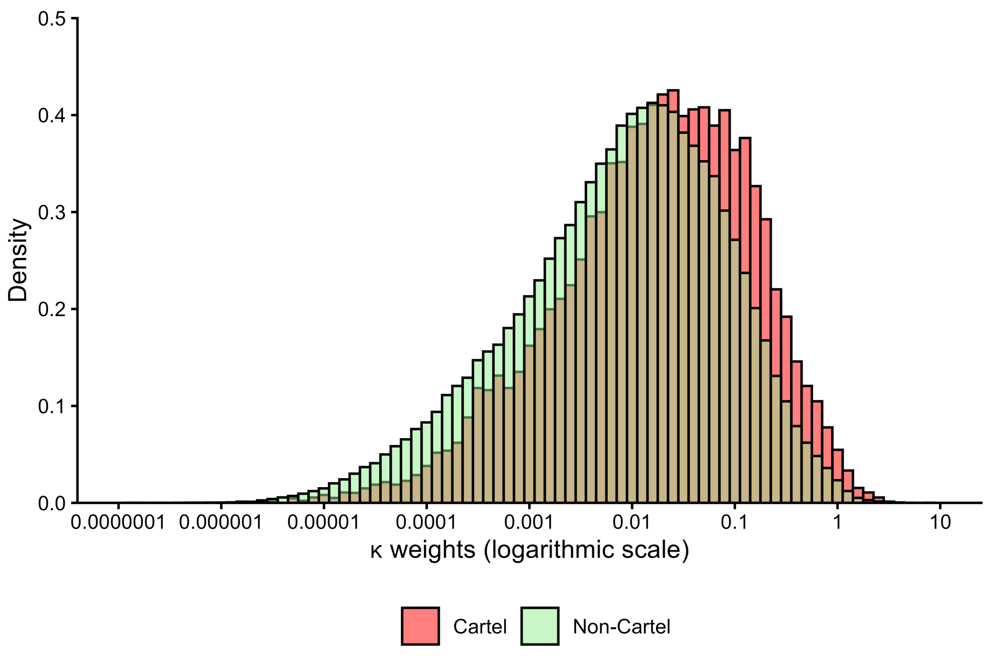
	Cartel_share	
PANEL A	(1)	(2)
PCS	0.0905*	0.0941*
	(0.0526)	(0.0572)
PANEL B	(1)	(2)
PCF	0.1972	0.1890
	(0.2163)	(0.2186)
PANEL C	(1)	(2)
Density	0.0613	0.0626
	(0.0470)	(0.0502)
PANEL D	(1)	(2)
COI	0.0075	0.0124
	(0.1054)	(0.1137)
In all panels:		
Macro controls	Y	N
Year FEs	N	Y
N	143	143

Notes: Standard errors clustered by sector are reported in parentheses. Significance levels are denoted by * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. Column (1) includes sector fixed effects, while Column (2) additionally includes year fixed effects. The dependent variable is the share of firms participating in cartels within a sector-year.

Figure 1: Distribution of Firm-Pair Profit Weights $\kappa_{fg} > 0$



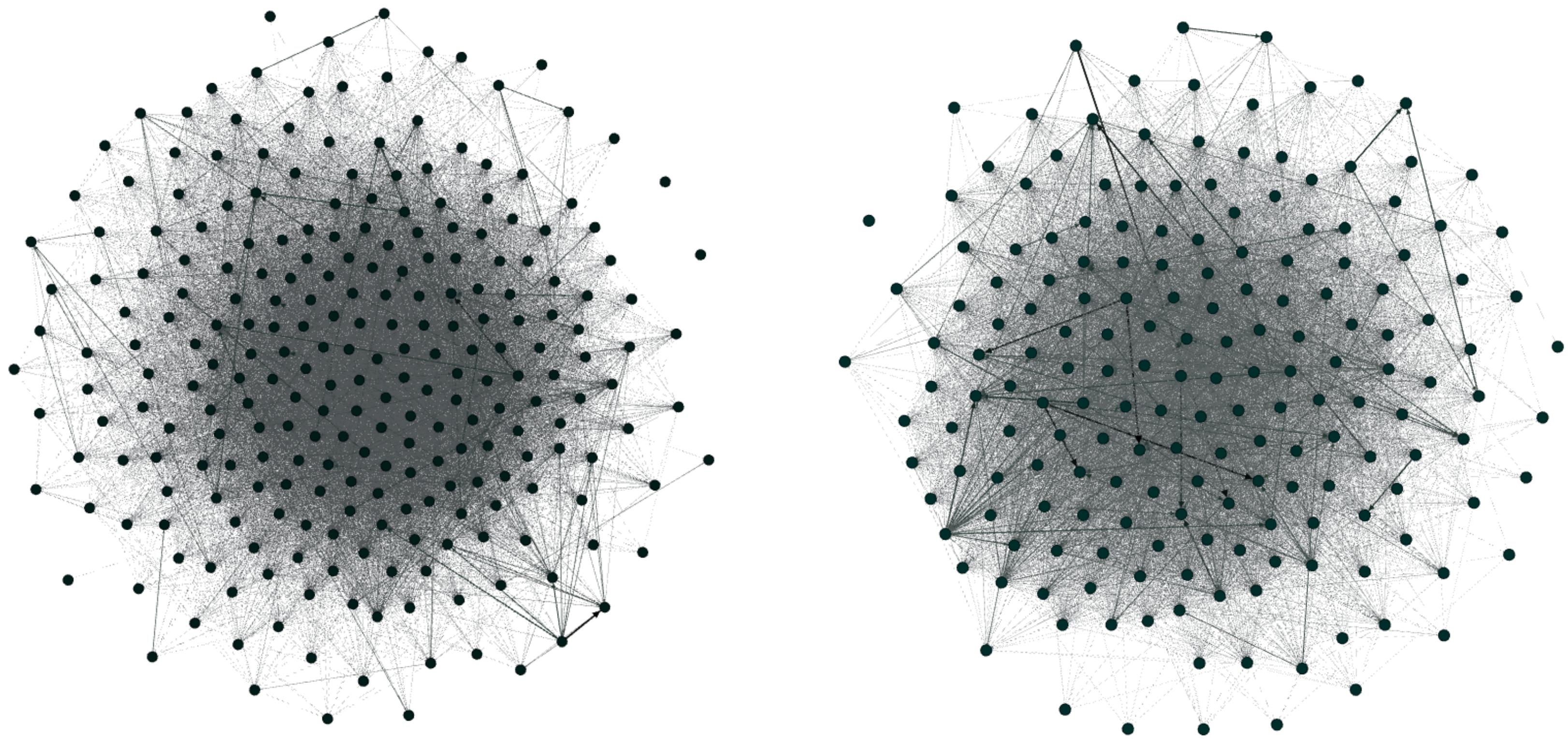
(a) Density Histogram of $\kappa_{fg} > 0$



(b) Density Histogram of $\kappa_{fg} > 0$ by Cartel Membership

Notes: The histograms include all firm pairs with positive $\kappa_{fg} > 0$ weights. Firm pairs where $\kappa_{fg} = 0$ are excluded from the plots.

