Connected Stocks via Business Groups: Evidence from an Emerging Market

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Abstract

We link stocks through direct and indirect common owners, and show that common ownership and business group affiliation (indirect common ownership) affect the stock price co-movement. Our analysis is based on the daily ownership of block-holders on the Tehran Stock Exchange, and we show that business group affiliation has a higher effect on stock's co-movement than having a common owner. Furthermore, we show that simultaneous trades in the same direction can explain stock price co-movement in the business groups.

1 Introduction

Existing literature has well established that stocks comove with each other. Traditional studies suggest that commonality in fundamental values generates comovement in stock return which is derived from economics without frictions and rational investors. For example, Shiller (1989) provides evidence that the comovement of real dividends could be accounted for the comovement in real stock prices. Although, in recent years, it has been recognized that the comovement rises from non-fundamental sources. Barberis and Shleifer (2003) and Barberis et al. (2005) provided theoretical models for predicting a comovement between fundamentally unrelated companies. Trying to explain factors affecting comovement, Anton and

Polk (2014) examined the effect of common ownership[1] on comovement[2]. They use mutual funds' ownership and suggest that comovement increases by increasing common ownership. Also, they show that the comovement increases when there is a significant net flow, either in or out-flow in the months for mutual funds. Subsequently, according to Koch et al. (2016) companies show comovement considering their owners' correlation in their liquidity needs. The authors also add that companies with higher mutual fund ownership have a more liquidity correlation than others. This paper contends that firms without a common owner would comove with each other.

While most of the prior investigations on factors affecting common-ownership have focused on the fund, the role of the block-holders as one of the most important factors in firms' governance has remained a black box[3]. the fact that funds are intermediates and behave differently due to their needs, making it difficult to generalize these results to other types of ownership. Edmans et al. (2014) provide a theoretical model to investigate the implications of common ownership of block holders for corporate governance and asset pricing. Regardless, the block holders' daily ownership data, including mutual fund ownership, is publicly accessible in Iran. So research through this data can show whether common ownership other than mutual fund ownership can lead to comovement or not. Following Anton and Polk (2014), we are the first study that uses block-holder ownership to investigate the relationship between common ownership and comovement.

Despite the presence of the business group in both emerging economies, e.g., Brazil, Chile, China, India, Indonesia, South Korea, and developed countries, e.g., Italy, Sweden, (Khanna and Yafeh (2007)), there is no evidence on whether being at the same business group can lead to the comovement. Business groups consist of legally independent firms operating across diverse industries different from commonly held firms. Although researchers have identified comovement among stock

[1]The common ownership concept has been observed in financial literature in recent years. There has been a surge in the popularity of index investing in the United States, which has led to an increase in common ownership. For instance, Azar et al. (2018) claims that an increase in mutual ownership in airline companies leads to less competitive ticket pricing. However, this subject is controversial, and many papers discuss whether mutual ownership affects companies' behavior. For example, Lewellen and Lowry (2021) realized that in previous investigations, other effective factors have wrongly been replaced by the mutual ownership effect.

[2]The followings are some of the other sources of comovement. Index inclusion (Barberis et al. (2005)), investors' attention to the companies (Wu and Shamsuddin (2014)), Investment banks' underwriting (Grullon et al. (2014)), correlated beliefs (David and Simonovska (2016)), shareholders' coordination (Pantzalis and Wang (2017)), and preference for companies' dividends (Hameed and Xie (2019)) are among contributing factors to comovement that have been identified by researchers.

[3]A long literature surveyed by Holderness (2003), Edmans (2014), and Edmans and Holderness (2017) considers the potential role of blockholders in firm governance

returns, to the best of our knowledge, we are the first comprehensive study about the different roles of the business groups and common ownership on comovement.

We hypothesize that stocks with a high level of common ownership and the same ultimate owner exhibit strong comovement. In fact, when we talk about the presence of two stocks in the same business group, we talk about a high level of invisible common ownership between two stocks that we cannot measure by common ownership measurements.

We test this hypothesis using Anton and Polk (2014) methodology and realize that common ownership is crucial for predicting the comovement. Business groups play a more critical role in predicting the correlation of companies' returns than common ownership, with a coefficient about seven times as large as the common ownership coefficient. Furthermore, We show that common ownership can predict comovement only inside the business groups.

We extend our analysis to validate the prominence of business groups. First, we find that the average of common ownership is five times larger for the firms in the business group. So, we restrict the study to the high level of common ownership to distinguish the effect of common ownership and business groups. In this subsample, like the mentioned ones, business groups significantly impact firms' comovement. Second, if business groups affect comovement, there is no need to restrict our investigation to firms with common owners, and also this would affect all the firms in the market. To address these concerns and distinguish the impact of common ownership and business group, we extend our investigation to all the firms in the market and show that the business group can increase firms' comovement for all the firms in the market.

Finally, we investigate different sources of business groups' comovement. We show that correlated trade in business groups is the channel of comovement. We provide evidence that the volume and direction of trades in business groups are related, and firms in the business groups with higher relation in trade have a higher level of comovement.

2 Data and Methodology

2.1 Data and Sample

Our data has several unique features which distiguishes our paper from the existing literature. Stock ownership data for Iranian public firms is available with daily frequncy reprted at the end of each trading day. This data includes all blockholders, defined as having at least one percent of the outstanding shares in a firm for all investor types- institutional as well as individuals- and is automatically reported by a central authority named Tehran Securities Exchange Technology Managament

Corporation (TSETMC), which is a subsidiary of Tehran Stcok Exchange. This eliminates potential issues present in self-reported data (such as those exisiting in US institutional holding data, known as 13F filings). In order to put together our dataset, we compile daily stock ownerhip tables (available in a separate table for each firm) which are publicaly available starting from 2010.

We use data on business groups, defined as groups of listed firms with interconnected ownership structures controlled by an ultimate owner. Business groups are common organizational structure in corporate ownership in Iran as well as many other parts of the world. Two-third of Iranian public firms are part of complex interlinked ownership networks each governed by an ultimate owner, which sits at the top of a multi-layer pyramid ownership structure (Aliabadi et al. (2021)). Unlike countries like South Korea, Japan, and India that formally announce business groups, we do not have officially defined business groups in Iran. We use data provided by Aliabadi et al. (2021) which builds a comprehensive data of all Iraninan business groups. Using two different methodologies, one introduced by Almeida et al. (2011) with a 40% threshold for control rights, and the other by Aminadav et al. (2011) which is based on Shapley-Shubik index (Shapley and Shubik (1954)) generates the same business group definitions in Iranian public sector(Aliabadi et al. (2021)).[4] Our business group data covers 2015 to 2020.

We also gather stock returns, trading volume, firm-level trading data and accounting information from Codal (equvalent to SEC's EDGAR) [5] and TSETMC's website[6]. We exclude ETFs. The final sample used in our empirical analysis covers 2015-2020 (1393/01-1398/12 Persian calendar).

Panel A table 1 reports summary statistics for ownership and business groups data. An average firm in our sample has 6 blockholders holding 75 percent of shares in aggregate. More than two-third of our sample firms are part of a business group. There are around 40 business groups each consist of on average 7 firms.

2.2 Pair composition

If any two firms have at least one common blockholder, we consider them a commonly hold firm pair. By this definition, there are 17522 unique pairs in our entire sample period, which is 11% of all possible pairs ($\frac{554*553}{2} = 153181$). Firm pairs in our sample have on average 1.8 common owner.

An important feature of common ownership in Iranian public sector is that business groups seem to be the main driver of common owenrship. This is in contrast to US data in which index and other passive funds seem to be the main

[4] For further discussion see appendix A

[5] www.codal.ir

[6] www.tsetmc.com

driver of common ownership. As such, we also identify pairs based on whether the two firms belong to any and/or the same business groups.

If both firms in a pair belong to the same ultimate owner, we identify that firm pair as being in the same business group. The two firms in a pair could also belong to different business groups, or to not be part of any business groups. Figure 1 illustrates all possibilities based on whether firms pair belong to business groups. In about one third of our pairs, neither of the two firms belong to any business groups, while in about 10 percent of our pair, the two firms are part of the same business group. Panel B of table 1 reports summary statistics for firm pairs.

Table 1: Summary Statistics
This table reports summary statistics of ownership features for all TSE stocks from 2015 to 2020. Panel A lists the total number of firms and Business groups and other features as of the year end for each of the years in our sample. Panel B reports summary statistics for firm pairs. The number of unique stock pairs is $n(n-1)/2$, where n is the number of stocks. In total, we have 17522 unique firm pairs in our sample.

