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Synchronicity and firm interlocks in an emerging market ☆

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ABSTRACT

Stock price synchronicity has been attributed to poor corporate governance and a lack of firm-level transparency. This paper investigates the association between different kinds of firm interlocks, control groups, and synchronicity in Chile. A unique data set containing equity cross-holdings, common individual owners, and director interlocks is used to map out firm ties and control groups. While there is a correlation between synchronicity and share ownership and equity ties, synchronicity is more strongly correlated with interlocking directorates. The presence of share directors is associated with either reduced firm-level transparency or increased correlation in firm fundamentals—due, for example, to joint resource allocation across the firms.

1. Introduction

Synchronicity in returns data, controlling for correlation in firm fundamentals, is attributed to blurred boundaries between firms, reducing the firm-specific information incorporated in stock prices (Barberis, Shleifer, and Wurgler, 2005). Morck, Yeung, and Yu (2000) demonstrate how firms' returns are more synchronous in emerging economies than in developed economies. They suggest that the nature of relatively opaque activities within control pyramids contributes to synchronicity. Jin and Myers (2006) develop a model where synchronicity is a result of poor investor protection and a lack of transparency.

Common firm ownership, family control, business groups, and other means of exercising joint control over firm activities have recently attracted considerable attention in the finance and economics literature. La Porta, Lopez-de-Silanes, and Shleifer (1999) document the worldwide prevalence of jointly owned and controlled firms, and several theoretical and empirical papers examine the phenomenon of tunneling within groups, as described in Johnson, La Porta, Lopez-de-Silanes, and Shleifer (2000). Khanna and Yafeh (2007) discuss the importance of diversified business groups in emerging markets and suggest that, in some countries at least, groups are a response to information asymmetry and institutional voids. Morck and Nakamura (2007) describe how in the presence of network externalities and potential hold-up problems, coordination of activities across firms serves to avoid the market failures that prevent industrial growth. In this way, joint control can facilitate a "big push" of the kind described by Murphy, Shleifer, and Vishny (1989) within a privately owned economy.

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Joint control across firms is the key mechanism through which coordination is achieved in these models. Much of the literature has focused on equity interlocks and ownership pyramids as the channel through which joint control is exercised, separating control from ownership in the case of large equity pyramids. The literature also demonstrates that firms are often tied in other ways, such as family ties and director interlocks which, while potentially less formal, are a frequently observed characteristic of groups in emerging markets. It seems reasonable to assert that when a particular individual, or the same family, is involved in the management of two or more firms, the coordination across those firms is more straightforward and potential hold-up mitigated. This assertion relates to the literature on power relationships and capital allocation. Rajan and Zingales (1998) suggest that relationships can substitute for formal contracts when capital is scarce relative to investment opportunities, and note that relationship-based systems suppress the price mechanism.

The goal of this paper is to investigate the relation between stock price synchronicity and joint control of firm activities. Following the literature on groups in emerging markets, we acknowledge that control can be exercised through various channels. We use a detailed data set on Chilean firms in 1996. To our knowledge, the data set is unique in a developing country setting as it contains information on the extent of equity ties, the names of common individual owners, and the names of common individual directors for pairs of a large number of listed and unlisted firms. The Santiago stock exchange had 270 listings during 1996, 52 of which were secondary listings. Our data on individual directors and owners include the 457 firms that were monitored by the financial regulatory authority, of which listed firms are a subset. We hence have a more comprehensive view of direct and indirect measures of joint control throughout the economy since the data allow us to map out ties between a large number of firms.

We construct several measures of the extent of firm-pair returns synchronicity and then test which types of ties are associated with increased synchronicity.[1] The firm-pair data also allow us to distinguish between groups of firms tied to each other through common ownership and groups tied through shared directors. Since our goal is to investigate the different channels through which joint control can be exercised, we map the Chilean firms in our data set into three types of networks within which all firms are either jointly owned or managed. Network membership is defined in turn by equity ties, individual ownership ties, and then by director interlocks. For the equity ties definition, we do not take a stand on the extent of equity holding required for a firm to exert control. Since the mapping process reveals several structures where hierarchy levels are ambiguous, we use the more general phrase "equity network" rather than "equity pyramid" to refer to these mappings. Membership of equity pyramids, as typically defined, is identified in our process but not the relative position of each firm in the pyramid.

Using the network affiliations, we form firm-pair-level indicator variables telling us whether both firms in a pair are members of the same network. The differently defined networks reveal disparate groupings of firms within the economy. That is, pairs of firms in the same equity network can be in different director networks or owner networks, or in no individual level network, and vice versa. The data on the extent of the ties of each kind between a pair of firms, together with the variables indicating whether both firms are members of a common network, are the key independent variables under analysis.

Since an observation in our data set comprises a pair of firms, the errors are potentially correlated across pairs due to unobservable firm effects. We address this problem by adopting the non-parametric bootstrapping estimation method described in Section 4 to determine the significance of estimated coefficients. We also make an adjustment for long-run trends by detrending the firm-level returns data. If two firms tied to each other through equity ties, ownership, or directorship interlocks are more likely to share an overall trend for some unobserved reason, using data that include these trends would lead us to overestimate the degree of synchronicity attributable to the effects of the ties. There are reasons why the presence of an interlock could cause firms' fundamentals to be correlated, such as the increased likelihood of a supplier–customer relationship. There are also other reasons why any two firms' returns could be correlated regardless of whether a tie exists, but independently also make a tie more likely. For example, two firms may use the same inputs, or operate in the same geographic market. To attempt to take account of the fact that jointly controlled firms are more likely to share fundamentals even if the tie were not to exist, we control for common industry effects. We also attempt to control for synchronicity due to anticipated dividend flows from equity holdings; this adjustment is described in the Appendix.

We recognize that further unobserved factors could be associated with both interfirm ties and synchronicity. There is relatively little change in the nature of shared ownership and director interlocks over time, providing little variation to use as part of our identification strategy. We do, however, know the business group affiliation of each firm in the data set for 1996. Business groups are widely recognized and well monitored entities within the Chilean economy (Khanna and Yafeh, 2007) and group membership has been shown to impact firm performance (Khanna and Palepu, 2000). We assert that common group membership could well be correlated with unobservable factors related to synchronicity and to equity, owner, and director interlocks. By controlling for group membership, and then also looking within groups, we relate the synchronicity above that which is attributable to shared

[1] Bertrand, Mehta, and Mullainathan (2002) investigate earnings tunneling in India by testing whether positive earnings spill over from firms at the bottom of a pyramid towards those at the top, while negative earnings do not. Our dependent variables are based on firm-level returns, which are predicted to take account of the expected value of all future spillover effects. In the presence of joint control, we expect both negative and positive returns shocks to affect tied firms by changing market expectations of their future value.

group membership and associated unobservables to the ties that are the focus of this paper. Membership of the same business group is positively correlated with pairwise synchronicity, suggesting that market participants view these entities as relevant. Our key results about the significant role played by director interlocks are robust to controlling for common business group affiliation.

Our results show that the presence of equity interlocks, shared individual owners, and director interlocks are all significantly correlated with increased returns synchronicity. This is consistent with the idea that the market views each tie as a mechanism through which joint control is being exercised. However, when all three pairwise measures are included, only the extent of director interlocks retains significance. Controlling for equity interlocks, common individual owners, and shared industry effects, we find that if both firms share half of their directors, the returns of the two firms are predicted to move in the same direction 10% more often than if the two firms had no directors in common. In addition, the returns of the two firms are predicted to be 20 percentage points more correlated than when there are no director interlocks.

Turning to the role of control groups of various kinds, pairs of firms in the same equity network are indeed more likely to exhibit synchronous returns. The same is true of pairs of firms in networks of shared individual ownership and shared directorates. When all three network variables are included, membership in the same director network is most strongly associated with synchronicity. Returns of pairs of firms in the same director network are 7% more likely to move in the same direction each week and have a pairwise correlation coefficient that is 16 percentage points higher than returns for pairs of firms in different networks or in no director network, controlling for membership of the same equity network, individual owner network, and a common industry effect.