Figure 2: Network Structure of Firm Pairs with Positive κ

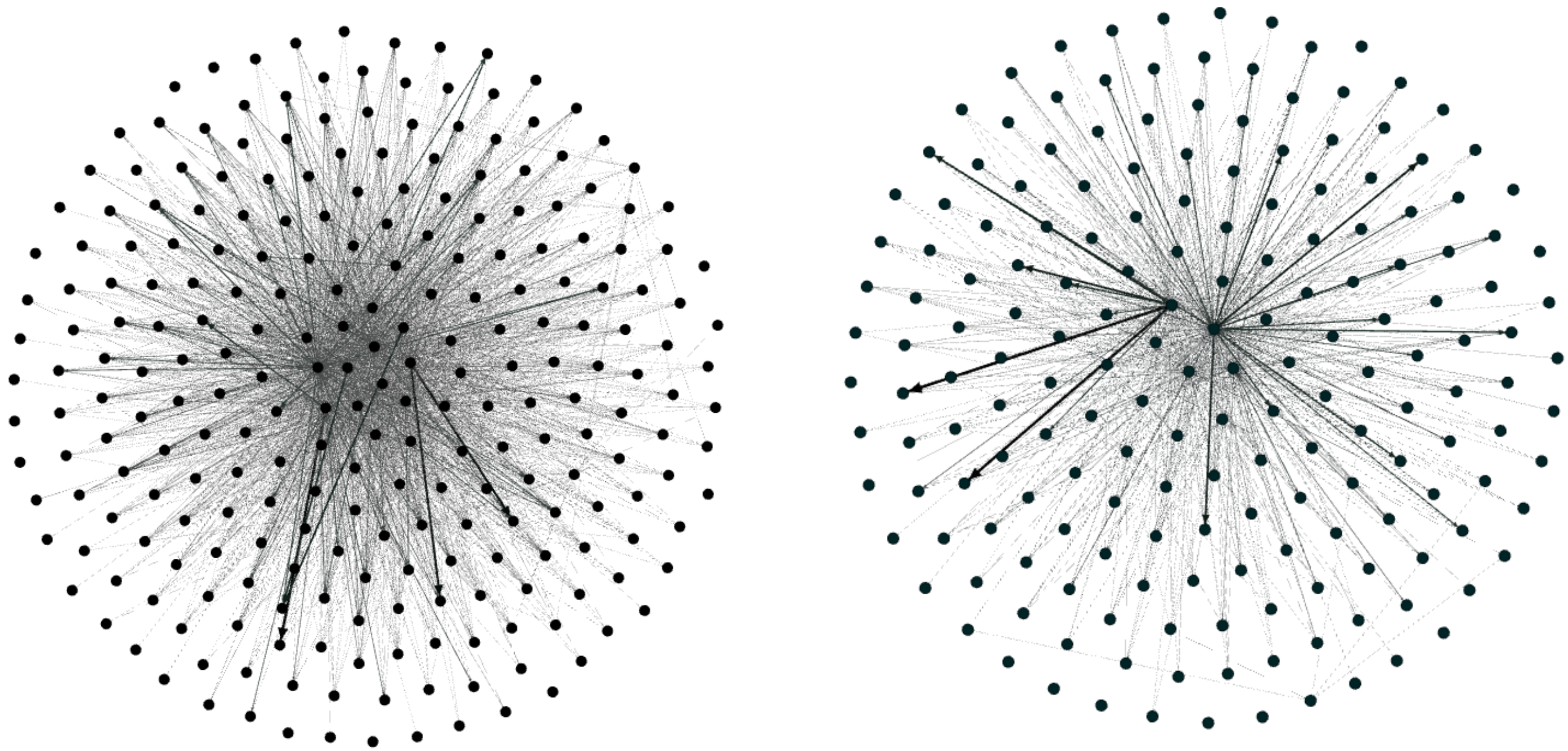


(a) 1985 Network

(b) 1993 Network

Notes: The networks are based on the entire sample of public firms in Sweden in the years 1985 and 1993.

Figure 3: Network Structure of Cartelists with Non-Zero κ on Non-Cartelists



(a) 1985 Network

(b) 1993 Network

Notes: The networks are based on the sample of firm pairs wherein the first firm f is a cartelist imposing a positive non-zero κ_{fg} on a non-cartelist.

Table 9: Evolution of Common Ownership Network Characteristics

	Full network		Cartel-owner network	
	1985	1993	1985	1993
Number of firms (nodes)	250	182	242	171
Number of ownership links (edges)	29,690	19,398	4,127	1,097
Network density	0.477	0.589	0.071	0.038
Average degree	237.520	213.165	34.107	12.830
Average profit weight (κ)	0.053	0.053	0.067	0.102
Largest connected component (% of firms)	100	100	100	100
Average clustering coefficient	0.769	0.812	0.000	0.000
Network centralization	0.336	0.280	0.646	0.814
Average eigenvector centrality	0.176	0.193	—	—
Average betweenness centrality	0.011	0.014	0.000	0.000

Notes: The table reports summary statistics for the common ownership network in the first and last years of the sample, separately for the full network and the cartel-owner network. Nodes correspond to firms, and directed edges represent ownership links with positive profit weights ($\kappa > 0$). The cartel-owner network consists of cartel firms imposing positive κ weights on non-cartel firms. Network density is the share of realized directed ownership links relative to all possible directed ownership links without self-links, $E/[N(N-1)]$. Average degree is the mean sum of in-degree and out-degree across firms. The largest connected component is the largest weakly connected component expressed as a percentage of all firms. The average clustering coefficient is the mean local clustering coefficient after treating the network as undirected and assigning zero to firms with fewer than two neighbors. Network centralization is the normalized Freeman out-degree centralization index, where higher values indicate that ownership links are concentrated among fewer owner firms. Average eigenvector centrality is the mean weighted directed eigenvector centrality score, with κ treated as connection strength. Average betweenness centrality is the mean normalized directed vertex-betweenness score, with shortest-path distance defined as $1/\kappa$ so that stronger ownership links are treated as shorter paths. In the cartel-owner network, no firm appears as both an owner and a target. Clustering and betweenness are therefore zero because the network contains no triangles or intermediate firms on directed paths. Directed eigenvector centrality is not defined because the network is acyclic and has a zero leading eigenvalue; — denotes this case.

A Additional Figures and Tables

This section contains additional figures and tables referenced in the main text.