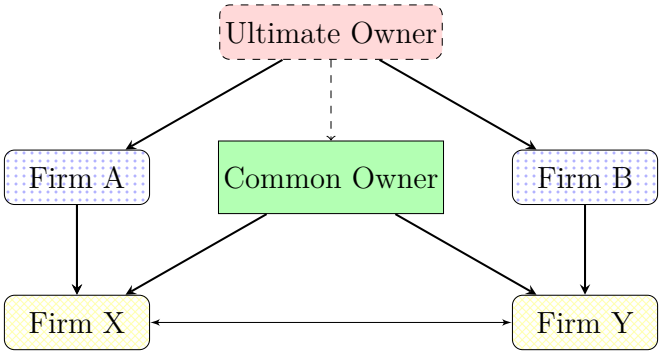
(A) Ownership Characteristics for listed firms

Year	2015	2016	2017	2018	2019	2020	Average
No. of Firms	337	356	392	479	499	560	437
No. of Blockholders	1563	1656	1893	2510	2701	2991	2219
No. of Groups	37	40	42	43	39	42	40
No. of Firms in Groups	233	254	278	311	323	357	292
Ave. Number of group Members	6	6	7	7	8	8	7
Ave. ownership of each Blockholders (%)	17	18	18	17	18	19	17
Med. ownership of each Blockholders (%)	5	4	4	4	4	5	4
Ave. Number of Owners	7	7	7	7	7	6	6
Med. Number of Owners	5	5	5	6	5	5	5
Ave. Block. Ownership (%)	77	77	76	76	75	72	75

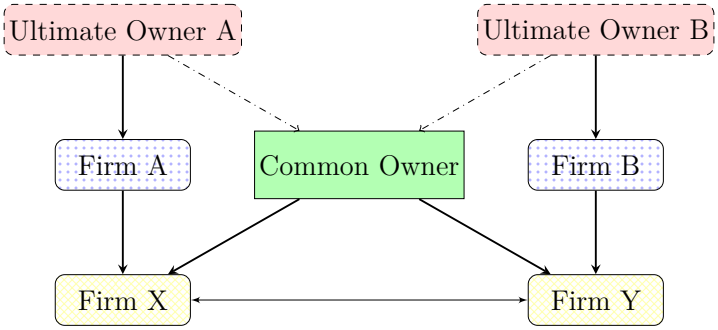
(B) Number of Pairs, in, and outside the Business Groups

Year	2015	2016	2017	2018	2019	2020	Average
No. of Pairs	9051	8980	9288	11147	11199	12171	10306
No. of Pairs not in Groups	3293	2979	3058	4427	4168	4571	3749
No. of Pairs not in the same Group	4727	4993	5129	5400	5464	5770	5247
No. of Pairs in the same Group	850	857	949	1126	1316	1556	1109
Ave. Number of Common owner	1.18	1.18	1.17	1.17	1.17	1.15	1.17

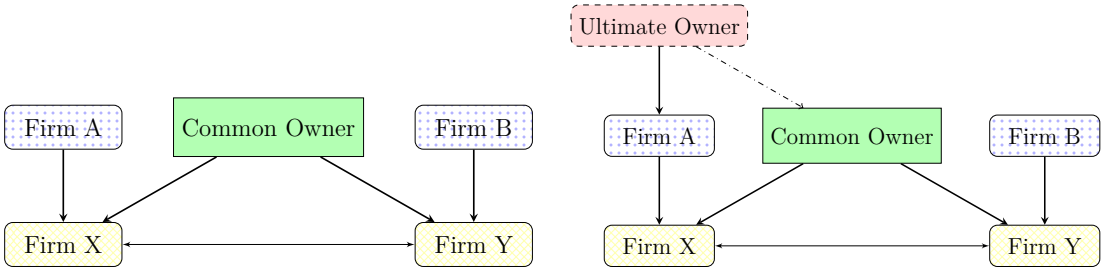
Figure 1: Firm pairs and business groups



(A) Pair in the same business group



(B) Pair in two distinct business group



(C) Pair not in the business group

2.3 Measurement of common-ownership

There are a number of different measures for common ownrship used in the literature. Table 2 summarizes all the major common ownership measures, which can be categorized into two groups; model-based (e.g, Harford et al. (2011); Azar et al. (2018); Gilje et al. (2020)) as well as ad hoc measures (e.g, Anton and Polk (2014); Azar (2011); Freeman (2019); Hansen and Lott Jr (1996); He and Huang (2017); Lewellen and Lowry (2021); Newham et al. (2018)).

Table 2: Common ownership measurements in the literature.

Group	Paper	measurment	Flaws
Model Based	Harford et al. (2011)	$\sum_{i \in I^{A,B}} \frac{\alpha_{i,B}}{\alpha_{i,A}+\alpha_{i,B}}$	Bi-directional
	Azar et al. (2018)	$\sum_j \sum_k s_j s_k \frac{\sum_i \mu_{ij}\nu_{ik}}{\sum_i \mu_{ij}\nu_{ij}}$	Industry level
	Gilje et al. (2020)	$\sum_{i=1}^{I} \alpha_{i,A} g(\beta_{i,A}) \alpha_{i,B}$	Bi-directional
Ad hoc	He and Huang (2017); He et al. (2019)	$\sum_{i \in I^{A,B}} 1$	Invariant to the level of common ownership
	Newham et al. (2018)	$\sum_{i \in I^{A,B}} min\{\alpha_{i,A}, \alpha_{i,B}\}$	Ignore level of ownership
	Anton and Polk (2014)	$\sum_{i \in I^{A,B}} \alpha_{i,A} \frac{\bar{\nu}_A}{\bar{\nu}_A+\bar{\nu}_B} + \alpha_{i,B} \frac{\bar{\nu}_B}{\bar{\nu}_A+\bar{\nu}_B}$	Invariant to the decomposition of ownership
	Freeman (2019); Hansen and Lott Jr (1996)	$\sum_{i \in I^{A,B}} \alpha_{i,A} \times \sum_{i \in I^{A,B}} \alpha_{i,B}$	Ignore importance of the firms

In our primary analysis, we want to estimate the impact of common ownership on firm pair's stock return comovement. Hence, we need a pair-level measure of common ownership. (Anton and Polk (2014)) study the impact of common ownership on US stock return comovements using a measure of common ownership which captures the total value held by the common owners of the two stocks, scaled by the total market capitalization of the two stocks. This measure is straight forward to construct, is not bi directional and provides a meaningful economic interpretation, which all are features we would like our measure of common ownership to have. One short coming of this measure, however, is it does not capture the distributional impact of owenrship by the common owners (e.g. the measure yields the same values if the common owners each hold 5 percent of the stock versus one golding 1 percent and the other 9 percent of the stock). As a result, we propose a modification to the measure used in (Anton and Polk (2014)) that captures the extent of common ownership distribution, by .

We reformulate mentioned Anton's measure in table 2. We re-weight this formula to capture the difference between ownership distribution (For further dis-

cussion appendix B). Our proposed measure is

$$\text{Overlap}_{Sqrt}(i,j) = [\frac{\sum_{f=1}^{F}(\sqrt{S_{i,t}^{f}P_{i,t}} + \sqrt{S_{j,t}^{f}P_{j,t}})}{\sqrt{S_{i,t}P_{i,t}} + \sqrt{S_{j,t}P_{j,t}}}]^2 \tag{1}$$

where $S_{i,t}^{f}$ is the number of shares held by owner f at time t trading at price Pi,t with total shares outstanding of $S_{i,t}$, and similarly for stock j. Modified measure represent the number of equal percents held block-holder. In other words, If for a pair of stocks with n mutual owners, all owners have even shares of each firm's market cap, then the proposed index will be equal to number of holders.

On each day, we measure common ownership by our proposed measure and then report an average of these daily calculations for the entire period at the end of each month. We also calculate Anton's measure in this way. Panel A table 3 report snapshots of the distribution of common ownership measure for both methods. As we expected, the modified measure creates higher values for a high level of common ownership than Anton's measure. The average common ownership measure is five and three times larger, respectively, in business groups and industries.

2.4 Stock Return comovement

We calculate the monthly correlation of each pair from stocks' daily abnormal returns. Benchmark for calculating abnormal return is the following equation which is a four-factor model plus industry return due to the importance of industries on stocks' return in the Tehran stock exchange (TSE) :

$$\begin{aligned} R_{i,t} = \alpha_i + \beta_{mkt,i}R_{M,t} + \beta_{Ind,i}R_{Ind,t} + \\ + \beta_{HML,i}HML_t + \beta_{SMB,i}SMB_t + \beta_{UMD,i}UMD_t + \varepsilon_{i,t} \end{aligned} \tag{2}$$

where $R_{i,t}$, $R_{M,t}$ and $R_{Ind,t}$ are excess daily return of respectivly firm, market and firm's industry from bank deposit's daily rate(risk free). Other variabales difinition is base on Carhart four-factor model [Carhart (1997)].