While the relevance of ownership ties in developing economies has been examined at some length in the literature on tunneling, the empirical work on the effects of director interlocks has for the most part been conducted in a U.S. context. Sociologists have studied how director interlocks can act as interorganizational coordination devices in the presence of environmental uncertainty (Burt, 1983; Mizruchi, 1996). Financial economists have examined the relation between CEO compensation, entrenchment, and mutually interlocking boards (Fich and White, 2003). Historically, in the United States, interlocks have been associated with collusive practices and higher shared profits, in response to which Appendix A of the Clayton Act of 1914 outlawed director interlocks between competing firms. In the United States and worldwide, interlocking directors have been seen as playing a monitoring role, with indebted firms frequently appointing bank representatives to their boards. New directorships for established business leaders are seen as a way to confer legitimacy on a firm, or as a means of career advancement for the individuals concerned (Zajac, 1988), or a byproduct of social elite entrenchment (Mills, 1956). These studies have differing implications and predictions for whether shared directors help or hinder firm performance, but all introduce channels through which firm returns become dependent.[2]

Our results demonstrate that the presence of mechanisms permitting joint control across firms is indeed correlated with increased returns synchronicity. We infer that shared firm ownership and management is considered to be relevant by the market, perhaps because it allows coordination of firm activities. It is particularly interesting that director interlocks are strongly associated with synchronicity. We might speculate that comovement associated with equity ties reflects coordination in the form of earnings tunneling for the benefit of an entrenched controlling shareholder (Morck, Wolfenzon, and Yeung, 2005) or is simply due to anticipated dividend flows. Morck and Nakamura (2007) point out that tunneling for cross-subsidization purposes could well be welfare increasing and that while minority shareholders could perceive this as poor governance, the anticipated level of tunneling will be incorporated into stock prices. It is more plausible within-director networks that synchronicity, after controlling for equity ties, is due to the effects of the joint control of activities such as efficient internal resource allocation, since directors are making day-to-day operating decisions within the firms.

In the next section we describe the ways in which firms are tied in our data and define our key independent variables. Section 3 describes the returns data and synchronicity measures that make up our dependent variables. Section 4 sets out the estimation methodology employed, and Section 5 presents our main results. In Section 6, we discuss several robustness tests of the significant role played by director interlocks. Section 7 concludes.

2. Pairwise interlocks between firms

There are three distinct types of interlocks between pairs of firms in the data. First, firms can own equity stakes in each other. Second, the same individual or individuals can own part of each firm. Third, the same individual(s) can serve as director(s) of both firms. The data are used to construct various measures of the degree of connection between each pair of firms. The pairwise data also allow mappings of firm networks to be constructed, providing information on whether both firms in a pair belong to the same equity network, director network, or individual network. Each of the measures is defined and described below.

2.1. Equity interlocks and equity networks

La Porta, Lopez-de-Silanes, and Shleifer (1999) find that firms are frequently linked to each other both directly and indirectly through equity holdings. Chains of equity

[2] Much of the literature makes a distinction between insider or outsider directors, which is something we cannot distinguish in our data. We have not looked at the particular directorship held in each firm by the tying individual(s). In keeping with most of the literature, we do not discuss how the director networks form or whether their formation is endogenous to the economic activity that also generates returns comovement.

ties create pyramids where ownership and control are often separated. The data on the direct equity ties between pairs of firms in Chile allow us to map out many of the equity networks that exist in the economy. The data are from the Superintendencia de Valores y Seguros (SVS), a regulatory authority based in Santiago. It gathers information on a large group of Chilean firms and the ties of various types between the firms. The data for 1996 include 457 firms and are described in more detail in the Appendix. The data are not exhaustive—for example, they exclude financial institutions—but they do allow a more complete mapping of equity holdings than we have seen elsewhere in the literature. For instance, La Porta et al. focus only on subsets of publicly listed firms for each country.

The equity holdings data contain 1,438 unique observations detailing the identity of the owning firm, the firm it owns, and the percentage that is owned. Of the 457 listed and non-listed firms in the sample, 205 are involved in at least one equity holding as either the owning or the owned firm. Table 1 provides summary statistics about the direct equity holdings between pairs of firms (i,j) where the variable sums the direct holdings of firm i in firm j and the direct holdings of firm j in firm i. Chains of direct equity ties mean that a firm can own an equity stake in another firm through a third firm, or perhaps through a third and a fourth firm. The indirect equity holding is calculated using an iterative process to take account of the fact that firm i might own a share of firm j through its share in any number of other firms. These totals of indirect ownership of firm j by firm i through any one other firm, two other firms, three other firms, and so on are summed to give us the value of all pairwise indirect equity holdings. Summary statistics about indirect equity holdings of firm i in firm j and firm j in firm i are shown in Table 1 along with those for the variable called total equity holdings, which sums direct and indirect equity holdings of firm i in firm j and firm j in firm i for each pair of firms in the data set.

Turning to equity network mappings, a firm is defined as belonging to an equity network if it either owns some part of, or is owned in part by, another firm in that network. Both listed and non-listed firms are potential members of an equity network. Fig. 1 shows the mapping of all equity holdings into networks, and Table A1 presents some summary information about the nature of each network. Since network membership is defined to include all firms that have any equity tie to at least one other firm in the network, both direct and indirect equity ties are subsumed in the mapping. The minor exceptions to the exclusivity of particular firms to one network are detailed in the Appendix, and are illustrated by dotted lines in Fig. 1. Our results are robust to each possible interpretation of these ambiguities.

Each oval in Fig. 1 represents one of the 457 individual firms. An arrow between two firms represents an equity holding in the firm at the point of the arrow by the firm at the origin of the arrow. The absence of an arrow means there is no direct holding of either firm by the other. Indirect holdings between firms are shown by arrows that pass through intermediate firms. The structure of each network in the figure is loosely arranged so that firms owned by no other firm in the network are located at the top of the network. Firms that are owned by other firms in the network but own no part of any other firm are located at the bottom. Firms that both own and are owned by other firms in the network are positioned in the middle. (As mentioned earlier, we do not exploit the hierarchical nature of pyramids in our equity network definition; one reason for this is that our data exclude financial institutions, which may serve to alter the relative position of firms in any pyramid.) The mapping process indicated 46 (almost) mutually exclusive equity networks. We have simply numbered them 1 to 46. Of the 46 networks, 29 contain three or more firms. It is worth noting that equity network membership, in our definition, is not related to the magnitude of interfirm equity holding. Holdings of 1% and 51% both imply same network membership. The firm mappings are used to construct an indicator variable equal to one if both firms in the pair belong to the same equity network.[3]

2.2. Individual owner and director interlocks and networks

Strachan (1976) surveyed prominent businesses in Central America and documented the existence of many control groups, suggesting that "control" was often exercised through ways other than equity ties. Leff (1976, 1978) echoed these observations. The SVS also collects data on the individual owners and directors of each of the 457 firms in the equity ties data set. The original data contain the first name and surname of each individual director and owner (often including two surnames to reflect both maternal and paternal family history). These names are then matched across each pair of firms. Khanna and Rivkin (2006) use the same data to characterize the nature of Chilean business groups, a measure that is used in Section 6 as a means of checking for robustness. We use this individual name information to measure the extent of shared ownership and director interlocks between each pair of firms. The extent of owner overlap is the number of individuals appearing on the ownership rolls for both firms in the pair divided by the average number of individual owners listed for each firm. There are many firm-pairs in the data that share individual owners without having equity ties. The extent of director overlap between two firms in a pair is the number of individuals serving on the boards of both firms in the pair divided by the average number of board members for each firm. These measures are defined on $[0,1]$.

[3] Fig. 1 allows us to emphasize the benefits of our extensive data set. For example, looking at Network 1, firms 75 and 55 are listed and their returns are part of the data which form the dependent variables. Firm 75 owns an indirect stake in firm 55 through an unlisted firm, firm 200. Narrowing our data set to listed firms only would lead us to overlook this equity tie. In addition, firm 55 would be incorrectly excluded from the equity network. Similarly, in Network 2, firm 228 is unlisted and firms 402 and 130 are listed. The indirect ties between 402 and 130 and other listed firms in the network would be overlooked with a narrower data set, and this equity network would include fewer firms.

Table 1

These panels present summary statistics about the dependent and independent variables in our analysis. The first panel is for all observations, followed by the results for subsets of the data.

"Comov" is the measure of pairwise comovement—the frequency with which firms' returns move in the same direction. The variable is defined in Eq. (1), and denoted $f_{i,j}$ in the text.

"Corr" is the pairwise correlative coefficient for the returns of each firm-pair. The variable is defined in Eq. (2), and denoted $C_{i,j}$ in the text.

"Total direct equity holding" is the sum of all direct equity holdings of one firm in the other in the pair.

"Total indirect equity holding" is the sum of all indirect equity holdings of one firm in the other in the pair, summed over many iterations of "indirectness" as described in the text.

"Total equity holding" is the sum of all direct and indirect equity holdings of one firm in the other in the pair.

"Owner overlap, pairwise" is the extent of owner overlap between firms in the pair, and "Director overlap, pairwise" is the extent of overlapping individual directors.

The variables that begin with "same.." are indicator variables equal to one if both firms in the pair belong to the same network or three-digit SIC industry code.