Figure A1: Number of Listed Firms in Sweden, 1985-1993

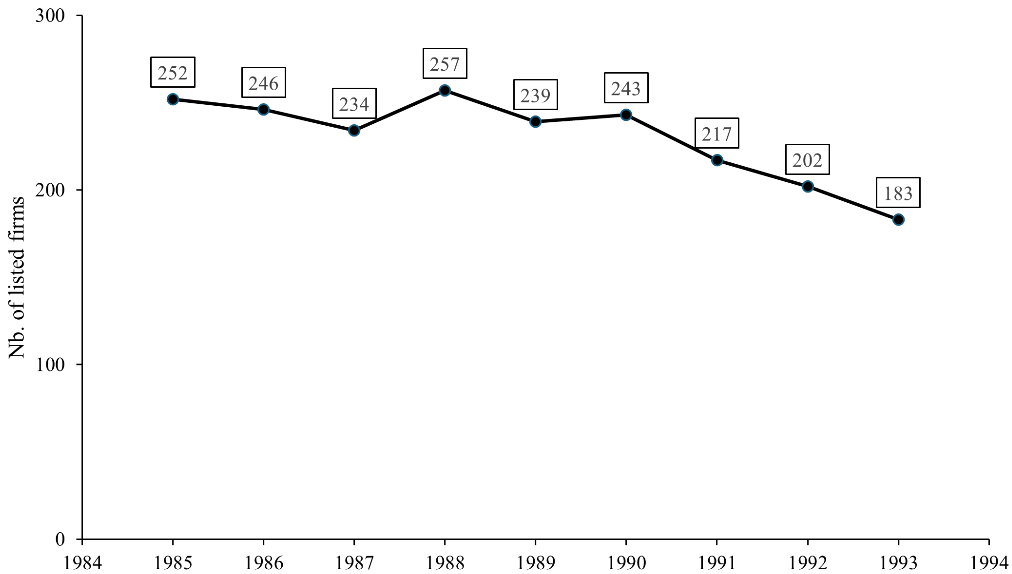


Figure A2: Pyramidal Structure of Investor Spheres

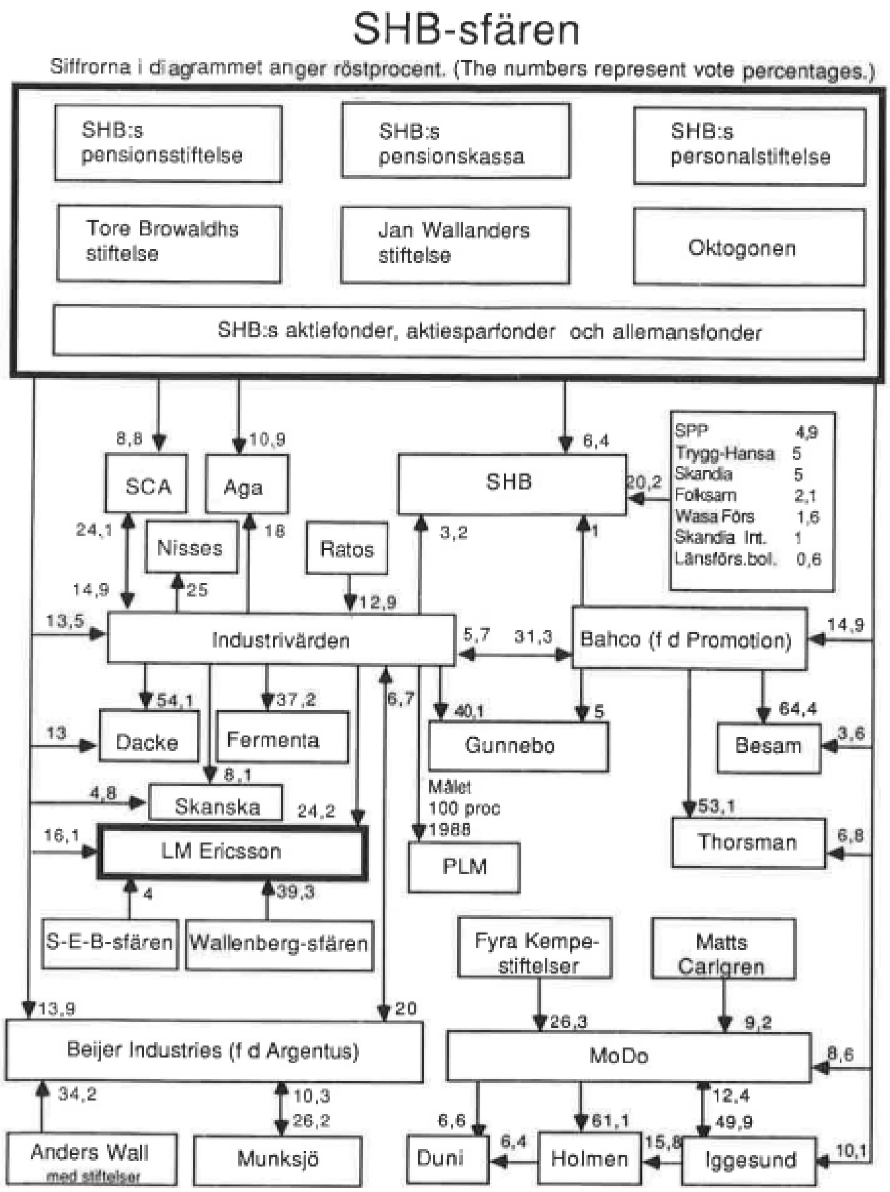
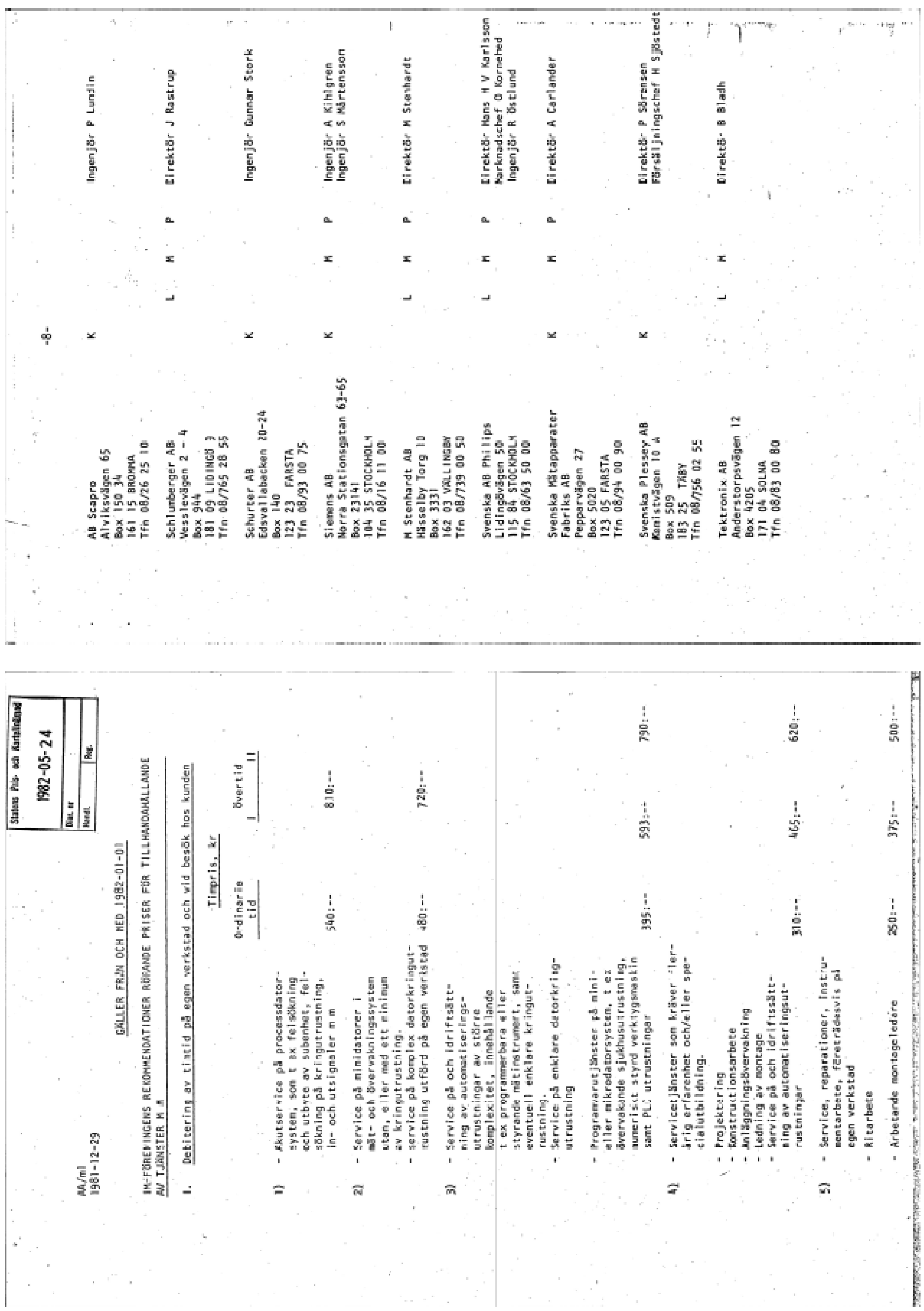