At the end of each month, we estimate our benchmark model base on the past three-month period (from two months before the end of the preceding month) and measure daily residuals. After that, we calculate the monthly correlation of daily residuals during that month for the pair.

We use other benchmarks (CAPM, 4 Factor, and Benchmark[7]) for calculating a monthly correlation and report its summary in panel B table 3. As we expected,

[7] we follow Daniel et al. (1997) to control risk characteristics: abnormal returns are calculated using a stock's daily return minus the average return of the stock's benchmark group, which is formed at every month's end based on stocks' capitalization and market-to-book ratio using the sample of all stocks

models that include industry returns remove pairs' correlation. According to the results, it seems that our selected benchmark (4 Factor + Industry) almost captures all the pairs' comovement because it is nearly a zero mean variable. We use this correlation for our analysis but our results are robust for other models.

2.5 Controls

We are interested in the effects of common ownership and business group on pair's comovement. Our prediction of a higher correlation for a connection dominates by stocks' intrinsic similarity, and these similarities motivate block-holders to hold these stocks simultaneously. These related stocks will comove regardless of who owns them.

The first group of controls is pair controls. These controls include a dummy variable for whether two stocks are in the same industry, **SameIndustry**; a dummy variable for whether two stocks are in the same business group, **SameGroup**. 10% and 14% of pairs are in the same industry and business group. Furthermore, we control for cross-ownership between two stocks and define **CrossOwnership** as the maximum percent of cross-ownership between two firms in the following month.

Another group of controls are firm-specific controls. We define these variables base on Anton and Polk (2014) methodology. One of these is size control based on the normalized rank-transform of the percentile market capitalization of the two stocks, **Size1** and **Size2** (where we label the larger stock in the pair as the first stock). The other one is a book to market ratio based on the normalized rank-transform of the percentile book to market of the two stocks, **BM1** and **BM2**. We also control these characteristics on a pair level. Our measures of similarity, **SameSize**, and **SameBM**, are the negative of the absolute difference in percentile ranking for a particular characteristic across a pair.

We calculate our controls daily and then report the average of these variables for the entire period at the end of each month. Panel C table 3 shows the summary statistics of specified controls in this section. In addition

Table 3: Summary Statistics of Pairs' Features

This table reports summary statistics for all the founded pairs from 2014 to 2019. Panel A reports snapshots from the calculation of common ownership for our measurement of common ownership (MFCAP) and Anton and Polk (2014) measure (FCAP). Panel B shows the distribution of calculated correlation of residuals for different models. Panel C depicts Control variables' distribution.

(A) Common Ownership with for two measures

Subset	MFCAP					FCAP				
	mean	std	min	median	max	mean	std	min	median	max
All	0.15	0.24	0.00	0.06	4.62	0.12	0.16	0.0	0.05	0.97
Same Group	0.47	0.41	0.00	0.41	4.04	0.38	0.25	0.0	0.37	0.97
Not Same Group	0.10	0.16	0.00	0.04	2.90	0.08	0.11	0.0	0.04	0.97
Same Industry	0.34	0.41	0.01	0.18	4.04	0.25	0.24	0.0	0.16	0.96
Not Same Industry	0.12	0.19	0.00	0.05	4.62	0.10	0.14	0.0	0.05	0.97

(B) Distribution of Correlation base on Different models

	mean	std	min	median	max
CAPM + Industry	0.016	0.127	-0.950	0.014	0.818
4 Factor	0.033	0.136	-0.875	0.024	0.869
4 Factor + Industry	0.013	0.124	-0.875	0.010	0.779
Benchmark	0.008	0.145	-0.933	0.006	0.860

(C) Distribution of specified Controls

	mean	std	min	median	max
Size1	0.72	0.22	0.01	0.77	1.00
Size2	0.45	0.24	0.00	0.43	0.99
SameSize	-0.28	0.20	-0.97	-0.23	-0.00
BM1	0.51	0.25	0.00	0.52	1.00
BM2	0.50	0.23	0.01	0.50	1.00
SameBM	-0.30	0.19	-0.96	-0.26	-0.00
CrossOwnership	0.56	5.14	0.00	0.00	95.56

Table 4: Summary Statistics of Sub-samples
This table reports the mean of control variables for the three subsamples, for the pairs in the same business group, same industry, and high level of common ownership, which is in the fourth quarter of each period.

	Mean					
	Comovement	SameGroup	SameInd.	SameBM	SameSize	CrossOwner.
SameGroup						
No (88%)	1.02%	0.00	0.09	-0.30	-0.28	0.18%
Yes (11%)	4.24%	1.00	0.45	-0.25	-0.26	4.53%
SameIndustry						
No (86%)	1.00%	0.07	0.00	-0.30	-0.29	0.33%
Yes (13%)	4.05%	0.40	1.00	-0.23	-0.21	2.96%
Pairs						
Others (74%)	1.08%	0.04	0.08	-0.29	-0.29	0.50%
ForthQuarter (25%)	2.35%	0.35	0.29	-0.28	-0.24	1.21%
Total (100%)	1.40%	0.11	0.13	-0.29	-0.28	0.68%

3 Empirical Evidences

3.1 Forecasting Comovement

In the following month, we empirically test the impact of current measured common ownership on the next period's comovement. At the first step, we study the effects of business groups and common ownership on the comovement. As it has shown in figure 2, a higher level of common ownership in the current period is associated with a higher level of correlation. In the following we examine the following period's comovement on the considered variables.

For this purpose, we estimate the cross-sectional regressions forecasting within-month realized correlation ($\rho_{i,j,t+1}$) of each pair of stocks abnormal return. By abnormal return, we mean daily four-factor plus industry residuals of estimated model (Specific details and reasons for using this model described in the section 2.4). We use $MFCA^*_{ij,t}$, $Same\ Group_{ij}$, and their interaction for our main analysis and other pair characteristics as controls:

$$\begin{aligned}\rho_{ij,t+1} = \beta_0 &+ \beta_1 * \text{MFCAP}^*_{ij,t} + \beta_2 * \text{SameGroup}_{ij} \\ &+ \beta_3 * \text{MFCAP}^*_{ij,t} \times \text{SameGroup}_{ij} \\ &+ \sum_{k=1}^{n} \alpha_k * \text{Control}_{ij,t} + \varepsilon_{ij,t+1}\end{aligned} \tag{3}$$

We estimate these regressions for each month and report the time-series average as in Fama and MacBeth (1973) to don't have any problem with cross-correlation in the residuals. We then use Newey and West (1987) to calculate standard errors of the Fama-MacBeth that take into account autocorrelation in the time series of cross-sectional estimates for four lags $(4(71/100)^{\frac{2}{9}} = 3.71 \sim 4)$.

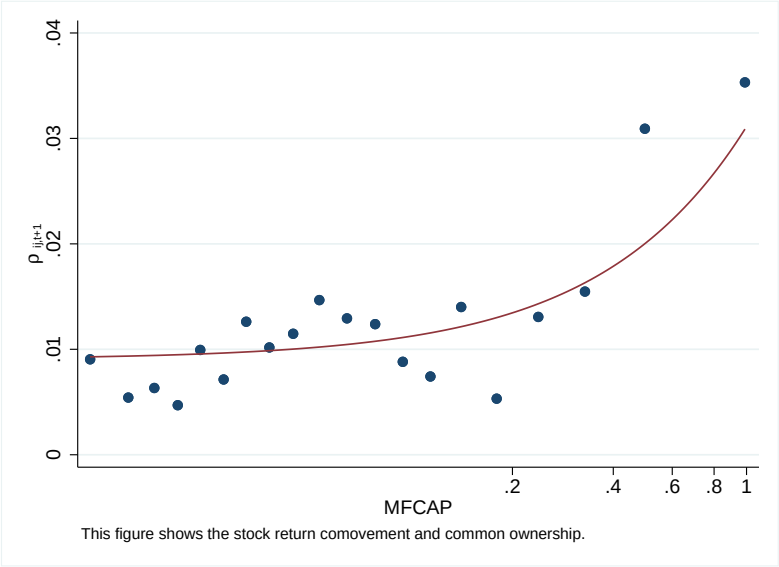


Figure 2: Comovement for different level of common ownership

The estimated results are presented in panel table 5. Panel A reports results from forcasting cross-sectional variation in comovement. In the two first columns, we estimate a simplified version of equation 3 with only common ownership measure ($MFCAP^*_{i,j}$) to investigate the relationship between common ownership and comovement. In the first column, we estimate the model without control variables. Recall that our control variables are *Same Industry*, *Same Size*, *Same Book to Market*, and *Cross-Ownership*. The *Same Size* and the *Same Book to Market* are normalized to have a standard deviation of one and are transformed so that higher values indicate greater style similarity. We find that $MFCAP^*_{i,j}$ is significant with a coefficient of 0.00325 and a t-statistics of 4.97 in the presence of control variables.