Panel A: Summary statistics of main dependent and independent variables

	All pairs of firms in pairwise sample			Pairs of firms where both in same equity network			Pairs of firms where both in same owner network			Pairs of firms where both in same director network			Pairs of firms where both in same business group		
Variable	# of obs.	Mean	Std. dev.	# of obs.	Mean	Std. dev.	# of obs.	Mean	Std. dev.	# of obs.	Mean	Std. dev.	# of obs.	Mean	Std. dev.
Comov (detrended), $f^d_{i,j}$	15,753	0.528	0.161	376	0.549	0.160	44	0.605	0.167	38	0.633	0.195	272	0.569	0.155
Corr (detrended), $C^d_{i,j}$	15,753	0.034	0.164	376	0.089	0.239	44	0.119	0.265	38	0.219	0.391	272	0.132	0.245
Total direct equity holding	16,653	0.002	0.032	376	0.073	0.195	51	0.139	0.276	38	0.196	0.333	272	0.089	0.221
Total indirect equity holding	16,653	0.000	0.006	376	0.010	0.041	51	0.004	0.014	38	0.010	0.032	272	0.012	0.047
Total equity holding	16,653	0.002	0.033	376	0.082	0.202	51	0.143	0.275	38	0.206	0.330	272	0.102	0.227
Owner overlap, pairwise	16,653	0.007	0.046	376	0.119	0.178	51	0.570	0.212	38	0.504	0.194	272	0.215	0.211
Director overlap, pairwise	14,706	0.007	0.048	376	0.130	0.216	33	0.593	0.203	38	0.655	0.223	253	0.217	0.241
Same equity network	16,653	0.023	0.149	376	1	0	51	0.529	0.504	38	0.842	0.370	272	0.540	0.499
Same owner network	16,653	0.003	0.055	376	0.072	0.259	51	1	0	38	0.579	0.500	272	0.158	0.365
Same director network	16,653	0.002	0.048	376	0.085	0.279	51	0.4314	0.5002	38	1	0	272	0.132	0.339
Same business group	16,653	0.016	0.127	376	0.391	0.489	51	0.8431	0.3673	38	0.947	0.226	272	1	0
Same industry	16,653	0.084	0.278	376	0.173	0.379	51	0.3725	0.4883	38	0.368	0.489	272	0.188	0.391

Panel B: Correlation coefficients between key independent variables

	Total equity holding	Owner overlap, pairwise	Director overlap, pairwise	Same equity network	Same owner network	Same director network	Same business group	Same industry
Total equity holding	1							
Owner overlap, pairwise	0.414	1						
Director overlap, pairwise	0.356	0.871	1					
Same equity network	0.366	0.412	0.367	1				
Same owner network	0.235	0.576	0.673	0.189	1			
Same director network	0.293	0.683	0.513	0.264	0.498	1		
Same business group	0.385	0.574	0.578	0.449	0.362	0.351	1	
Same industry	0.057	0.066	0.081	0.049	0.058	0.049	0.048	1

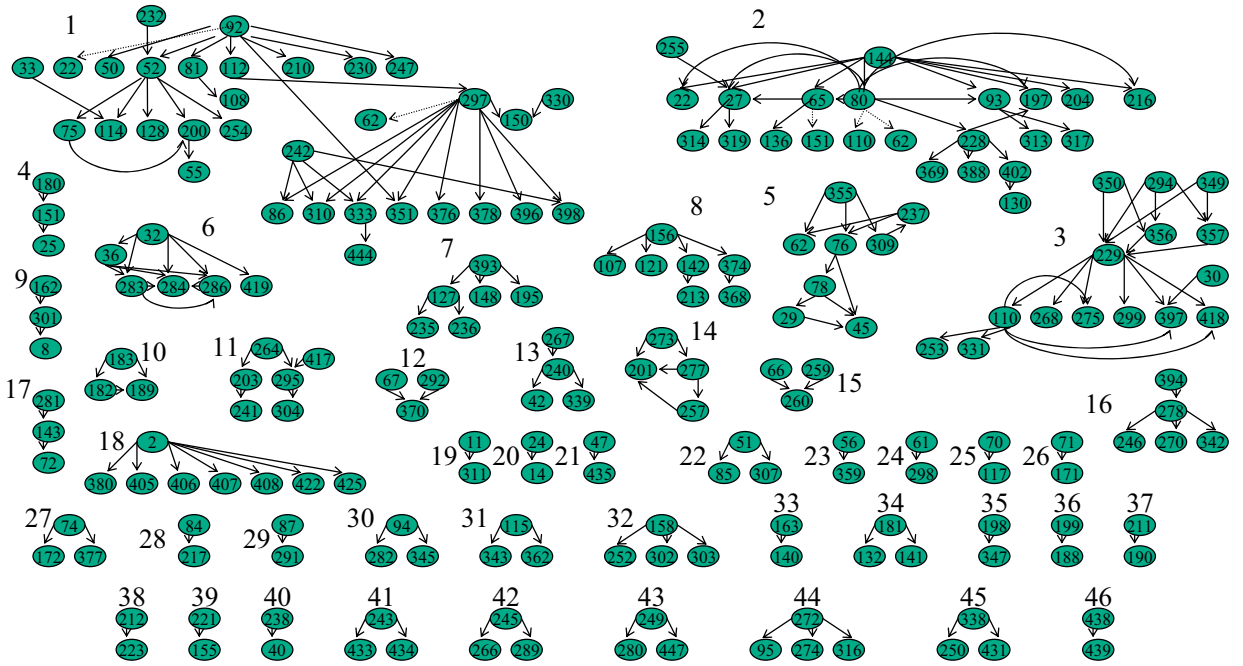

Fig. 1. Equity networks. Each oval represents an individual firm. Arrows represent a non-zero direct equity holding between firms. The networks are labeled 1 to 46. The number inside each oval is the firm's position in the SVS data set of 457 firms.

Just as equity ties allow us to map out equity networks within our data set, we map out firm networks using the data on the common roles played by particular individuals across firms. These networks summarize the extent of overlapping ownership and boards of directors. A firm is defined as belonging to an owner network if it shares at least one individual owner with at least one other firm in the owner network. A firm belongs to a director network if it shares at least one director with at least one other firm in the director network.

The data set contains 1,162 pairwise observations where the two firms have at least one director in common. It contains 1,627 observations where both firms have at least one owner in common. Of the 457 firms in the sample, 125 share owners with at least one other firm, and 116 share directors. There are 50 mutually exclusive owner networks identified in the data. Of these, 15 contain three or more firms. Fig. 2 shows the mappings of the owner networks and Table A2 contains summary data about each of the networks. The mapping of pairs of firms with overlapping directors indicates 46 mutually exclusive director networks. Of these, 17 contain three or more firms. Fig. 3 shows the mapping of director networks and Table A3 contains summary data about each of the networks. In contrast to equity interlocks, both the individual owner and director interlocks are non-directional. Any tie in Figs. 2 and 3 is represented by a line rather than arrow to reflect this fact. We create two indicator variables where an observations is equal to one if both firms belong to the same owner network or the same director network. Table 1, Panel A, contains summary statistics and Panel B presents pairwise correlation measures for these variables. The share of observations equal to one is very small for each network variable since the sample includes all possible firm pairs and an observation equals one only if the firms are tied, as represented in Figs. 1 to 3.

The owner and director networks tend to contain fewer firms than the equity networks but it is not the case that the former are subsets of the latter. Table 1, Panel B, contains the three pairwise correlation coefficients between the indicator variables for same network membership; each is less than 0.5. The final two columns of Table A1 show whether firms belonging to a particular director or owner network are represented in each equity network. There are numerous examples of individual networks crossing the boundaries of equity networks. For example, director Network 17 contains three firms but only two appear in equity Network 1, and firm 227 is not affiliated with any equity network. Director Network 3 contains four firms, two of which (30 and 397) are affiliated with equity Network 3 and two of which are affiliated with equity Network 26. Of the nine firms in owner Network 10, five are affiliated with equity Network 2 and four are unaffiliated with any equity network. In almost every equity network, there are firms that are unaffiliated with any director or owner network.