Figure A3: Example of a Cartel Contract



Statens Pris- och Kartellnämnd
1982-05-24
Diar. nr
Handl. | Reg.

AA/ml
1981-12-29

GÄLLER FRÅN OCH MED 1982-01-01

EM-FÖRENINGENS REKOMMENDATIONER RÖRANDE PRISER FÖR TILLHANDAHÅLLANDE AV TJÄNSTER M M

I. Debitering av timtid på egen verkstad och vid besök hos kunden

	Timpris, kr		
	Ordinarie tid	Övertid I	Övertid II
1) - Akutservice på processdatorsystem, som t ex felsökning och utbyte av subenhet, felsökning på kringutrustning, in- och utsignaler m m	540:--	810:--	
2) - Service på minidatorer i mät- och övervakningssystem utan, eller med ett minimum av kringutrustning. - service på komplex datorkringutrustning utförd på egen verkstad	480:--	720:--	
3) - Service på och idriftsättning av automatiseringsutrustningar av större komplexitet, innehållande t ex programmerbara eller styrande mätinstrument, samt eventuell enklare kringutrustning. - Service på enklare datorkringutrustning - Programvarutjänster på mini- eller mikrodatorsystem, t ex övervakande sjukhusutrustning, numeriskt styrd verktygsmaskin samt PLC utrustningar	395:--	593:--	790:--
4) - Servicetjänster som kräver flerårig erfarenhet och/eller specialutbildning. - Projektering - Konstruktionsarbete - Anläggningsövervakning - Ledning av montage - Service på och idriftssättning av automatiseringsutrustningar	310:--	465:--	620:--
5) - Service, reparationer, instrumentarbete, företrädesvis på egen verkstad - Ritarbete - Arbetande montageledare	250:--	375:--	500:--

-8-

AB Scapro Alviksvägen 65 Box 150 34 161 15 BROMMA Tfn 08/26 25 10	K				Ingenjör P Lundin
Schlumberger AB Vesslevägen 2 - 4 Box 944 181 09 LIDINGÖ 3 Tfn 08/765 28 55		L	M	P	Direktör J Rastrup
Schurter AB Edsvallabacken 20-24 Box 140 123 23 FARSTA Tfn 08/93 00 75	K				Ingenjör Gunnar Stork
Siemens AB Norra Stationsgatan 63-65 Box 23141 104 35 STOCKHOLM Tfn 08/16 11 00	K		M	P	Ingenjör A Kihlgren Ingenjör S Mårtensson
M Stenhardt AB Hässelby Torg 10 Box 3331 162 03 VÄLLINGBY Tfn 08/739 00 50		L	M	P	Direktör M Stenhardt
Svenska AB Philips Lidingövägen 50 115 84 STOCKHOLM Tfn 08/63 50 00		L	M	P	Direktör Hans H V Karlsson Marknadschef O Kornehed Ingenjör R Östlund
Svenska Mätapparater Fabriks AB Pepparvägen 27 Box 5020 123 05 FARSTA Tfn 08/94 00 90	K		M	P	Direktör A Carlander
Svenska Plessey AB Kanistvägen 10 A Box 509 183 25 TÄBY Tfn 08/756 02 55	K				Direktör P Sörensen Försäljningschef H Sjöstedt
Tektronix AB Anderstorpsvägen 12 Box 4205 171 04 SOLNA Tfn 08/83 00 80		L	M		Direktör B Bladh

Notes: The cartel contract includes a price list for technical services, dated December 29, 1981, and effective from January 1, 1982. For example, an emergency service on processor systems should be charged 540 SEK during regular hours, or 810 SEK for overtime. The right-hand side page (nb.30 of a 62 page contract) lists some of the cartel members (e.g. Siemens).