In Columns 3 and 4 of that table, we use another simplified version of equation 3, with only Same Group. The estimated coefficient in this specification, Same Group is highly statistically significant, with a coefficient of 0.0246 and a t-statistics of 8.2. According to the results, there is a significant difference in the impact of the same business groups and the common ownership.

In the fifth specification of panel A, we use both *Same Group* and $\text{MFCAP}^*_{ij,t}$ as a forecasting variable. In this specification, only *Same Group* has a significant effect on our estimation. It suggests that common ownership affects the firms through the same business group. In the last column, we control for pairs size type (Pairs is large or small if both firms are large or small . If one firm is large and the other is small, we call it a hybrid.), which seems important for investigating firms' comovement. Anton and Polk (2014) restrict their analysis to large firms,

but we do not restrict our investigation, and our result may be driven due to this difference. Estimation result shows that by controlling pairs' type *Same Group* significantly increases comovement rather than common ownership.

In panel A, we report estimation with our control variables. Recall that these control variables (Except CrossOwnership and dummy variables) are normalized to have a standard deviation of one and are transformed so that higher values indicate greater style similarity. The presence of two firms in the same industry, SameIndustry, forecasts an abnormal return correlation with a statistically significant coefficient of 0.021 (t-statistic of6.68). The similarity in book-to-market has an effect as the coefficient on SameBM is 0.022 (t-statistic of 6.34). Of course, one should consider the fact that we are already controlling for exposure to the book-to-market factor, HML, and industry return by forecasting the correlation of four-factor plus industry residuals rather than the correlation of raw returns. We find that stocks with a similar size; the coefficient on SameSize is 0.014 (t-statistic of 4).

In panel B, we examine the effect of common ownership in the business groups. In the two first columns, we restrict our investigation to two sub-samples. In the first one, we run our model for the pairs in the same business group and others who do not belong to the same one. It provides evidence that common ownership only matters for the pairs in the same business groups. Now for the main analysis, we include the interaction of *Same Group* and $\text{MFCA}^*_{ij,t}$. We include the business group fixed effects to capture the group's characteristics for the last column. In these specifications, the economic effect of *Same Group* is not significant anymore, which cannot be reliable due to the high correlation of interaction term with *Same Group*($\rho = 0.75$). These results aver that $\text{MFCA}^*_{ij,t}$ has a larger effect for the pairs in the same business group. It puts forward that the *Same Group* affects comovement through indirect common ownership, which arises due to the same ultimate owner.

Table 5: Connected Comovement

This table reports Fama and MacBeth (1973) estimates of monthly cross-sectional regressions forecasting the correlation of daily Fama et al. (1993)–Carhart (1997) plus industry residuals in month t + 1 for the sample of stocks defined in Table 1. The independent variables are updated monthly include our measure of institutional connectedness, the number of equal percents held block-holder, $MFCA^{*}_{ij,t}$, and a series of controls at time t. We measure the negative of the absolute value of the difference in size and book-to-market ratio (BE/ME) percentile ranking across the two stocks in the pair (SameSize, and SameBM, respectively). All independent variables, excluding dummy variables, are then rank-transformed and normalized to have a unit standard deviation. We calculate Newey and West (1987) standard errors (four lags) of the Fama and MacBeth (1973) estimates that take into account autocorrelation in the cross-sectional slopes. We report the associated t-statistics in parentheses. We report estimates of regressions using variables to investigate the effect of common ownership and business group in Panel A. Panel B shows the estimation result for investigating the effect of common ownership in the business groups.

(A) The main analysis

	Dependent Variable: Future Pairs's Comovement					
	(1)	(2)	(3)	(4)	(5)	(6)
MFCAP*	0.0149***	0.00413***			-0.000406	-0.000579
	(11.56)	(5.18)			(-0.54)	(-0.79)
SameGroup			0.0907***	0.0470***	0.0474***	0.0443***
			(20.63)	(13.05)	(12.51)	(11.15)
SameIndustry		0.118***		0.107***	0.107***	0.107***
		(24.64)		(21.48)	(22.17)	(22.32)
SameBM		0.0442***		0.0421***	0.0422***	0.0406***
		(10.65)		(10.28)	(10.34)	(10.04)
SameSize		0.0231***		0.0260***	0.0262***	0.0448***
		(4.42)		(4.91)	(5.00)	(6.00)
CrossOwnership		0.126***		0.0716***	0.0714***	0.0796***
		(10.91)		(5.36)	(5.34)	(5.72)
Constant	0.0342***	0.0375***	0.0241***	0.0343***	0.0343***	0.0493***
	(15.88)	(10.60)	(12.34)	(9.76)	(9.76)	(9.47)
PairType Control	No	No	No	No	No	Yes
Observations	389591	389591	389591	389591	389591	389591

(B) Common Ownership and Business Group

	Dependent Variable: Future Pairs's Comovement			
	(1)	(2)	(3)	(4)
MFCAP*	0.00613**	-0.00140	-0.00151	-0.000944
	(3.39)	(-1.71)	(-1.86)	(-1.17)
SameGroup			0.0342***	0.0264***
			(9.36)	(6.37)
MFCAP* × SameGroup			0.0106***	0.0110***
			(5.15)	(5.77)
Sub-sample	SameGroup	Others	All	All
Business Group FE	No	No	No	Yes
Observations	47076	342515	389591	389591

t statistics in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

3.2 High level of common ownership

In line with the previous estimations, figure 3 provides that a higher level of common ownership affects more on the firms' comovement. As shown in panel A table 3, pairs in the same business group have a higher level of common ownership than others. So, the previous results could be driven by a high level of common ownership. For detailed analysis, we restrict our sample to the higher level of common ownership, which we define as the pairs with $\text{MFCAP}_{ij,t}$ in the fourth quarter in each period. Figure 4 shows the relation between future comovement and current measurement of common ownership for that pairs. As you can see in right panel, in line with the last explanation, common ownership only affects the pairs in the same group, and common ownership without the same group will not affect pairs' comovement although for a high level of common ownership.

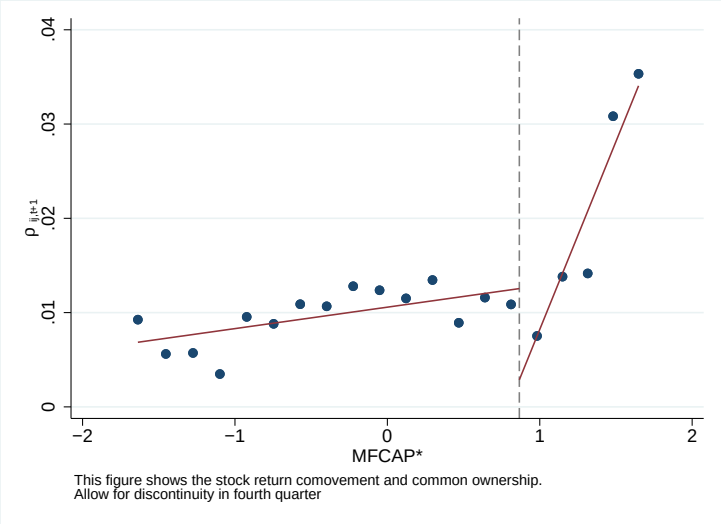
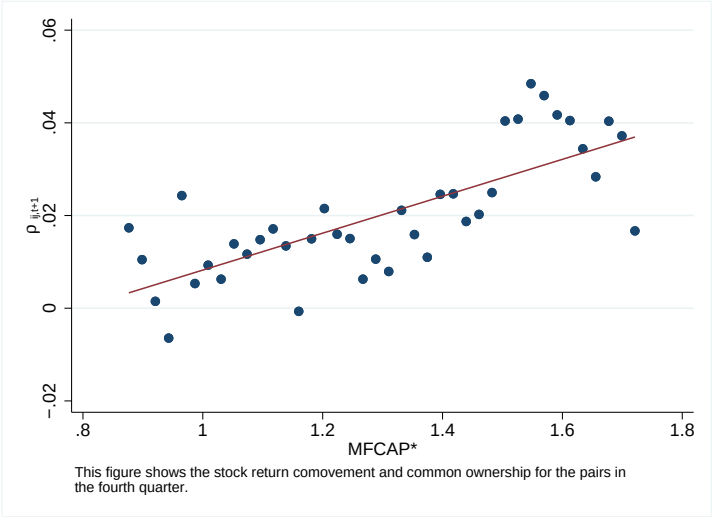


Figure 3: Comovement for different level of common ownership

We estimate the equation 3 with the same methodology in section 3.1 for the sub-sample of a high level of common ownership. Panel A of table 6 reports estimations results. As expected, firms in the same business group have a high statistical and economically significant effect on forecasting future comovements. Columns three to seven confirm our prior explanations for the importance of business groups compared to common ownership in pairs with a higher level of common ownership. Pairs in the fourth quarter may have different characteristics that affect our results. In table 4, we summarized our control variables which shows that pairs' attributes do not look significantly different than other pairs except the presence of the pairs in the same group, which we want to examine this feature.