As mentioned in the Introduction, we also consider the role played by business groups in Chile. Previous studies detail how these groups are important entities in the Chilean economy. Indeed, the financial regulatory authority collects and classifies firm data by business group since they recognize that firms in a business group are under common "effective control." The SVS data assign each firm to one group or to no groups. Our data allow us to distinguish between business group membership, equity

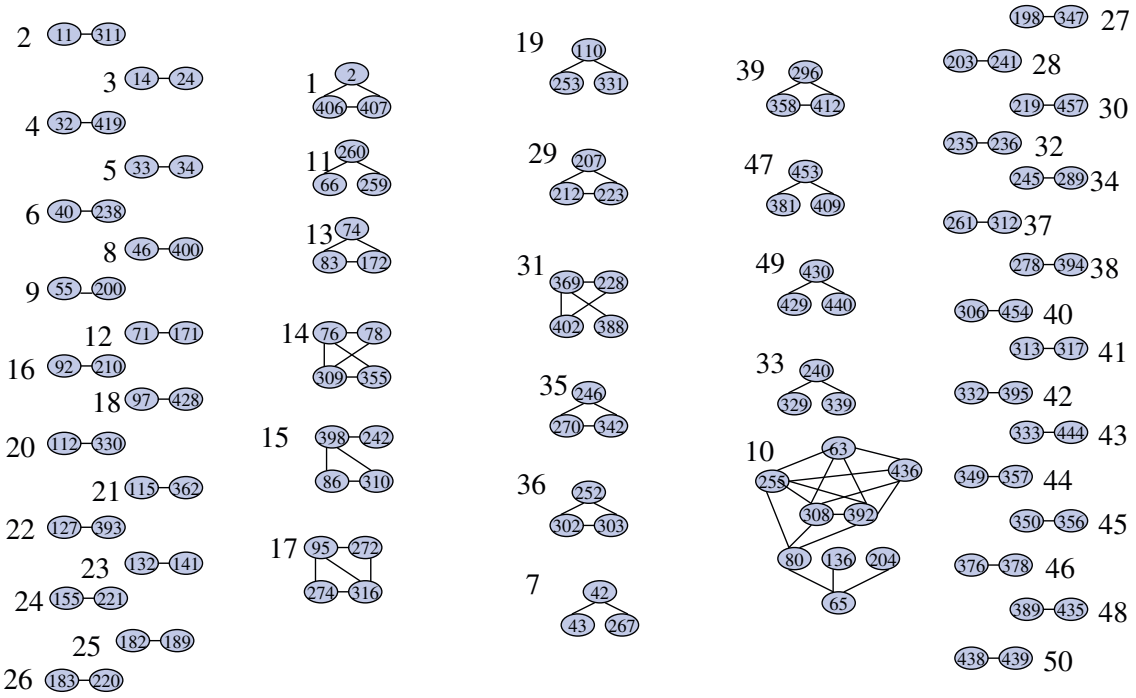

Fig. 2. Owner networks. The presence of at least one shared director is indicated by a line between firms. These links are undirected since they are symmetric ties. The number inside each oval is the firm's position in the SVS data set of 457 firms.

network membership, and director and owner network membership and is hence more detailed than the data used in previous studies. For example, Bertrand, Mehta, and Mullainathan's (2002) study of tunneling within Indian business groups infers the relative share of family ownership in each group firm using data on the share of outside owners.

The pairwise measures of the extent of total equity holdings, director overlap, and individual owner overlap, together with the dummy variables to indicate common equity network, common director network, and owner network membership, form the independent variables of interest in this paper. We test whether pairs of firms with stronger interlocks or in the same networks exhibit greater or reduced returns synchronicity. We assert that same business group membership is associated with unobserved factors possibly related to the degree of returns synchronicity and could itself be related to synchronicity. Controlling for same business group membership allows us to control for network-level unobservables and to focus attention on the extent of synchronicity attributable to membership of our key networks.

3. Stock price data

Weekly stock price and dividend data for 1996 were collected for all firms listed in Santiago during the year. These data form the basis of the dependent variable measures of synchronicity. Of the set of listed firms, we matched 183 individual firms to the data on overlapping owners and directors obtained from the SVS. The remaining firms in the SVS data set are unlisted. Of the 183 firms, 112 are members of one of the equity networks constructed and defined in the previous section; 18 of the 46 equity networks in the overall sample are represented in our subsample by two or more firms. The data contain 376 pairs of firms where each firm in the pair belongs to the same equity network. In the subset of 183 firms, 53 are affiliated with an owner network as described in the previous section; 14 of the 50 owner networks are represented by two or more firms in our listed subsample, and we have 51 pairs of firms where both firms belong to the same owner network. The equivalent numbers for director networks are 57 firms, 18 networks, and 38 pair-level observations. Table 1, Panel A, presents summary statistics about the key dependent and independent variables for the complete data set and for the subset of observations in each network mapping.

Using our data from 1996, we replicate several of the measures presented in Morck, Yeung, and Yu (2000) for Chile in 1995. Morck et al. calculate the fraction of stocks that move either up or down in each of their sample countries in an average week. Their Table 2 shows that this figure for Chile in 1995 is 66.9%. We reconstruct this measure for Chile using 1996 data. In our 1996 sample, 63.6% of firm stock prices move in the same direction in an average week. This figure is the extent of pairwise comovement for the weekly data before each firms' returns were detrended. The detrended data exhibit pairwise comovement of 61.0%. Morck et al. also conduct a firm-level regression of biweekly stock returns on a Chilean market index and a U.S. market index. They then find an aggregate *R*-squared measure representing the

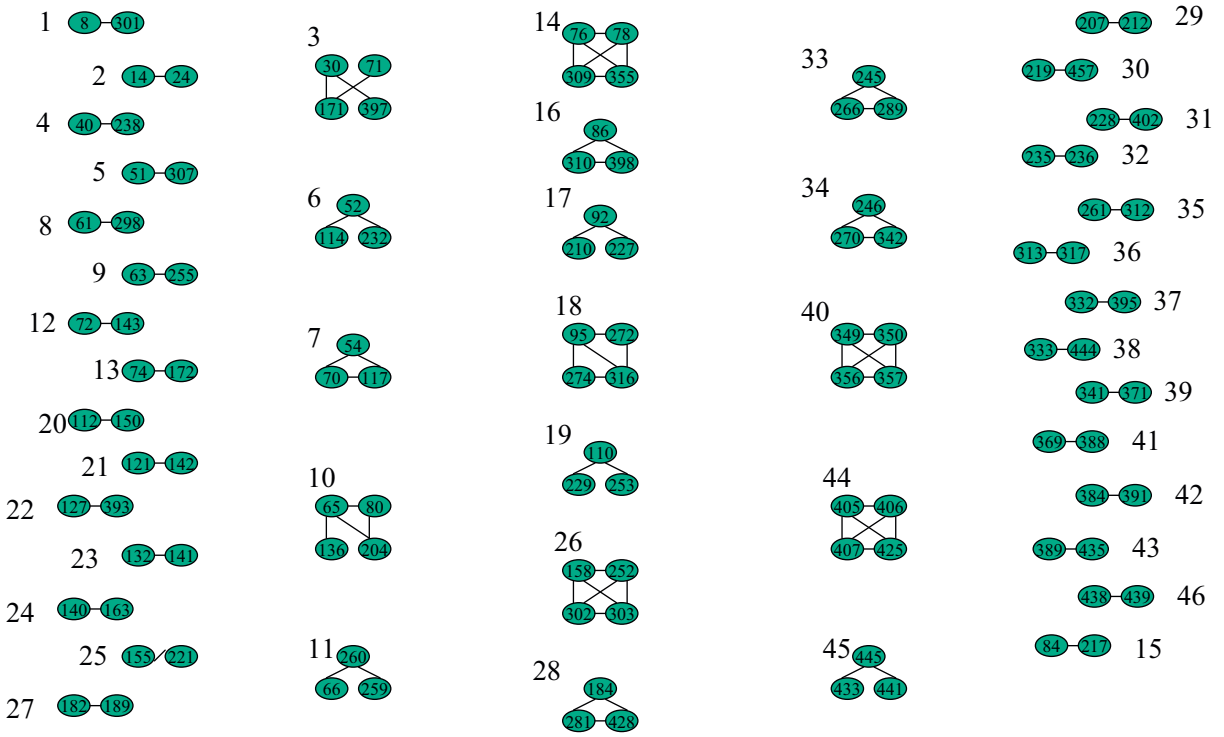

Fig. 3. Director networks. The presence of at least one shared director is indicated by a line between firms. These links are undirected since they are symmetric ties. The number inside each oval is the firm's position in the SVS data set of 457 firms.

share of the variation in firm returns explained by total market variation. The equivalent *R*-squared measure is also the focus of Jin and Myers (2006). $(1 - R^2)$ is inferred to represent the share of variation that is firm specific. Panel C of their Table 2 gives the aggregated *R*-squared of the regression as 0.209. In this spirit, we regress weekly firm returns on a Chilean market index and a week-specific, firm-varying constant using a subset of 28 of our 183 firms in 1996. The *R*-squared measure for this regression is 0.1529. On average, around 15% of the variation in returns for firms in our sample can be attributed to marketwide variation and 85% remains unexplained by market-level effects. In the Appendix, we use our data to construct industry and network measures indexes. We further decompose variation in returns to ask how much is attributable to variation in network-level effects. One shortcoming of this analysis is the small number of firms we can investigate, since we require firms to be part of each of the three types of networks and for each included network to include at least one other listed firm to construct the relevant index. We find that equity network and individual network measures do contribute to market-level variation.