Figure A4: Punishment Mechanisms in the Swedish Cartel Register, 1985-1993

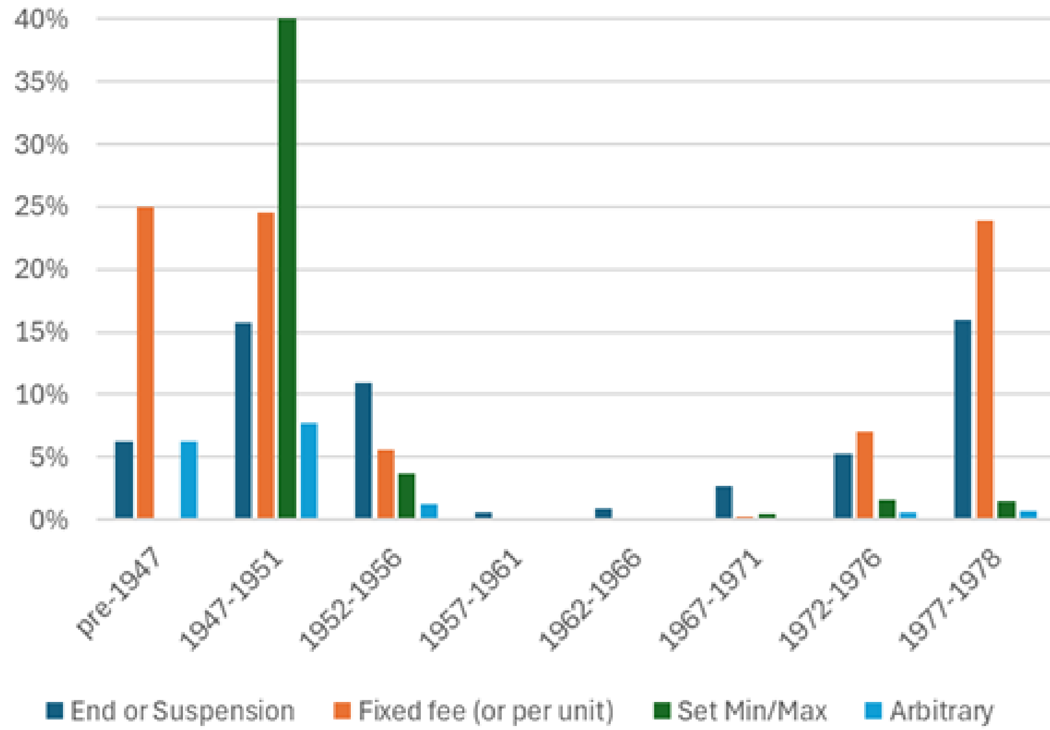


Figure A5: GDP Shocks and GDP Trend for Sweden, 1985-1993

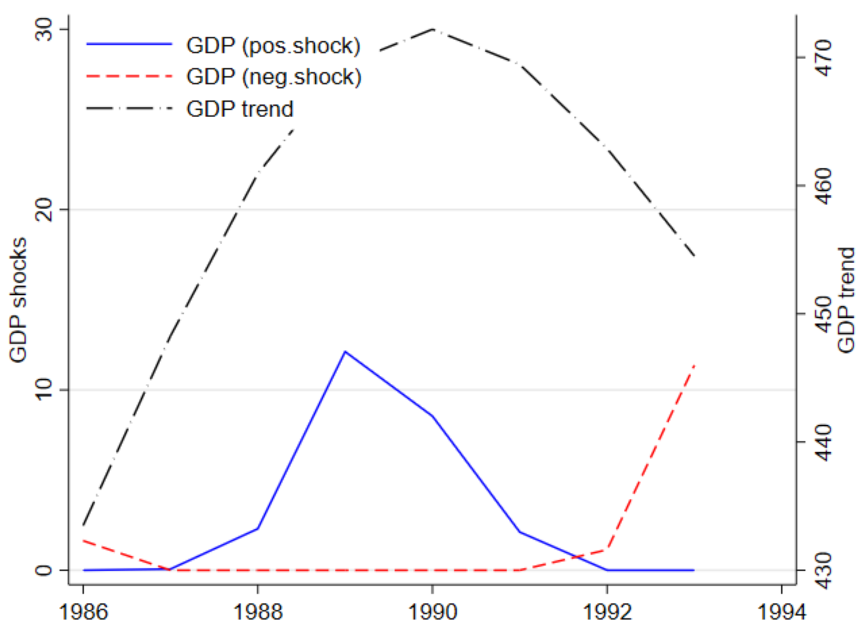


Figure A6: Average κ across Sectors

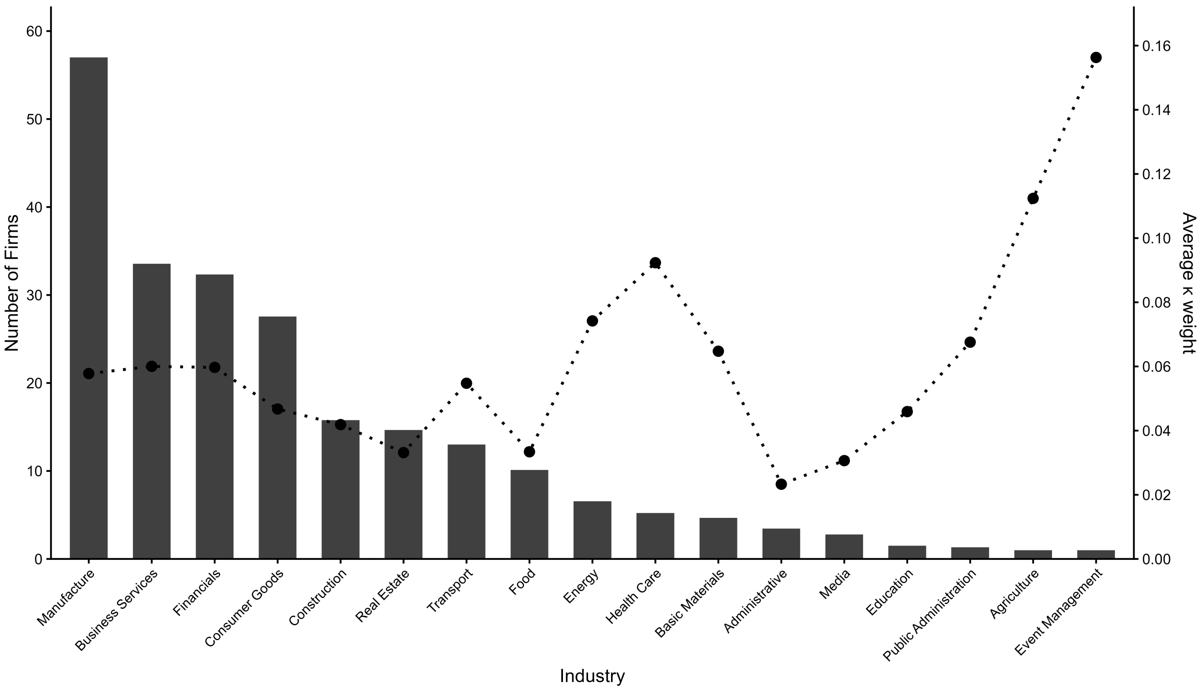


Figure A7: Inflation Rate in Sweden, 1985-1993

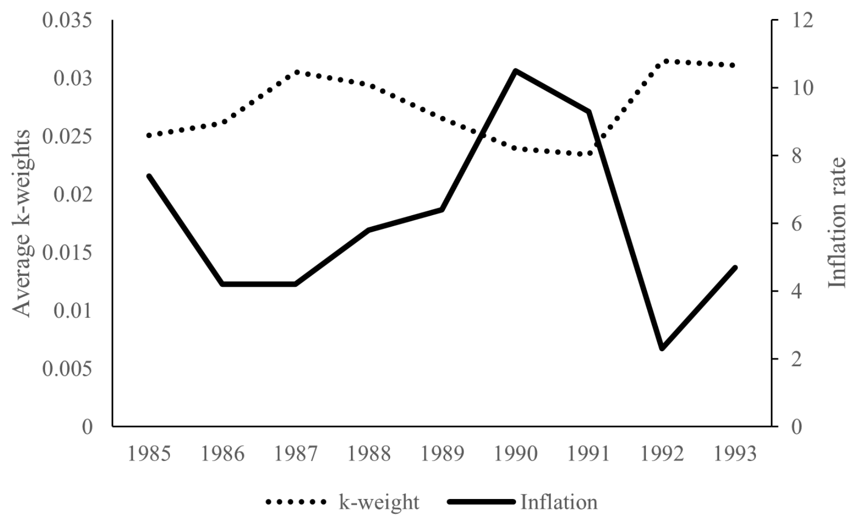


Table A1: Panel Regressions for κ, with NACE-2 Sector Controls

	(1)	(2)
PANEL A	$\boldsymbol{Cartel}_t(f)$	
κ	0.0430***	0.0348***
	(0.0056)	(0.0058)
R^2	0.1776	0.0274
PANEL B	$\boldsymbol{Cartel}_t(f\_and\_g)$	
κ	0.0006	0.0005
	(0.0006)	(0.0006)
R^2	0.0018	0.0004
PANEL C	$\boldsymbol{Cartel}_t(f\_not\_g)$	
κ	0.0416***	0.0351***
	(0.0056)	(0.0058)
R^2	0.1527	0.0194
PANEL D	$\boldsymbol{Cartel}_t(g)$	
κ	-0.0018	-0.0011
	(0.0030)	(0.0030)
R^2	0.0296	0.0266
PANEL E	$\boldsymbol{Cartel}_t(g\_not\_f)$	
κ	-0.0022	-0.0009
	(0.0028)	(0.0027)
R^2	0.0228	0.0185
In all panels:		
Macro controls	N	Y
Firm-pair FEs	Y	Y
Sector (NACE-2) $\times$ Year FEs	Y	N
Sector (NACE-2) FEs	N	Y
N	480,304	480,304

Notes: Significance levels are denoted by * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. Clustered standard errors (by firm pair) are reported in parentheses. Both specifications include macroeconomic controls and firm-pair fixed effects. Column (1) includes NACE-2 sector-year fixed effects. Column (2) includes NACE-2 sector fixed effects.

Table A2: Heckman Two-Stage Models for Cartel Duration Using Nominal Interest Rates

	(1)	(2)
Selection Stage:		
	$\text{Cartel}_t(f)$	$\text{Cartel}_t(f \neq g)$
κ_t	0.9079***	0.8219***
	(0.0184)	(0.0188)
Interest rates	0.0142***	0.0111***
	(0.0014)	(0.0014)
Constant	-1.6238***	-1.6297***
	(0.0160)	(0.0164)
N (nonselected)	443,625	446,561
Outcome Stage:		
	Duration	Duration
κ_t	14.1017***	14.9222***
	(2.5833)	(3.2506)
IMR	26.7912***	29.5590***
	(3.4985)	(4.8340)
Constant	-15.8329**	-22.0484**
	(6.6615)	(9.3735)
N (selected)	36,679	33,743

Notes: Significance levels are denoted by * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. The inverse Mills ratio (IMR) is an indicator of selection bias.

Table A3: Conditional Fixed-Effects Logit Tests of Common Ownership and Cartel Membership

	Cartel$_t(f)$	
	(1)	(2)
κ	15.2480***	5.4516***
	(5.3897)	(1.4903)
Macro controls	Y	N
Year FEs	N	Y
Firm-pair FEs	Y	Y
N	13,330	13,330