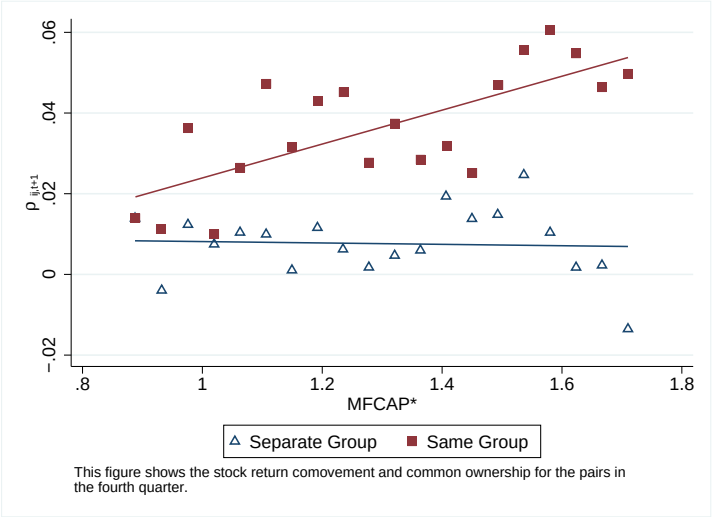


Figure 4: Comovement for different level of common ownership for pairs in the fourth quarter

3.3 All Pairs

We restrict our investigations to firms with at least one common owner in the former analyses. By this analysis, we cannot separate the effect of the business group and common ownership; both of them can affect comovement. Furthermore, this restriction limits our result to commonly held firms, but if belonging to the same business group can increase stocks' comovement, it would affect all the firms in the same business groups. So, we extend our investigations by constructing all the pairs in the market to separate the effect of direct common ownership and business group and solve the mentioned problems.

For this purpose, we include stocks in one pair if they have at least two months in common. By this definition, we do not restrict our investigation to commonly held stocks and set $\text{MFCA}_{ij,t}$ to zero for a pair without any common owner. Controls are defined as before, and we use equation 3 by the same methodology as used in section 3.1.

Panel B table 6 reports results of estimations. These results suggest that pairs in the same group comove more than stocks not in the same group. In addition, pairs with common ownership common do not comove greater than others. In column three, we use variables of common ownership and the same business group together. Results supported our previous explanation of table 5. The *Same Group* is critical for forecasting future comovement, and common ownership matters for the pairs in the same business group.

Table 6: Connected Comovement

Panel A represents the estimates of monthly cross-sectional regressions forecasting the comovement for the high level of common ownership. This means that our estimation is limited to the subsample of stocks defined in Table 1 with common ownership, which is in the fourth quarter of each period. Panel B shows the results for the estimation of that feature for all the pairs in the market, which means that the pairs with stocks that have at least two months in common and set $MFCA_{ij,t}$ to zero for a pair without any common owner. Other methods and definitions of variables are as the table 5.

(A) High level of Common Ownership

	Dependent Variable: Future Pairs's Comovement						
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
SameGroup	0.0254***		0.0249***			0.00477	0.00252
	(8.45)		(8.21)			(1.32)	(0.66)
(MFCAP > 75th Percentile)		0.00660***	0.000777	0.0230***	-0.00258*	-0.00157	-0.000513
		(5.48)	(0.73)	(7.09)	(-2.00)	(-1.29)	(-0.46)
(MFCAP > 75th Percentile) × SameGroup						0.0248***	0.0237***
						(7.24)	(7.34)
Sub-sample	All	All	All	SameGroup	Others	All	All
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Business Group FE	No	No	No	No	No	No	Yes
Observations	389591	389591	389591	47076	342515	389591	389591

t statistics in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

(B) All the Pairs

	Dependent Variable: Future Pairs' co-movement						
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
SameGroup	0.0184***		0.0185***			0.0154***	0.0138***
	(8.46)		(9.00)			(6.00)	(5.26)
MFCAP*		0.000404	-0.0000630	0.00191	-0.000289	-0.000832**	-0.000314
		(1.56)	(-0.26)	(1.97)	(-1.19)	(-3.36)	(-1.27)
MFCAP* × SameGroup						0.00281**	0.00261**
						(3.43)	(3.12)
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Sub-Sample	Total	Total	Total	SameGroups	Others	Total	Total
Business Group FE	No	No	No	No	No	No	Yes
Observations	4566594	4566594	4566594	94035	4472559	4566594	4566594

t statistics in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

4 Evidence for correlated trading

In the previous sections, we have provided evidence consistent with the hypothesis that the presence of firms in the business groups can raise firms' comovement. Although we don't have definitive insight into the specific channel that business groups can promote commonality, our analysis provides a useful overview. We claim that this relationship exists because the business group is an important proxy for the likelihood that trading in these stocks will be correlated. To better understand how the business group can generate comovement in firms' returns, we now refine our basic analysis to consider other proxy measures for business group trading. We employ two proxies for business group trading that are designed to capture different trading motivations: turnover and institutional imbalance. While the first could be due to buying or selling of business groups, the latter reflects buying.

4.1 Turnover

First, we should show that stocks in groups have a similar daily trading behavior. Accordingly, We use the turnover measure as a daily trading measures. For each firm, we run time-series regressions of the firm's daily change in turnover, $\Delta\text{TurnOver}_{i,t}$, on changes in market turnover, $\Delta\text{TurnOver}_{Market,t}$, changes in the industry and business group portfolio's turnover, $\Delta\text{TurnOver}_{Ind,t}$ and $\Delta\text{TurnOver}_{Group,t}$ and ,as well as control variables. We compute the daily change of turnover by this definition $\Delta\text{TurnOver}_{i,t} = \ln(\frac{\text{TurnOver}_{i,t}}{\text{TurnOver}_{i,t-1}})$. We estimate the following regression for each stock across trading days in a given year separately, and cross-sectional averages of the estimated coefficients are reported, with t-statistics in parentheses :

$$\begin{aligned}\Delta\text{TurnOver}_{i,t} = \alpha + \beta_{Market,t}\Delta\text{TurnOver}_{Market,t} + \beta_{Ind,t}\Delta\text{TurnOver}_{Ind,t} \\ + \beta_{Group,t}\Delta\text{TurnOver}_{Group,t} + \delta\text{Controls} + \varepsilon_{i,t}\end{aligned}$$

We control for lead and lag changes in the two portfolios and the firm's measures and size. We estimate that model with Fama and MacBeth (1973) method and adjust its standard errors with Newey and West (1987) for seven periods. As shown in Table 7, firms' change in turnover comes from market reaction and group's change (This result is robust to the different methods of weighting for portfolios). This observation shows that firms in one group trade together each day.

Furthermore, we use our previous methodology to investigate these results. We calculate correlation of $\Delta\text{TurnOver}$ for founded pairs and examine its relation with our variables. Panel A table 8 reports the estimation result, which confirms that

pairs in the business groups lead to correlated trade. In addition, we study the effect of correlation of liquidity change on comovement for founded pairs in panel B table 8. These results suggest that business groups yield to future comovement through correlated trading in that month.

Table 7: ΔTurnOver of firm and Business group
This table reports Fama and MacBeth (1973) estimates of daily change in turnover ($\Delta\text{TurnOver}_{i,t} = \ln(\frac{\text{TurnOver}_{i,t}}{\text{TurnOver}_{i,t-1}})$) for all the firms in the market. The independent variables are change in turnover for Market, Insudtry, and Business group for that day. We exclude firm's change from associated groups to prevent spurious correlations. We calculate Newey and West (1987) standard errors (seveb lags) of the Fama and MacBeth (1973) estimates that take into account autocorrelation in the cross-sectional slopes. We report the associated t-statistics in parentheses.

	Dependent Variable: $\Delta\text{TurnOver}_i$			
	(1)	(2)	(3)	(4)
$\Delta\text{TurnOver}_{\text{Market}}$	0.416***	0.326***	0.252***	0.228***
	(12.25)	(5.35)	(6.41)	(4.24)
$\Delta\text{TurnOver}_{\text{Industry-i}}$	0.142***	0.213***	0.0335	0.167**
	(3.79)	(6.29)	(1.34)	(2.87)
$\Delta\text{TurnOver}_{\text{Group,-i}}$			0.330***	0.218***
			(12.74)	(3.80)
Control	No	Yes	No	Yes
Observations	854662	851772	333789	331263
R^2	0.285	0.543	0.433	0.712

t statistics in parentheses
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 8: Simultaneous trade and Comovement

This table reports Fama and MacBeth (1973) estimates of the pairwise correlation in liquidity for the sample of stocks defined in Table 1. Other methods and definitions of variables are as same as in the table 5. We report the associated t-statistics in parentheses. Controls not shown here are reported in the Internet Appendix. We report estimates of regressions using variables to investigate the effect of common ownership and business group in Panel A. Panel B shows the estimation result for investigating the effect of commonality in liquidity and comovement.