3.1. Constructing the dependent variables

We investigate whether intrafirm ties contribute to the observed synchronicity left unexplained by marketwide movement and by independent common shocks. As our first dependent variable, we use a pairwise measure of stock price synchronicity based on Morck et al.'s measure and adjusted to the context of our within-country study. Rather than look at the fraction of firm returns moving up or down in a week, we look at the frequency with which the returns of two firms move in the same direction in a given time period. In doing this, we take the 85% of firm-level return variation unexplained by market variation and ask whether network membership of different kinds is associated with pairwise synchronicity in the data.

The measure of pairwise returns synchronicity, or comovement, is the number of times that the stock price of two firms in a pair move in the same direction in the same week, divided by the total number of weeks in which both firms move in either direction. For firms *i* and *j*, we define

$$f_{i,j} = \frac{\sum_t (n^{up}_{i,j,t} + n^{down}_{i,j,t})}{T_{i,j}} \quad (1)$$

where $n^{up}_{i,j,t} = 1$ if both returns are positive during a particular time period, and 0 otherwise; $n^{down}_{i,j,t}$ is defined analogously, and $T_{i,j}$ is the number of time periods in which both firms' stock prices move in any direction. $f_{i,j}$ is equal to zero if the two stock prices always move in opposite directions and equals 1 if both firms always move in the same direction. We have one observation for each pair of firms taken from the sample of 183, giving 16,653 pairs in total. For some pairs of firms, there are no weeks in which both firms' stock prices change so the denominator in the synchronicity measure does not exist. Excluding these pairs leaves us with 15,753 non-missing

observations (see Table 1, Panel A). In addition, when finding the pairwise measure (summing over time periods) we omit weeks where the price of either firm remains unchanged. This avoids any bias due to non-trading, which could be of particular concern for the relatively illiquid Chilean market. This adjustment is also used in Morck, Yeung, and Yu (2000, p. 222). We use weekly time periods as our base case. To address concerns about market illiquidity, we repeat all our analysis using a biweekly measures of synchronicity (results available from the authors on request).

The second dependent variable is the correlation coefficient between the returns of each pair of firms. For firms i and j, we define

$$C_{i,j} = \frac{Cov(i,j)}{\sqrt{Var(i).Var(j)}} \tag{2}$$

where $Cov(i,j)$ is the covariance between the weekly returns of i and j for all weeks in 1996, $Var(i)$ is the variance of firm i's weekly returns, and $Var(j)$ is the variance of firm j's weekly returns. In our base case correlation measure, we include weeks in which the price of either firm remains unchanged. The results when measuring pairwise correlation in returns including only those weeks in which both firms exhibit some change in price are available on request. As for the count measure of comovement, we repeat all our analysis using biweekly returns. The main results are robust to these different specifications of synchronicity.

Our measure of pairwise synchronicity, $f_{i,j}$, is intended to capture time-period-specific shocks and is based on the number of time periods in which stock prices move in the same direction. The pairwise correlation coefficient, $C_{i,j}$, reflects both the direction and the magnitude of the movement in prices. In the presence of a significant time trend that affects both firms in the same way, the extent of overall synchronicity will be overstated. If there is an exogenous factor determining the fate of firms that share some sort of tie, we might expect the stock prices of these firms to be more likely to trend in the same direction over time.

We address this concern by detrending the returns data. There is a large literature in finance about how best to do this, the answer depending on beliefs about the underlying model of the time series (as shown in Chan, Hayya, and Ord, 1977). Frequently employed methods include first differencing and simple linear regression. We use linear regression since the issue is that two firms in a network could be more likely to share an underlying linear trend over the year and that their returns will tend to move in the same direction due to this trend rather than due to the presence of a network tie, hence biasing the count-based measure of synchronicity. For each firm, we find the value of its average trend over the year 1996. For 3.8% of total pairs, both firms have a positive trend. For 60.1% of total pairs, both firms have a negative trend. For the remaining pairs, one firm's trend is positive and the other negative. We then construct the difference between the actual weekly return and the predicted weekly return using the estimated trend and the previous week's price. We interpret this difference as the deviation in the firm's stock price in any given week from its own underlying trend. We then use this detrended return to construct the pairwise synchronicity measures using the definitions above. All of the pairwise analysis is conducted using the synchronicity measures from the detrended data, denoted $f^d_{i,j}$ and $C^d_{i,j}$, and the measures using the original returns data, denoted $f_{i,j}$ and $C_{i,j}$. The main results with the dependent variable based on the returns data without detrending, $f_{i,j}$ and $C_{i,j}$, are given in Table A4.[4]

4. Estimation

The pairwise nature of the empirical structure presents several estimation challenges. First, the detrended and with-trend dependent variables ($f_{i,j}$, $C_{i,j}$, $f^d_{i,j}$, $C^d_{i,j}$) are truncated on [0, 1]. Morck, Yeung, and Yu (2000) address this by transforming their analogous measure using a logistic transformation to avoid the econometric issue of data that are potentially censored at the boundaries. Other papers on stock price synchronicity, such as Li (2003), apply the Fisher transformation to their dependent variable. These transformations lead to the exclusion of observations on either boundary. Since we have data equal to both zero and one, we adopt a different approach and employ a Tobit estimation where appropriate. We estimate different specifications of the following equation:

$$f^d_{i,j} = \boldsymbol{\alpha} I_{i,j} + \boldsymbol{\beta}(1 * N_{i,j}) + \boldsymbol{\gamma} Ind_{i,j} + \varepsilon_{i,j} \tag{3}$$

where $I_{i,j}$ is a vector of various pairwise variables: total equity holdings, the extent of individual owner overlap, and the extent of pairwise director overlap. $N_{i,j}$ is a vector of the network indicator variables. $Ind_{i,j}$ is an indicator variable that captures whether both firms are in the same three-digit SIC code. $\boldsymbol{\alpha}$, $\boldsymbol{\beta}$, and $\boldsymbol{\gamma}$ are vectors of estimated coefficients and $\varepsilon_{i,j}$ is a pairwise error term.

Tobit regression analysis using the pairwise data will potentially yield coefficient estimates with correlated standard errors. For instance, if there is a firm-specific component to the error, the error term for the observation for the firm-pair (A,B) will be correlated with the errors for the firm-pairs (A,C) and (B,C). We use a non-parametric bootstrapping estimation method to determine the significance of our estimated coefficients. This involves generating an empirical distribution for each of the coefficients under a null hypothesis. We then compare the estimated coefficient from the Tobit regression to the empirically generated distribution.

In this context, the null hypothesis is that none of the ties between pairs of firms affect the extent of pairwise synchronicity. The empirical distribution of coefficient estimates under this null is produced as follows. We construct a matrix with the first firm in each pair as a different row and the second firm in each pair as a different column. The dependent variable observations corresponding with each pair (the degree of synchronicity) are entered as elements in the matrix. We then rearrange

[4] The main results with the dependent variable based on the returns data without detrending, $f_{i,j}$ and $C_{i,j}$, are given in Appendix Table A4.

the rows and columns of the matrix, using the same permutation for the columns as for the rows, and reassign the dependent variable observations to the independent variables. This process maintains any dependence between elements of the same row or column (firm-level effects) but eliminates the hypothesized relation between the dependent and independent variables. The coefficient for each variable is then estimated under the new permutation. We carry out 500 permutations for each regression. As for the estimated coefficient under the alternative hypothesis of a significant relationship; if the coefficient is located sufficiently far within one tail of the distribution generated under the null, we assert that there is a significant correlation between the two variables given the error structure, and the independent variable is able to explain some part of the observed variation in the dependent variable.

This procedure is intuitively similar to classical hypothesis testing except that the observed data are used to construct a distribution centered on the null rather than imposing a theoretical distribution centered on the estimated coefficient. We ask whether our estimated coefficient is significantly different from the center of the empirical distribution under the null, rather than asking if zero is significantly different from the estimated coefficient based on the parameters of a theoretical distribution. This method is widely used in the field of sociology when dealing with dyadic data and is known as the Quadratic Assignment Procedure. Krackhardt (1988) demonstrates how this procedure is superior to ordinary least squares for testing hypotheses in multiple regression analysis using pair-level data. An alternative approach would be to include firm fixed effects, but this will reduce the efficiency of the estimation. Another possibility would be to use a generalized least squares approach which would involve imposing some structure on the covariance matrix. A third alternative is to assume independence in OLS and cluster the errors, grouping by each firm in the pair.