Notes: This table repeats the analysis of Panel A of Table 2 using conditional fixed-effects logit models. Firm-pair fixed effects are conditioned out of the likelihood. Significance levels are denoted by * $p < 0.1$, ** $p < 0.05$, and *** $p < 0.01$. Standard errors clustered at the firm-pair level are reported in parentheses. The macroeconomic controls in Column (1) include GDP_pos, GDP_neg, GDP_trend, and GDP_trend2. Column (2) includes year fixed effects. The national macroeconomic controls are omitted from Column (2) because they are absorbed by the year fixed effects. Conditional fixed-effects logit estimation retains only firm pairs with within-pair variation in cartel participation.

Table A4: Robustness Check, by (Un)differentiated Products

	Differentiated (Rajan, Zingales, 1998)				**Undifferentiated**			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
PANEL A	$\boldsymbol{Cartel}_t(f)$							
κ	0.0929***	0.0917***	0.0970***	0.0929***	0.0192***	0.0188***	0.0270***	0.0192***
	(0.0138)	(0.0138)	(0.0134)	(0.0138)	(0.0046)	(0.0046)	(0.0043)	(0.0046)
R-squared	0.0458	0.0535	0.1931	0.0458	0.0215	0.0231	0.2083	0.0215
PANEL B	$\boldsymbol{Cartel}_t(f\_and\_g)$							
κ	0.0028	0.0028	0.0028	0.0028	-0.0001	-0.0001	-0.0000	-0.0001
	(0.0024)	(0.0024)	(0.0024)	(0.0024)	(0.0004)	(0.0004)	(0.0004)	(0.0004)
R-squared	0.0008	0.0008	0.0014	0.0008	0.0004	0.0004	0.0021	0.0004
PANEL C	$\boldsymbol{Cartel}_t(f\_not\_g)$							
κ	0.0864***	0.0854***	0.0903***	0.0864***	0.0212***	0.0210***	0.0284***	0.0212***
	(0.0132)	(0.0132)	(0.0130)	(0.0132)	(0.0049)	(0.0049)	(0.0047)	(0.0049)
R-squared	0.0359	0.0415	0.1536	0.0359	0.0141	0.0151	0.1674	0.0141
PANEL D	$\boldsymbol{Cartel}_t(g)$							
κ	0.0010	0.0003	0.0003	0.0010	-0.0017	-0.0023	-0.0023	-0.0017
	(0.0076)	(0.0076)	(0.0076)	(0.0076)	(0.0032)	(0.0032)	(0.0032)	(0.0032)
R-squared	0.0264	0.0294	0.0295	0.0264	0.0266	0.0296	0.0296	0.0266
PANEL E	$\boldsymbol{Cartel}_t(g\_not\_f)$							
κ	-0.0055	-0.0059	-0.0064	-0.0055	0.0004	-0.0001	-0.0009	0.0004
	(0.0068)	(0.0068)	(0.0068)	(0.0068)	(0.0029)	(0.0029)	(0.0030)	(0.0029)
R-squared	0.0157	0.0171	0.0213	0.0157	0.0198	0.0219	0.0241	0.0198
Macro controls	Y	N	N	Y	Y	N	N	Y
Year FEs	N	Y	N	N	N	Y	N	N
Year-sector FEs	N	N	Y	N	N	N	Y	N
Sector FEs	N	N	N	Y	N	N	N	Y
Firm-pair FEs	Y	Y	Y	Y	Y	Y	Y	Y
N	142,654	142,654	142,654	142,654	337,650	337,650	337,650	337,650

Notes: Significance levels are denoted by * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. The clustered standard errors by firm pairs are shown in brackets. The macroeconomic controls include GDP_pos, GDP_neg, GDP_trend and GDP_trend2.