(A) Correlation of ΔTurnOver and interested variables

	Dependent Variable: Monthly Correlation of Delta turnover						
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
SameGroup	0.0177***		0.0176***			0.0144***	0.0167***
	(5.56)		(5.24)			(4.39)	(5.26)
MFCAP*		0.00168	0.0000714	0.00110	-0.000141	-0.000201	-0.00108
		(1.99)	(0.09)	(0.57)	(-0.15)	(-0.21)	(-0.92)
MFCAP* × SameGroup						0.00347	0.00395
						(1.42)	(1.63)
Sub-sample	All	All	All	SameGroup	Others	All	All
Business Group FE	No	No	No	No	No	No	Yes
Observations	327447	327447	327447	40605	286842	327447	327447

(B) Correlation of ΔTurnOver and Comovement

	Dependent Variable: Future Pairs's Comovement				
	(1)	(2)	(3)	(4)	(5)
$\rho(\Delta\text{TurnOver})\_t+1$	0.0856***	0.0742***	0.152***	0.0611***	0.0743***
	(14.09)	(13.91)	(15.57)	(11.82)	(13.94)
ρ_t	0.0456***	0.0373***	0.0944***	0.0262***	0.0356***
	(11.44)	(10.58)	(13.66)	(6.57)	(10.71)
Control	No	Yes	Yes	Yes	Yes
Sub-sample	Total	Total	SameGroup	Others	Total
Business Group FE	No	No	No	No	Yes
Observations	338895	338895	41955	296940	338895

t statistics in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Besides, we have to directly show that firms within correlated turnover groups have a higher level of comovement. So, we extract the annual average level of firms and monthly turnover for each month. We assume that the residual of the model belongs to the business groups. We expect firms in the groups to have a lower dispersion in their residuals than other firms, and firms in the low dispersion groups comove more than others. We calculate firms' residuals by the mentioned hypothesis. Its summary stats is in panel A table 9. After that, we calculate the standard error of calculated residuals in each business group. Groups' standard errors description is shown in panel B table 9 and time series in in figure 5. On average, the affiliated firms' standard error is lower than unaffiliated ones. As we expected, residuals in business groups have a lower dispersion than others. For finding the relation between these groups and comovement, we define a dummy variable for groups in the low level of standard error, which is lower than the median of each period. We use this dummy variable to study our connection. Panel A table 11 reports our estimation result and shows that pairs in the business groups of low dispersion have a higher level of comovement than other firms. For analysis, we restrict our investigations to a subsample of *Same Group* and others and estimate our desired variable. Also, we use the interaction of *Same Group* with our dummy variable for the full sample, which confirmed our prior results.

Table 9: Summary statistics

(A) Frims' Monthly residuals

	Firm× Month	mean	std	min	25%	50%	75%	max
Ungrouped	8206	-0.004	0.783	-4.702	-0.471	-0.013	0.466	5.061
Grouped	18022	0.002	0.712	-5.997	-0.416	-0.009	0.424	3.392

(B) Groups' Monthly residuals' standard erros

	Group × Month	mean	std	min	25%	50%	75%	max
Ungrouped	72	0.776	0.113	0.504	0.685	0.781	0.867	1.030
Grouped	2441	0.601	0.313	0.001	0.403	0.567	0.763	3.274

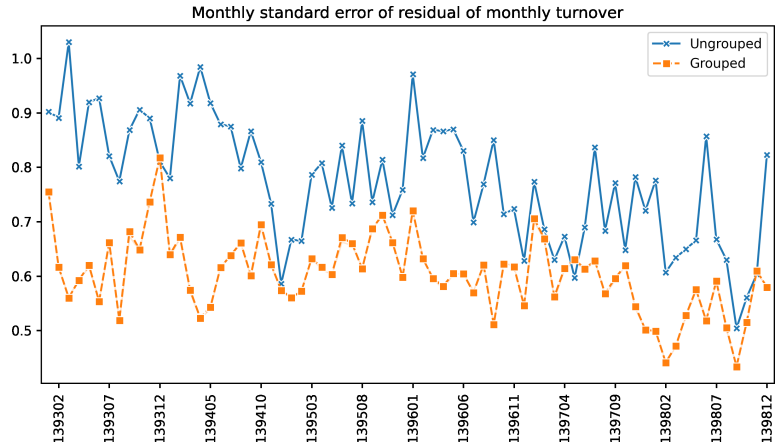


Figure 5: Time series of standard errors in residuals of Turnover for groups

4.2 Institutional Imbalance

Although we provide evidence for simultaneous trade in the last section, we should show that stocks in groups that trade together are traded in the same direction. So, for each firm, we calculate daily institutional imbalances, which is the net buying value of institutional investors relative to total traded value on that day ($\text{InsImb} = \frac{\text{Buy}_{\text{value}} - \text{Sell}_{\text{value}}}{\text{Buy}_{\text{value}} + \text{Sell}_{\text{value}}}$ [Seasholes and Wu (2007)]). We expect that institutional imbalances have a lower variation in groups due to the correlated tradings that the ultimate owner ordered to do. So, we calculate monthly institutional imbalances for firms at the first step. As we expected, firms in the business groups have a lower level of standard error in imbalances (Panel B table10). Then, we calculate the monthly standard deviation of the group's imbalances and compare them to unaffiliated ones. The standard error is 12.2% and significantly (with a p-value of 0) lower than ungrouped firms.

According to the main hypothesis, we need to compare pairs in groups with low standard error and other pairs. For this purpose, we define a dummy for groups whose average standard errors are lower than half of the sample;**LowImbalancestd**. So, this dummy is equal to one if at least one pair's firms belong to the low imbalance std business group. We expect pairs in the same business groups with a low standard imbalance error to move more than others. Panel B table 11 reports estimation results and confirms that pairs in that group comove greater than others.

Table 10: Summary statistics

(A) Panel A: Frims' Monthly Imbalances

	Group × Month	mean	std	min	25%	50%	75%	max
Ungrouped	20896	0.004	0.626	-1.0	-0.478	0.013	0.462	1.0
Grouped	12177	-0.043	0.574	-1.0	-0.453	-0.011	0.330	1.0

(B) Panel B: Groups' Monthly Imbalances' standard erros

	Group × Month	mean	std	min	25%	50%	75%	max
Ungrouped	72	0.619	0.054	0.481	0.594	0.627	0.655	0.734
Grouped	2062	0.497	0.247	0.000	0.334	0.495	0.636	1.414

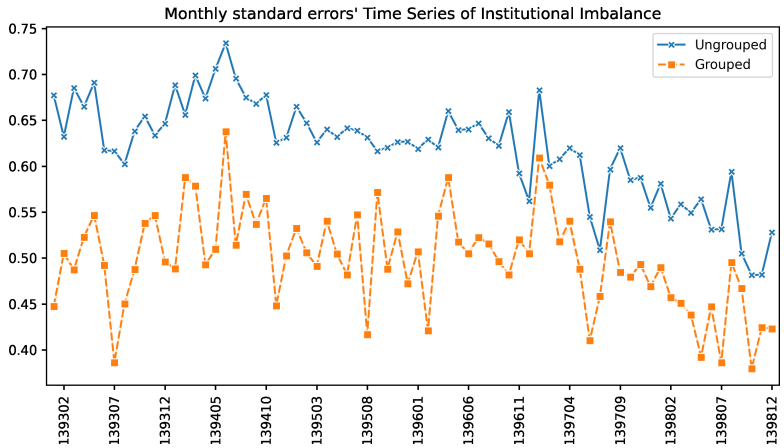


Figure 6: Time series of standard errors in Imbalance for groups

Table 11: Turnover and Imbalance and Comovement

This table reports Fama and MacBeth (1973) estimates of monthly cross-sectional regressions forecasting the comovement for the sample of stocks defined in Table 1. Other methods and definitions of variables are as in the table 5. We also define two dummy variables for the firm's presence in the particular group. LowTurnoverStd is a dummy variable for groups in which the standard error of ΔTurnOver ($\Delta\text{TurnOver}_{i,t} = \ln(\frac{\text{TurnOver}_{i,t}}{\text{TurnOver}_{i,t-1}})$) is lower than the median of each period and LowImbalanceStd for a group with low dispersion in institutional imbalances ($\text{InsImb} = \frac{\text{Buy}_{\text{value}} - \text{Sell}_{\text{value}}}{\text{Buy}_{\text{value}} + \text{Sell}_{\text{value}}}$). Controls not shown here are reported in the Internet Appendix. We report estimates of regressions using variables to investigate the effect of Turnover and Imbalance in Panel A and Panel B.