5. Results

Tables 2 to 4 present the output of a series of Tobit regressions set out in Eq. (3) using the non-parametric estimation procedure with the detrended synchronicity measures, $f^d_{i,j}$and $C^d_{i,j}$, as the dependent variables. In each specification, the first row for a dependent variable gives the estimated Tobit coefficient. The second row for each independent variable (with the figures in italics) gives the percentage of the 500 coefficient estimates generated under the null hypothesis of no significance that were less than the actual estimated coefficient given the row above. Coefficient estimates judged to be significantly different from zero are emboldened in these and subsequent tables to aid interpretation.

In Table 2, the first six specifications show that each of the pairwise measures of equity holdings, the extent of director overlap, and the extent of individual owner overlap are shown to be positively associated with both the count-based measure of synchronicity, $f^d_{i,j}$, and the correlation-based measure, $C^d_{i,j}$, when controlling for industry. The coefficients for the extent of director and individual owner overlap tend to be of larger magnitude, while the standard deviations of all three independent variables are similar in size (see Table 1, Panel A). The returns of two firms with a total equity interlock of 50% are nine percentage points more correlated than the returns of two firms with no equity ties, when controlling for whether both firms are in the same industry. For shared individual ownership, the returns of firms where half the names out of the average number of individual owners appear on both ownership lists are 7% more likely to move in the same direction in any one week and are 15 percentage points more correlated. The returns of two firms where half of the average number of directors sit on both boards are 7% more likely to move in the same direction in any one week and have a correlation coefficient that is 15 percentage points higher than the

Table 2
This table presents the results of the Tobit analysis using detrended synchronicity data based on weekly returns data as the dependent variables.
The first row for each dependent variable gives the estimated Tobit coefficient.
The second row for each dependent variable (in italics) gives the percentage of estimates generated under the null hypothesis of no significance that are less than the estimated Tobit coefficient.
If the share of estimated coefficients under the null smaller than the Tobit coefficient is close to 100% (0%), we infer that the variable is significant and positively (negatively) associated with the dependent variable.
To aid interpretation, a significant (at the 10% or lower level) coefficient is shown in bold type.

The association between firm-pair ties and $f^d_{i,j}$ and $C^d_{i,j}$								
	1	2	3	4	5	6	7	8
Variable	$f^d_{i,j}$	$C^d_{i,j}$	$f^d_{i,j}$	$C^d_{i,j}$	$f^d_{i,j}$	$C^d_{i,j}$	$f^d_{i,j}$	$C^d_{i,j}$
Total equity holding	0.056	**0.181**	–	–	–	–	−0.020	0.027
	84.2	*99.4*					*35.6*	*63.8*
Owner overlap, pairwise	–	–	**0.140**	**0.246**	–	–	−0.089	−0.194
				100.0	*100.0*		*15.8*	*6.0*
Director overlap, pairwise	–	–			**0.133**	**0.297**	**0.207**	**0.437**
					99.8	*100.0*	*99.0*	*100.0*
Same industry	0.012	**0.028**	0.011	**0.027**	*0.003*	**0.024**	0.003	0.024
	85.8	*96.8*	*83.6*	*95.8*	*62.4*	*95.2*	*61.0*	*94.8*

Table 3
This table presents the results of the Tobit analysis using detrended synchronicity data based on weekly returns data as the dependent variables.
The first row for each dependent variable gives the estimated Tobit coefficient.
The second row for each dependent variable (in italics) gives the percentage of estimates generated under the null hypothesis of no significance that are less than the estimated Tobit coefficient.
If the share of estimated coefficients under the null smaller than the Tobit coefficient is close to 100% (0%), we infer that the variable is significant and positively (negatively) associated with the dependent variable.
To aid interpretation, a significant (at the 10% or lower level) coefficient is shown in bold type.

The association between network membership and $f^d_{i,j}$ and $C^d_{i,j}$								
	1	2	3	4	5	6	7	8
Variable	$f^d_{i,j}$	$C^d_{i,j}$	$f^d_{i,j}$	$C^d_{i,j}$	$f^d_{i,j}$	$C^d_{i,j}$	$f^d_{i,j}$	$C^d_{i,j}$
Same equity network	0.021	**0.074**					0.012	**0.062**
	88.8	*100.0*					*79.8*	*99.6*
Same owner network			**0.075**	0.082			0.031	−0.027
			97.2	*90.8*			*76.2*	*32.0*
Same director network					**0.102**	**0.199**	**0.075**	**0.164**
					99.8	*100.0*	*95.2*	*99.4*
Same industry	0.012	**0.028**	0.012	**0.042**	0.012	**0.028**	0.011	**0.027**
	85.4	*97.6*	*86.8*	*98.6*	*84.2*	*97.8*	*83.6*	*97.6*

Table 4
This table presents the results of the Tobit analysis using detrended synchronicity data based on weekly returns data as the dependent variables.
The first row for each dependent variable gives the estimated Tobit coefficient.
The second row for each dependent variable (in italics) gives the percentage of estimates generated under the null hypothesis of no significance that are less than the estimated Tobit coefficient.
If the share of estimated coefficients under the null smaller than the Tobit coefficient is close to 100% (0%), we infer that the variable is significant and positively (negatively) associated with the dependent variable.
To aid interpretation, a significant (at the 10% or lower level) coefficient is shown in bold type.

The association between firm-pair ties, network membership and $f^d_{i,j}$ and $C^d_{i,j}$												
	1	2	3	4	5	6	7	8	9	10	11	12
Variable	$f^d_{i,j}$	$C^d_{i,j}$	$f^d_{i,j}$	$C^d_{i,j}$	$f^d_{i,j}$	$C^d_{i,j}$	$f^d_{i,j}$	$C^d_{i,j}$	$f^d_{i,j}$	$C^d_{i,j}$	$f^d_{i,j}$	$C^d_{i,j}$
Total equity holding			−0.024	−0.017	0.029	**0.157**	−0.019	0.032	0.014	**0.110**	−0.020	0.027
			36.4	*43.6*	*69.0*	*98.6*	*36.2*	*67.6*	*62.6*	*95.2*	*38.8*	*69.4*
Owner overlap, pairwise	−0.095	**−0.234**	−0.092	**−0.232**			−0.079	−0.142			−0.088	**−0.194**
	15.0	*2.0*	*17.6*	*2.0*			*22.4*	*12.0*			*18.0*	*4.6*
Director overlap, pairwise	**−0.202**	**0.418**	**0.206**	**0.420**			**0.211**	**0.458**			**0.187**	**0.438**
	98.6	*100.0*	*98.8*	*100.0*			*98.4*	*100.0*			*97.6*	*100.0*
Same equity network	0.003	0.043	0.004	**0.044**								
	56.6	*98.2*	*62.6*	*97.0*								
Same owner network					**0.070**	0.063	−0.021	**−0.110**				
					95.8	*89.6*	*35.4*	*3.8*				
Same director network									**0.099**	*0.177*	0.027	−0.001
									99.0	*100.0*	*63.2*	*48.4*
Same industry	0.003	**0.024**	0.003	**0.024**	0.012	**0.028**	0.003	**0.024**	0.012	0.027	0.003	0.024
	60.6	*95.6*	*66.4*	*96.4*	*87.6*	*95.4*	*65.6*	*96.4*	*85.0*	*96.6*	*65.0*	*94.6*

returns of two firms with no directors in common. When all three pairwise measures are included, in the last two specifications of Table 2, only the extent of director overlap retains significance. Controlling for pairwise equity ties, individual owner overlap, and common industry membership, a pair of firms where half of the average number of directors sit on both boards is 10% more likely to have comoving returns, and the correlation coefficient for firm returns is predicted to be 21 percentage points higher than for pairs of firms with no interlocking directorates.

The results from the specifications including the network affiliation measures are given in Table 3. The returns of pairs of firms in the same equity network, director network, and owner network are all more likely to be synchronous. The magnitude of the coefficient on shared director network membership is larger than the equivalent coefficient for either type of ownership network. When all three network affiliations are included at the same time, in the final two columns of Table 3, all three are positively associated with $f^d_{i,j}$, but only common director network membership is significantly associated

with this pairwise measure of the direction of returns. Both equity network membership and common director network membership are significantly associated with the correlation measure $C^d_{i,j}$. The coefficient on same director network membership is larger than the equivalent coefficient for equity network membership. Controlling for equity network, individual owner network, and shared industry effects, pairs of firms in the same director network are 7% more likely to have returns that move in the same direction and the correlation in returns is predicted to be 16 percentage points higher.

Table 4 presents the results of specifications that include both pair-level and network affiliation measures. The extent of shared directors is positively and significantly associated with both measures of synchronicity throughout, even when controlling for membership of the same equity network and the extent of equity holdings between the firms. Membership of the same director network is positively and significantly associated with synchronicity when equity holdings are included. However, when both director overlap and equity holdings are included along with director network membership, only the pairwise level of director overlap remains positive and significant.