Table A5: Robustness Check, by Manufacturing and Other Sectors

	Manufacturing				Other sectors			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
PANEL A	$\boldsymbol{Cartel}_t(f)$							
κ	0.1071***	0.1051***	0.1100***	0.1071***	0.0185***	0.0182***	0.0261***	0.0185***
	(0.0155)	(0.0155)	(0.0152)	(0.0155)	(0.0044)	(0.0044)	(0.0041)	(0.0044)
R-squared	0.0559	0.0660	0.1935	0.0559	0.0199	0.0214	0.2082	0.0199
PANEL B	$\boldsymbol{Cartel}_t(f\_and\_g)$							
κ	0.0032	0.0032	0.0032	0.0032	-0.0001	-0.0001	-0.0000	-0.0001
	(0.0028)	(0.0028)	(0.0028)	(0.0028)	(0.0004)	(0.0004)	(0.0004)	(0.0004)
R-squared	0.0009	0.0009	0.0014	0.0009	0.0004	0.0004	0.0021	0.0004
PANEL C	$\boldsymbol{Cartel}_t(f\_not\_g)$							
κ	0.0995***	0.0980***	0.1024***	0.0995***	0.0205***	0.0203***	0.0276***	0.0205***
	(0.0148)	(0.0149)	(0.0147)	(0.0148)	(0.0047)	(0.0047)	(0.0044)	(0.0047)
R-squared	0.0438	0.0511	0.1540	0.0438	0.0131	0.0140	0.1674	0.0131
PANEL D	$\boldsymbol{Cartel}_t(g)$							
κ	-0.0015	-0.0023	-0.0023	-0.0015	-0.0010	-0.0016	-0.0017	-0.0010
	(0.0084)	(0.0084)	(0.0085)	(0.0084)	(0.0031)	(0.0031)	(0.0031)	(0.0031)
R-squared	0.0269	0.0299	0.0299	0.0269	0.0265	0.0294	0.0295	0.0265
PANEL E	$\boldsymbol{Cartel}_t(g\_not\_f)$							
κ	-0.0091	-0.0094	-0.0099	-0.0091	0.0010	0.0005	-0.0003	0.0010
	(0.0076)	(0.0076)	(0.0076)	(0.0076)	(0.0029)	(0.0029)	(0.0029)	(0.0029)
R-squared	0.0140	0.0150	0.0197	0.0140	0.0201	0.0223	0.0244	0.0201
Macro controls	Y	N	N	Y	Y	N	N	Y
Year FEs	N	Y	N	N	N	Y	N	N
Year-sector FEs	N	N	Y	N	N	N	Y	N
Sector FEs	N	N	N	Y	N	N	N	Y
Firm-pair FEs	Y	Y	Y	Y	Y	Y	Y	Y
N	108,784	108,784	108,784	108,784	371,520	371,520	371,520	371,520

Notes: Significance levels are denoted by * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. The clustered standard errors by firm pairs are shown in brackets. The macroeconomic controls include GDP_pos, GDP_neg, GDP_trend and GDP_trend2.

B Details for Comparative Statics

In Section B we derived comparative statics from equation (15) which computes the critical discount factor, given by

$$\delta^*(\kappa, F) = \frac{\Delta^{\text{dev}}}{\Delta^{\text{dev}} + \Delta^{\text{coop}}},$$

where

$$\begin{aligned} \Delta^{\text{dev}} &= (\pi^D - \pi^C) + (n-1)\kappa(\pi^{D,-} - \pi^C) \\ \Delta^{\text{coop}} &= (1 + (n-1)\kappa)(\pi^C - \pi^{\text{NC}}) - F, \end{aligned}$$

Thus, the critical discount factor is given by

$$\begin{aligned} \delta^*(\kappa, F) &= \tfrac{(\pi^D - \pi^C) + (n-1)\kappa(\pi^{D,-} - \pi^C)}{(\pi^D - \pi^C) + (n-1)\kappa(\pi^{D,-} - \pi^C) + (1 + (n-1)\kappa)(\pi^C - \pi^{\text{NC}}) - F} \\ &= \tfrac{(\pi^D - \pi^C) + (n-1)\kappa(\pi^{D,-} - \pi^C)}{\pi^D - \pi^{\text{NC}} - F + (n-1)\kappa(\pi^{D,-} - \pi^{NC})} \end{aligned}$$

To compute the comparative statics, we define the following:

$$A(\kappa) \equiv (\pi^D - \pi^C) + (n-1)\kappa(\pi^{D,-} - \pi^C),$$

$$D(\kappa, F) = \pi^D - \pi^{\text{NC}} - F + (n-1)\kappa(\pi^{D,-} - \pi^{\text{NC}}).$$

which allows us to express the critical discount factor in the following way

$$\delta^*(\kappa, F) = \frac{A(\kappa)}{D(\kappa, F)}.$$

(i) Effect of F on $\delta^*(\kappa, F)$

Since $A(\kappa)$ does not depend on F, and

$$\frac{\partial D(\kappa, F)}{\partial F} = -1,$$

we have

$$\frac{\partial \delta^*}{\partial F} = \frac{0 \cdot D(\kappa, F) - A(\kappa) \cdot (-1)}{D(\kappa, F)^2}.$$

Therefore,

$$\frac{\partial \delta^*}{\partial F} = \frac{A(\kappa)}{D(\kappa, F)^2}.$$

Substituting back,

$$\frac{\partial \delta^*}{\partial F} = \frac{(\pi^D - \pi^C) + (n-1)\kappa(\pi^{D,-} - \pi^C)}{[\pi^D - \pi^{\mathrm{NC}} - F + (n-1)\kappa(\pi^{D,-} - \pi^{\mathrm{NC}})]^2}.$$

Thus,

$$\frac{\partial \delta^*}{\partial F} > 0.$$

i.e., higher expected penalties destabilize collusion (*substitution effect*)

(ii) Effect of κ on $\delta^*(\kappa, F)$

$$\frac{\partial \delta^*}{\partial \kappa} = \frac{A_\kappa D(\kappa, F) - A(\kappa) D_\kappa}{D(\kappa, F)^2},$$

where

$$A_\kappa = (n-1)(\pi^{D,-} - \pi^C), \qquad D_\kappa = (n-1)(\pi^{D,-} - \pi^{\mathrm{NC}}).$$