(A) Low Turnover residual std groups and Comovement

	Dependent Variable: Future Pairs's Comovement					
	(1)	(2)	(3)	(4)	(5)	(6)
SameGroup	0.0438***	0.0348***			0.0124*	0.0168**
	(11.50)	(10.63)			(2.35)	(3.17)
LowTurnoverStd		0.00315	0.0501***	-0.00111	-0.00281	0.0125***
		(1.94)	(5.84)	(-0.70)	(-1.63)	(5.24)
LowTurnoverStd × SameGroup					0.0559***	0.0503***
					(5.59)	(5.10)
Sub-sample	Total	Total	SameGroup	Others	Total	Total
Business Group FE	No	No	No	No	No	Yes
Observations	389591	389591	47076	342515	389591	389591

(B) Low Imbalance std groups and Comovement

	Dependent Variable: Future Pairs's Comovement					
	(1)	(2)	(3)	(4)	(5)	(6)
SameGroup	0.0438***	0.0444***			0.00457	0.00262
	(11.50)	(11.57)			(1.25)	(0.59)
LowImbalanceStd		0.00422*	0.0844***	-0.00824***	-0.00740***	0.0122***
		(2.50)	(9.71)	(-4.13)	(-3.65)	(4.34)
LowImbalanceStd × SameGroup					0.0967***	0.0893***
					(10.29)	(9.42)
Sub-sample	Total	Total	SameGroup	Others	Total	Total
Business Group FE	No	No	No	No	No	Yes
Observations	389591	389591	47076	342515	389591	389591

t statistics in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

5 Conclusion

Although the importance of blockholders in firm governance, the impact of common ownership of blockholders on the stock price comovement is relatively unexplored. This study investigates the effect of blockholder common ownership on commonality in stock prices. We find positive and significant comovement in stock return of with common ownership.

We also examine the comovement of firms in the business groups which are linked through an ultimate owner. Our results indicate that firms in the business groups comove more than commonly held firms. Furthermore, we provide evidence that common ownership matters for the firms in the business groups.

Finally, given that group-affiliated firms comove with each other, we explore more about the source of this commonality by examining the correlated trades in group-affiliated firms. We find that the volume and direction of trades in group-affiliated firms are related, and firms in groups with higher relations in trade have a higher level of comovement.

When we talk about the presence of two stocks in the same business group, we talk about a high level of invisible common ownership between two stocks that we cannot measure that by mutual stockholders.

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Appendix A Overview of Business Groups in Tehran Stock Exchange

There is no difference between emerging markets (such as Chile, India, Indonesia, South Korea, Pakistan, and many more) and developed ones (like Italy and Sweden); business groups present everywhere. However, group-affiliated firms are relatively large and economically important in emerging markets. These groups principally consist of legally independent firms grouped by persistent formal (e.g., equity) and informal (e.g., family) links.(Khanna and Yafeh (2007)) There is a complex ownership network in TSE as an emerging market. This complicated ownership creates a vast number of business groups in which an ultimate owner controls them through a multi-layer of ownership. (Farajpour et al. (2019))

The reason for many of these business groups back to the 1979 Iran revolution. After the revolution, due to social sentiment, critical sectors of the economy nationalized, and their ownership transferred to the government or other pseudo-government foundations. Also, some other groups of firms in heavy industries were established and controlled by the Industrial Development and Renovation Organization (IDRO) during the 1960s and 1970s. (IDRO was a state-owned holding company for investing in capital-intensive industries)

The business groups are formed from mentioned ancestors due to two related forces; A multi-phased privatization by the state and the development of the domestic stock market. In the first wave of privatization, more than 300 companies were fully or partially privatized. In the second one, approximately $150 billion ownership of State-Owned Enterprises (SOEs) and assets were transferred. Pension funds, military institutions, cultural and religious foundations, and revolutionary foundations (pseudo-government groups) primary customers in the second wave of privatization. These waves of privatization transferred control of hundreds of SOEs to semi-governmental groups and were the main driver of the formation of business groups in Iran. In addition, the developing stock market from the early 2000s intensifies this effect. The government tried to develop the stock market as a tool for better privatization. (Aliabadi et al. (2021))

In conclusion, the multiple waves of privatization with the development of the stock market changed ownership structure in pre-revolutionary holding companies

and post-revolutionary foundations and create large business groups that govern primary industries.

Appendix B Modified Anton's measure

We reformulate mentioned Anton's measure in table 2. This factor measure common ownership as the total value of stock held by the F common-holders of the two stocks, scaled by the total market capitalization of the two stocks

$$\text{Overlap}_{Sum}(i,j) = \frac{\sum_{f=1}^{F}(S_{i,t}^{f}P_{i,t} + S_{j,t}^{f}P_{j,t})}{S_{i,t}Pi,t + S_{j,t}Pj,t} \tag{4}$$

where $S_{i,t}^{f}$ is the number of shares held by owner f at time t trading at price Pi,t with total shares outstanding of $S_{i,t}$, and similarly for stock j. As shown in equation 4, this measure neglects different distributions of common owners and represents the percent of joint-held market capitalization from the total market capitalization of the two stocks.

We re-weight this formula to capture the difference between ownership distributions. Our proposed measures are shown in equations 5 and 6, where all variables are as the same as Anton's measure. Both modified measures represent the number of block-holders with equal-percent ownership. In other words, if for a pair of stocks with n mutual owners, all owners have even shares of each firm's market cap, the proposed indices equals to the number of holders.[8] There are some numeric examples for a better comparison.

$$\text{Overlap}_{Sqrt}(i,j) = [\frac{\sum_{f=1}^{F}(\sqrt{S_{i,t}^{f}P_{i,t}} + \sqrt{S_{j,t}^{f}P_{j,t}})}{\sqrt{S_{i,t}Pi,t} + \sqrt{S_{j,t}Pj,t}}]^2 \tag{5}$$

$$\text{Overlap}_{Quadratic}(i,j) = [\frac{\sum_{f=1}^{F}[(S_{i,t}^{f}P_{i,t})^2 + (S_{j,t}^{f}P_{j,t})^2]}{(S_{i,t}Pi,t)^2 + (S_{j,t}Pj,t)^2}]^{-1} \tag{6}$$

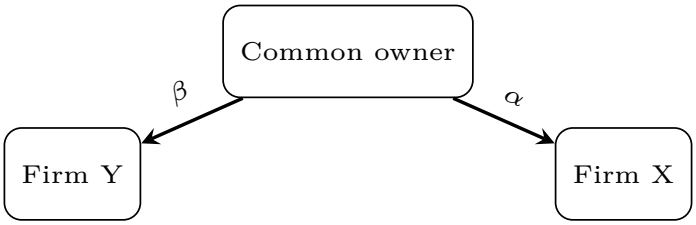
For the first example, two firms (X and Y) have one common owner who has α and β from each market capitalization, respectively (illustrated in figure 7). For better illustration, assume that the sum of holders' ownership equals to 100 percent ($\alpha + \beta = 100$), and two firms' market caps have equal amounts. We

[8] Each holder owns $1/n$ of each firm ,firm's market cap is α_1 and α_2, so for each holder of firms we have $S_{i,t}^{f}P_{i,t} = \alpha_i/n$

$[\frac{\sum_{f=1}^{n}\sqrt{\alpha_1/n}+\sum_{f=1}^{n}\sqrt{\alpha_2/n}}{\sqrt{\alpha_1}+\sqrt{\alpha_2}}]^2 = [\frac{\sqrt{n}(\sqrt{\alpha_1}+\sqrt{\alpha_2})}{\sqrt{\alpha_1}+\sqrt{\alpha_2}}]^2 = n$

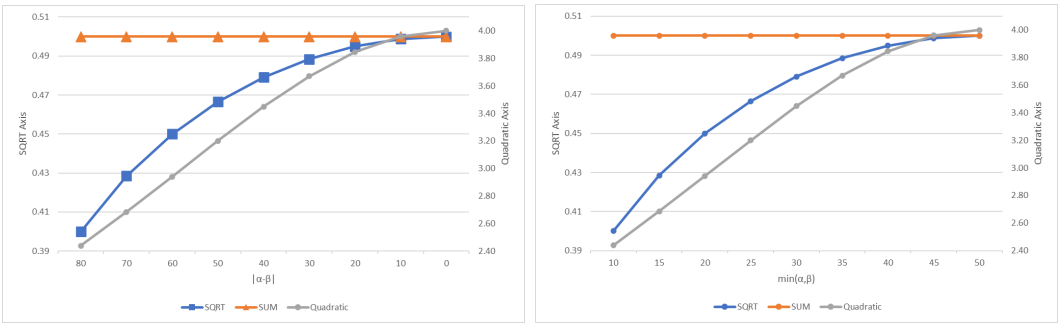
$[\frac{\sum_{f=1}^{n}(\alpha_1/n)^2+\sum_{f=1}^{n}(\alpha_2/n)^2}{\alpha_1^2+{\alpha_2}^2}]^{-1} = [\frac{\alpha_1^2+\alpha_2^2}{n(\alpha_1^2+\alpha_2^2)}]^{-1} = n$

Figure 7: Numeric example 1



calculate common ownership measures based on equations 4 (Sum), 5 (SQRT), and 6 (Quadratic) for different ownership distributions. Figure 8 reports calculations results. As we expected, Anton's measure is constant at a fixed level of aggregated common ownership, but SQRT and Quadratic vary from concentrated to dispersed ownership. Concentrated ownership (50-50) has a greater common ownership measure than dispersed (10-90).