One other finding, which holds across all specifications, is that belonging to the same industry is positively associated with both measures of synchronicity but significantly so only with the correlation-based measure, $C^d_{i,j}$. Since we expect firms in the same industry to experience common shocks that generate comovement, it is important to include this variable as a control.

6. Robustness checks on the role of director interlocks

The prior results show that two firms' stock prices are more synchronous when they have interlocking directorships. In addition, pairs of firms belonging to a network defined by director interlocks are more likely to have comoving returns. We interpret the results as evidence that the market views director ties as leading to more correlated fundamentals or as creating opacity of firm-specific boundaries. One objection to this interpretation is that, as mentioned in the introduction, the board structure of each firm might not be exogenous to the firm-specific information that generates changes in stock prices. Any unobservable factor that determines board structure could also be associated with pairwise synchronicity. Unobserved factors could come from many different sources, but one example is industry-level news. Firms with director interlocks might be more likely to be in the same industry, and industry-specific shocks will be reflected directly in both firms' stock prices independent of the presence of shared directors. While we have attempted to control for common industry-level news events by including a same industry indicator variable in our results, the three-digit industry classification we have available is fairly broad. We have attempted to extend our data on firm director and owner overlap to subsequent years to allow an investigation of variation in synchronicity over time as network membership changes. While it is possible to construct the extent of director overlap for listed firms using public sources, we have been unable to find detailed data from the SVS about the roles played by individuals in non-listed firms for other years. Another problem with this approach is that the shared director ties and common individual ownership across the firms we observe tend to be very stable over time.

One omitted factor in our analysis involves the business group construct. It has been well documented elsewhere that business groups are a characteristic feature of the Chilean economy (see, e.g., Khanna and Palepu, 1999; Khanna and Yafeh, 2007). As with the other network measures, firms within-business groups can be expected to experience common shocks because the market views them as opaque entities and/or because pairs of firms in business groups share other unobserved features that can also be correlated with synchronicity. Table 5 presents summary data about business groups and the extent of overlap with each of the networks previously discussed. We conduct a series of additional analyses including an indicator variable as a control measure for same business group membership. The results for the detrended dependent variables, $f^d_{i,j}$ and $C^d_{i,j}$, including the same business group control, are given in Table 6. Each specification reveals that returns for pairs of firms in the same business group are more likely to be synchronous. This finding suggests that the activities undertaken within these relatively opaque organizations are perceived to affect firm values. However, even controlling for the business group effect, pairwise director overlap and director network effects continue to be positively and significantly associated with both measures of synchronicity. In contrast, the estimated coefficients for equity ties and equity network membership are not significant once we control for business groups effects.

Further, we look within-business groups to assess whether the significance of director overlap in explaining synchronicity is robust to the inclusion of business group fixed effects. Within group, we have very few observations near to the boundaries 0 and 1, so do not use Tobit regressions but instead use fixed-effects regression in the same estimation framework. Table 7 gives the results for this analysis for the detrended data. The first two specifications reveal that same equity network membership is not associated with synchronicity when pairwise director overlap is included. Director ties remain significant when controlling for equity network and looking only within-business group. Specifications 3 and 4 show that membership in the same director network is positively and significantly associated with synchronicity within-business groups even when controlling for pairwise equity holdings. The fact that the within-business group results are consistent with our main results is particularly reassuring because, as shown in Table 1, Panel A, pairwise membership of the same equity network, owner network, or director network is a much less rare event within-business groups than in the overall sample.

We finish this section by reporting on whether we see any evidence that ties of different types act together to blur firm boundaries to an even greater extent. Table 7 reports the results of several within-equity network

Table 5
This table gives information about the extent of network overlap.
The business groups are numbered between 1 and 71, although there are only 43 in total.
The 457 firms are the firms monitored by the SVS. The 183 firms are those for which we have returns data.
The last three columns reveal which of the other networks are represented in the relevant business group.
Equity, director, and owner networks cross-business group borders.

Summary statistics about business groups.

Business group	# firms in 458	# firms in 183	Group name, where available	Different equity networks represented in business group	Different director networks represented in business group	Different owner networks represented in business group
1	10	9	Grupo Angelini	EP1, EP39. No EP.	0,17,20,25	0,16,20,24
2	15	11	Grupo Matte	EP2, EP4. No EP.	0,9,10	0,10
3	19	11	Grupo Luksic	EP1, EP8, EP27, EP33. No EP.	0,13,21,24,39	0,13
4	3	3	Grupo Izquierdo-Menendez	EP11.	0	0,28
5	6	1		EP13. No EP.	0	0,7,33
6	7	7	Grupo Ricardo Claro	EP5.	0,14	0,14
7	3	3	Grupo Guilisasti	EP15.	11	0,11
8	3	3	Grupo Pathfinder	EP17. No EP.	12	0
11	2	0		No EP.	12,28	0
12	3	2	Grupo Roberto Andraca	EP7.	0	22,32
13	5	1		EP16.	0,34	35,38
15	3	0		EP43. No EP.	0	0
16	13	10	Grupo Yuraszeck	EP3.	0,19,40	0,19,44,45
18	4	4	Grupo Phillipi	EP1.	0,16	15
19	4	3	Conglomerado CGE	EP1. No EP.	0,6	0
20	2	2		EP2.	0,36	0,41
21	4	4	Grupo Sigdo Koppers	EP3, EP26. No EP.	0,3	0,12
22	19	5	State-owned	EP1, EP2, EP18, EP24. No EP.	0,8	0,1
23	4	1		EP2.	31,41	31
24	2	2	Grupo Hurtado	EP11.	0	0
25	5	5	Holding Soquimich	EP14. No EP.	0	0
26	6	4	Grupo Emel	EP6.	0	0,4
27	2	1		EP1.	0	9
29	3	1		EP44.	18	17
31	5	1		EP1. No EP.	0,38	0,43,46
36	3	1		EP31.	0	0,21
37	2	1		No EP.	0	0
38	3	0		No EP.	0	0,47
39	3	0		No EP.	0	49
40	7	1	Grupo Cruzat	EP18, EP45. No EP.	0	0
42	2	1		EP41.	0,45	0
46	2	2	Telephonica	EP29.	0	0
47	3	1		EP22.	0,5	0
48	3	1		EP34.	0,23	0,23
50	2	0		No EP.	0	0
57	6	4	Grupo Larrain	EP1, EP10, No EP.	0,27	0,25,26
58	2	1		EP40.	4	6
61	3	1		EP38. No EP.	0,29	29
62	4	1		EP32.	26	0,36
63	2	1		No EP.	0	0
64	2	0		No EP.	30	30
70	2	0		No EP.	42	0
71	2	1		EP11. No EP.	0	0,28

estimation specifications. The extent of pairwise director ties is positively and significantly associated with comovement within-equity networks. The coefficients in specifications 3 and 4 are similar in magnitude to those in Table 2, specifications 7 and 8. Together with the result in Table 3 showing us that equity network membership is

Table 6
This table presents the results of the Tobit analysis using detrended synchronicity data based on weekly returns data as the dependent variables.
The first row for each dependent variable gives the estimated Tobit coefficient.
The second row for each dependent variable (in italics) gives the percentage of estimates generated under the null hypothesis of no significance that are less than the estimated Tobit coefficient.
If the share of estimated coefficients under the null smaller than the Tobit coefficient is close to 100% (0%), we infer that the variable is significant and positively (negatively) associated with the dependent variable. To aid interpretation, a significant (at the 10% or lower level) coefficient is shown in bold type.

The association between firm-pair ties, network membership and $f^d_{i,j}$ and $C^d_{i,j}$, controlling for same business group membership

	1	2	3	4	5	6	7	8	9	10
Variable	$f^d_{i,j}$	$C^d_{i,j}$	$f^d_{i,j}$	$C^d_{i,j}$	$f^d_{i,j}$	$C^d_{i,j}$	$f^d_{i,j}$	$C^d_{i,j}$	$f^d_{i,j}$	$C^d_{i,j}$
Total equity holding	−0.030	−0.026					−0.025	−0.001		
	31.0	*35.0*					*35.0*	*52.0*		
Owner overlap, pairwise	−0.107	−**0.300**								
	15.6	*0.8*								
Director overlap, pairwise	**0.200**	**0.402**	**0.120**	**0.176**						
	97.2	*100.0*	***98.0***	***98.4***						
Same equity network			−0.002	0.024					0.003	0.034
			47.4	*88.4*					*60.0*	*94.2*
Same owner network										
Same director network					**0.073**	**0.111**	**0.076**	**0.111**	0.072	**0.099**
					95.2	*99.0*	*96.2*	*97.0*	*94.2*	*97.8*
Same business group	0.016	**0.085**	0.009	**0.057**	0.032	**0.094**	**0.034**	**0.094**	0.030	**0.077**
	74.2	*100.0*	*69.8*	*98.0*	*93.8*	*100.0*	*96.6*	*100.0*	*92.0*	*100.0*
Same industry	0.0031	**0.024**	0.003	**0.024**	0.011	0.026	0.011	0.026	0.011	**0.026**
	63.8	*96.8*	*61.4*	*95.2*	*86.4*	*94.8*	*84.4*	***96.2***	*83.2*	*97.0*

Table 7
This table presents the results of the OLS analysis using detrended synchronicity data based on weekly returns data as the dependent variables.
The first row for each dependent variable gives the estimated coefficient.
The second row for each dependent variable (in italics) gives the percentage of estimates generated under the null hypothesis of no significance that are less than the estimated coefficient.
If the share of estimated coefficients under the null smaller than the coefficient is close to 100% (0%), we infer that the variable is significant and positively (negatively) associated with the dependent variable. To aid interpretation, a significant (at the 10% or lower level) coefficient is shown in bold type.