Equivalently,

$$\frac{\partial \delta^*}{\partial \kappa} = \frac{(n-1)\left[(\pi^{D,-} - \pi^C)(\pi^D - \pi^{\mathrm{NC}} - F) - (\pi^{D,-} - \pi^{\mathrm{NC}})(\pi^D - \pi^C)\right]}{D(\kappa, F)^2}.$$

The numerator does not depend on κ, so its sign determines that of $\partial\delta^*/\partial\kappa$ globally. Substituting the one-period Cournot profits and writing $K \equiv (a-c)^2/b$, we have $\pi^{D,-} - \pi^C = -K(n-1)/(8n^2) < 0$, $\pi^D - \pi^C = K(n-1)^2/(16n^2)$, $\pi^D - \pi^{\mathrm{NC}} = K(n-1)^2(n^2+6n+1)/(16n^2(n+1)^2)$, and $\pi^{D,-} - \pi^{\mathrm{NC}} = K(n-1)(n^2-4n-1)/(8n^2(n+1)^2)$. The bracketed term then factors as

$$(\pi^{D,-} - \pi^C)(\pi^D - \pi^{\mathrm{NC}} - F) - (\pi^{D,-} - \pi^{\mathrm{NC}})(\pi^D - \pi^C) = \frac{K(n-1)}{8n^2}\left(F - \bar{F}\right),$$

so that

$$\frac{\partial \delta^*}{\partial \kappa} = \frac{(a-c)^2(n-1)^2}{8\,b\,n^2} \cdot \frac{F - \bar{F}}{D(\kappa, F)^2}, \qquad \bar{F} \equiv \frac{(a-c)^2(n-1)^2}{8\,b\,n(n+1)} = \frac{n+1}{2}\,(\pi^C - \pi^{\mathrm{NC}}).$$

Hence $\partial\delta^*/\partial\kappa < 0$ if and only if $F < \bar{F}$. We maintain $\kappa < \frac{1}{2}$, which holds throughout our data (where κ lies far below $\frac{1}{2}$) and guarantees $A(\kappa) = K(n-1)^2(1-2\kappa)/(16n^2) > 0$, so deviation remains tempting and $\delta^* \in (0,1)$ is an interior critical discount factor. A cartel is viable only if the weighted continuation gain is positive, $\Delta^{\text{coop}} = (1+(n-1)\kappa)(\pi^C - \pi^{\text{NC}}) - F > 0$, i.e. $F < (1+(n-1)\kappa)(\pi^C - \pi^{\text{NC}})$. For $\kappa < \frac{1}{2}$ this bound lies below $\frac{n+1}{2}(\pi^C - \pi^{\text{NC}}) = \bar{F}$, so any viable cartel satisfies $F < \bar{F}$ and therefore

$$\frac{\partial \delta^*}{\partial \kappa} < 0,$$

so greater profit weights from common ownership stabilize collusion (*complementarity effect*). The same restriction $A(\kappa) > 0$ underlies the sign of $\partial\delta^*/\partial F > 0$ in part (i).

C Derivation of κ

In Section 3.2, we describe the objective function ϕ_f for firm f with shareholders s. Let v_s denote the sum of profits over the portfolio of investments of shareholder s weighted by cash flow rights

$$v_s = \sum_g \beta_{gs}\pi_g. \tag{21}$$

The firm objective function can then be rewritten in the following way:

$$\begin{aligned} \phi_f &= \textstyle\sum_{\forall s} \gamma_{fs} v_s \\ &= \textstyle\sum_{\forall s} \gamma_{fs} \sum_{\forall g} \beta_{gs}\pi_g \\ &= \textstyle\sum_{\forall s} \gamma_{fs}\beta_{fs}\pi_f + \sum_{\forall s} \gamma_{fs} \sum_{\forall g \neq f} \beta_{gs}\pi_g. \end{aligned} \tag{22}$$

This maximization problem can be rewritten as a maximization of own and competing firms' profits when normalized by $\sum_{\forall s} \gamma_{fs}\beta_{fs}$ such that we obtain:

$$\begin{aligned} \phi_f &\propto \pi_f + \textstyle\sum_{g\neq f} \frac{\sum_{\forall s} \gamma_{fs}\beta_{gs}}{\sum_{\forall s} \gamma_{fs}\beta_{fs}} \pi_g \\ &\propto \pi_f + \textstyle\sum_{g \neq f} \kappa_{fg}(\gamma_f, \beta)\pi_g. \end{aligned} \tag{23}$$

In the equation above, κ_{fg} denotes, in firm f's maximization problem, the value of a dollar of profits to firm g, relative to a dollar of profits for firm f.

Next, as in Rotemberg (1984) and Backus et al. (2021), we use the "proportional control assumption" which captures the commonly used "one share, one vote", such that the voting shares γ_{fs} are equal to the ownership stakes of shareholders β_{fs}, that is $\gamma_{fs} = \beta_{fs}$.[13] Hence,

[13]We adopt this convention for comparability with the common ownership literature. Because controlling Swedish owners typically hold voting rights exceeding their cash-flow rights, it is likely to understate rather than overstate the degree of profit internalization our measure captures.

we have:

$$\kappa_{fg} = \frac{\sum_{\forall s} \gamma_{fs}\beta_{gs}}{\sum_{\forall s} \gamma_{fs}\beta_{fs}},$$
$$\kappa_{fg} \equiv \frac{\sum_s \beta_{fs}\beta_{gs}}{\sum_s \beta_{fs}^2}. \tag{24}$$

Alternatively, allowing β_f and γ_f to be vectors over s, equation (24) can be written as a ratio of (geometric) inner (dot) products, where $\cos(a, b)$ is the cosine similarity between vectors a and b and $\| a \|$ is the L_2 norm $\sqrt{\sum_i a_i^2}$:

$$\kappa_{fg} = \frac{< \gamma_f, \beta_g >}{< \gamma_f, \beta_f >} = \frac{\cos(\gamma_f, \beta_g) \| \gamma_f \| \| \beta_g \|}{\cos(\gamma_f, \beta_f) \| \gamma_f \| \| \beta_f \|}. \tag{25}$$

Given that β_{fs} is the fraction of firm f owned by shareholder s, then we have that $\| \beta_f \|^2 = \sum_{s=1}^{S} \beta_{fs}^2$ is the Herfindahl-Hirschman Index for investors in firm f, denoted in Backus et al. (2021) by $IHHI_f$. Therefore, equation (25) can be rewritten as:

$$\kappa_{fg} = \frac{\cos(\gamma_f, \beta_g)}{\cos(\gamma_f, \beta_f)} \sqrt{\frac{IHHI_g}{IHHI_f}}. \tag{26}$$

Given the "proportional control assumption" ($\gamma_{fs} = \beta_{fs}$), and that $\cos(\beta_f, \beta_f) = 1$

$$\kappa_{fg} = \cos(\beta_f, \beta_g) \sqrt{\frac{IHHI_g}{IHHI_f}}. \tag{27}$$