Figure 8: Comparison of three measures for common ownership



For the second example, assume that there are three common owners for the two mentioned firms. First holder's ownership from firm X and Y are respectively α_1 and β_1. It is similar for other holders (illustrated in figure 9). As before, the firm's market cap is equal. We calculate measures for concentrated or disparate ownerships, and ownerships that are less than the sum of the market caps. Table 12 reports calculation results. For ownerships that consist of total market cap, results are consistent with the first example. Although, when total ownership decreases, the Quadratic measure denotes unrealistic numbers. We conclude that our Quadratic measure is not suitable for lower levels of common ownership.

A fundamental assumption in previous examples, is the equality of firms' market cap. In the last example, we relax this assumption. Table 13 reports calculated measures for fixed total ownership on different relative market cap ratios. We extend our analysis to higher market cap ratios and report our results in figures 10 and 11. In this setting, the SQRT measure has a better variation compared to

Figure 9: Numeric example 2

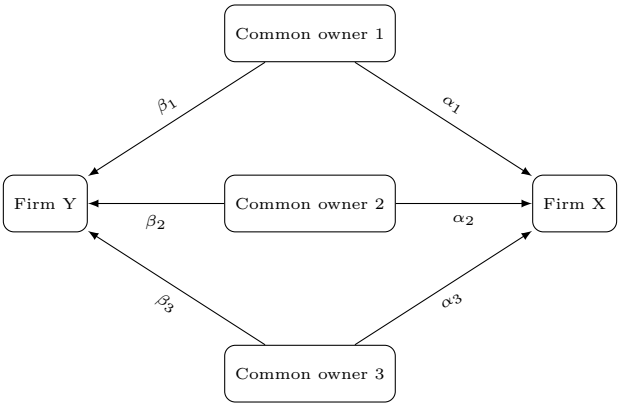
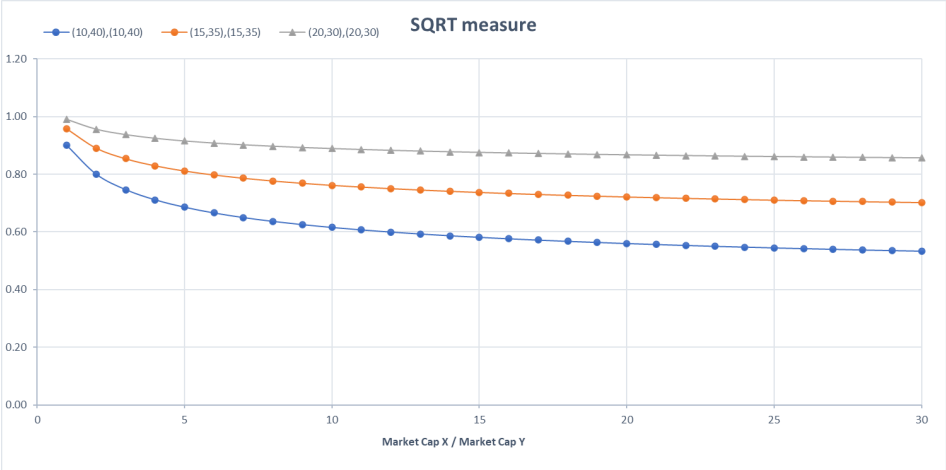


Table 12: text

Ownership	Type I	Type II	Type III	Type IV	Type V	Type VI	Type VII
α_1	1/3	20	10	20	10	5	1
β_1	1/3	10	10	20	10	5	1
α_2	1/3	10	80	20	10	5	1
β_2	1/3	20	80	20	10	5	1
α_3	1/3	70	10	20	10	5	1
β_3	1/3	70	10	20	10	5	1
SQRT	3	2.56	2.33	1.8	0.9	0.45	0.09
SUM	1	1	1	0.6	0.3	0.15	0.03
Quadratic	3	1.85	1.52	8.33	33.33	133.33	3333.33

Anton's measure.

Figure 10: SQRT measure for fixed aggregate ownership on different relative market cap ratios



In conclusion, We use the SQRT measure for our main study. This measure has an acceptable variation within different distributions and relative market caps. Also, it has a fair value at a lower level of total common ownership. As it is presented in the table 14, the obtained results are robust to different measurements of common ownership.

Figure 11: Sum measure for fixed aggregate ownership on different relative market cap ratios

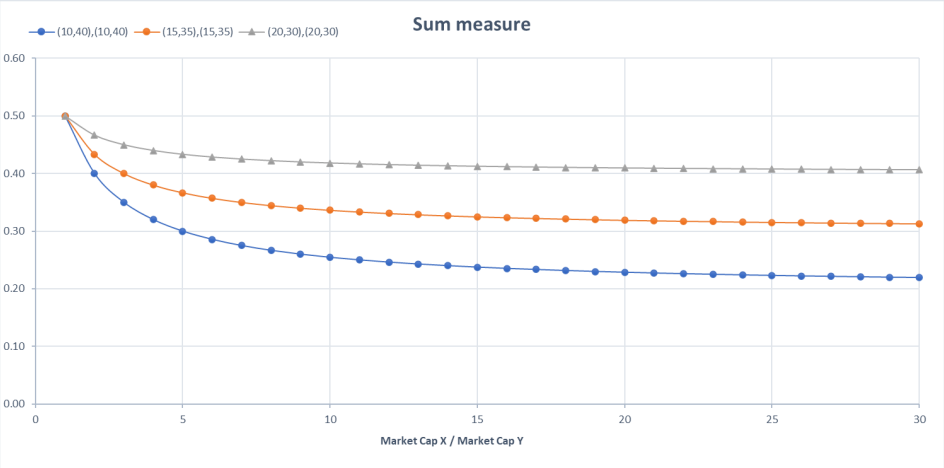


Table 13: text

	$(\alpha_1,\beta_1),(\alpha_2,\beta_2)$					
	(10,40),(10,40)		(15,35),(15,35)		(20,30),(20,30)	
$\frac{\text{MarketCap}_x}{\text{MarketCap}_y}$	SQRT	SUM	SQRT	SUM	SQRT	SUM
1	0.90	0.50	0.96	0.50	0.99	0.50
2	0.80	0.40	0.89	0.43	0.96	0.47
3	0.75	0.35	0.85	0.40	0.94	0.45
4	0.71	0.32	0.83	0.38	0.92	0.44
5	0.69	0.30	0.81	0.37	0.91	0.43
6	0.67	0.29	0.80	0.36	0.91	0.43
7	0.65	0.28	0.79	0.35	0.90	0.43
8	0.64	0.27	0.78	0.34	0.90	0.42
9	0.63	0.26	0.77	0.34	0.89	0.42
10	0.62	0.25	0.76	0.34	0.89	0.42

Table 14: Connected Co-movement

	Dependent Variable: Future Monthly Correlation of 4F+Industry Residuals							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Common Ownership Measure	0.00370***	0.00325***	0.00155*	0.00109	0.000333	-0.000105	0.000550	0.000283
	(5.58)	(4.97)	(2.61)	(1.84)	(0.54)	(-0.17)	(1.07)	(0.58)
SameGroup			0.0229***	0.0234***	0.0100**	0.0103**	0.00626	0.00668
			(7.89)	(7.93)	(3.26)	(3.17)	(1.79)	(1.79)
Common Ownership Measure × SameGroup					0.0134***	0.0135***	0.0127***	0.0126***
					(9.47)	(10.65)	(9.23)	(9.71)
Observations	398818	398818	398818	398818	398818	398818	398818	398818
Group FE	No	No	No	No	No	No	Yes	Yes
Measurement	Sum	Sum	Sum	Sum	Sum	SQRT	Sum	SQRT
R^2	0.00433	0.00427	0.00518	0.00515	0.00554	0.00551	0.0182	0.0182

t statistics in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$