The association between firm-pair ties, network membership and $f^d_{i,j}$ and $C^d_{i,j}$

	1	2	3	4	5	6	7	8	9	10	11	12
Variable	$f^d_{i,j}$	$C^d_{i,j}$	$f^d_{i,j}$	$C^d_{i,j}$	$f^d_{i,j}$	$C^d_{i,j}$	$f^d_{i,j}$	$C^d_{i,j}$	$f^d_{i,j}$	$C^d_{i,j}$	$f^d_{i,j}$	$C^d_{i,j}$
Total equity holding			−0.048	−0.127							−0.056	−0.115
			24.6	*8.6*							*19.8*	*9.4*
Owner overlap, pairwise			−0.109	−0.293								
			16.2	*9.0*								
Director overlap, pairwise	**0.148**	**0.254**	**0.214**	**0.430**			**0.157**	**0.264**				
	98.6	*98.0*	*97.6*	*98.4*			*98.0*	*97.2*				
Same equity network					−0.015	−0.009	−0.022	−0.026	−0.027	−0.018		
					38.2	*42.6*	*31.2*	*29.0*	*29.0*	*34.8*		
Same owner network									0.021	0.002		
									68.8	*52.0*		
Same director network									**0.093**	0.074	**0.101**	0.080
									96.6	*86.0*	*99.4*	*87.2*
Same industry	0.021	0.031	0.024	0.037	**0.068**	0.079	0.021	0.031	0.052	0.041	**0.060**	0.081
	70.0	*67.2*	*72.2*	*72.4*	*96.4*	*90.6*	*69.6*	*94.4*	*94.4*	*60.2*	*95.2*	*93.2*

itself associated with synchronicity, these results suggest that the effect of different types of ties can be additive, specifically that director ties are complementary to equity network membership as channels for joint control. Membership in the same director network is also positively associated with synchronicity within-equity networks. Here the magnitude of the coefficients in Table 8 (specifications 5 and 6) is greater than the

Table 8
This table presents the results of the OLS analysis using detrended synchronicity data based on weekly returns data as the dependent variables.
The first row for each dependent variable gives the estimated coefficient.
The second row for each dependent variable (in italics) gives the percentage of estimates generated under the null hypothesis of no significance that are less than the estimated coefficient.
If the share of estimated coefficients under the null smaller than the coefficient is close to 100% (0%), we infer that the variable is significant and positively (negatively) associated with the dependent variable. To aid interpretation, a significant (at the 10% or lower level) coefficient is shown in bold type.

The association between firm-pair ties, network membership and $f^d_{i,j}$ and $C^d_{i,j}$ within-equity network										
	1	2	3	4	5	6	7	8	9	10
Variable	$f^d_{i,j}$	$C^d_{i,j}$	$f^d_{i,j}$	$C^d_{i,j}$	$f^d_{i,j}$	$C^d_{i,j}$	$f^d_{i,j}$	$C^d_{i,j}$	$f^d_{i,j}$	$C^d_{i,j}$
Total equity holding			−0.075	−0.121			−0.055	−0.075		
			15	12.8			21	25.6		
Owner overlap, pairwise			−0.124	−0.237						
			13.6	13.6						
Director overlap, pairwise	**0.138**	**0.288**	**0.232**	**0.464**					**0.166**	**0.265**
	98.2	99.4	97.2	96.8					97.8	96.8
Same owner network					−0.036	−0.083				
					32.6	17.8				
Same director network					**0.134**	**0.214**	**0.114**	**0.165**		
					97.2	96.6	99.6	97.0		
Same business group									−0.029	0.023
									26.8	62.4
Same industry	0.013	0.029	0.013	0.029	0.018	0.044	0.019	0.045	0.012	0.030
	61.0	74.8	65.0	73.0	72.8	82.4	73.0	83.8	62.8	74.8

coefficients shown in specifications 7 and 8 of Table 3, again consistent with complementarity between membership of director and equity networks. (We cannot estimate within-director networks effects since there is not enough variation in the key independent variables within these networks.)

7. Conclusions

Our results establish that marketwide synchronicity can be attributed at least in part to increased synchronicity between pairs of firms under joint control. The findings suggest that joint control through director networks plays as much, if not more, of a role as equity and individual owner interlocks. Firms that have interlocking directorates or are part of the same network of director interlocks are particularly likely to have synchronous returns. Controlling for ownership ties, common industry effects, and overall trends in returns, pairs of firms that have one or more directors in common are significantly more likely to have returns that move in the same direction in any one week and to have a higher correlation coefficient. Pairs of firms in the same business group are also more likely to have synchronous returns, and director interlocks are shown to be positively associated with synchronicity even when controlling for common business group effects. While director ties continue to play a role within-equity networks and business groups, equity ties are not significantly associated with increased synchronicity within-business groups. This provides further evidence that the shared role played by individual directors is particularly important in the Chilean market.

Limitations of our study include that we do not examine any specific predictions for asymmetric spillovers between firms in the presence of an equity tie. For example, anticipated earnings tunneling would give rise to spillovers from a firm with low cash flow rights to a firm with larger controlling shareholder cash flow rights and not vice versa. The symmetric pairwise measures of synchronicity employed in this paper could mask the impact of these effects on firm returns. Second, we do not treat equity ties that constitute a controlling stake differently from other equity ties. Other corporate governance papers focus on firms with an obvious controlling shareholder. For example, the data used in La Porta, Lopez-de-Silanes, Shleifer, and Vishny (2002) include firms where a shareholder controls more than 10% of firm votes. Last, it is important to note that our findings are specific to Chile in the mid-1990s, facilitated by access to an unusually detailed data set. It remains to be seen whether the results presented here generalize to other countries and other time periods.

Our results are consistent with previous studies which suggest that synchronicity at the market level is due to blurred firm boundaries. Other empirical papers on group effects, such as Bertrand, Mehta, and Mullainathan (2002) in their study of Indian business groups, have focused on groups whose boundaries are defined by ownership ties. Bertrand, Johnson, Sampthantharak, and Schoar (2004) demonstrate how familial relationships have an impact on family business performance, and we add to the literature on how relationships and social ties are viewed as important in capital markets. Networks defined by shared directorships map out one type of relationship-based system of the type described by Rajan and Zingales (1998).

The significant association between director interlocks and synchronicity could indicate that director interlocks facilitate coordination across firms, serving to reduce hold-up problems and achieve faster growth as described in Morck and Nakamura (2007). The ways and means by which overlapping directors achieve coordination is an open question and a topic for future research.

Appendix A

A.1. Data sources and selection

The data used in this paper come from four main sources and several additional reference data sets for matching the sources (Tables A1–A3).

Table A1
Summary statistics about equity networks in Chile. Each firm in a network has at least one equity tie with at least one other firm in the network. The networks are numbered 1 to 46.

The 457 firms are the firms monitored by the SVS. The 183 firms are those for which we have returns data.

The mean and standard deviation refer to the pairwise returns comovement for all pairs of firms from the 183 firms that are both in the relevant equity network.

The last two columns detail the extent of overlap of equity networks with director and owner networks, respectively.

Equity network	# Firms in 457	# Firms in 183	# Pairwise observations from the 183	Mean pairwise comovement, detrended	Standard deviation	Different director networks represented in equity network	Different owner networks represented in equity network
1	29	19	171	0.509	0.160	0,6,16,17,20,38	0,5,9,15,16,20, 43,46
2	20	13	78	0.553	0.155	0,9,10,31,36,41	0,10,31,41
3	15	11	55	0.657	0.130	0,3,19,40	0,19,44,45
4	3	2	1	0.560	–	0	0
5	8	7	21	0.581	0.069	0,14	0,14
6	6	4	6	0.557	0.069	0	0,4
7	6	4	6	0.600	0.070	0,22,32	0,22,32
8	7	5	10	0.471	0.236	0,21	0
9	3	1	0			0,1	0
10	3	1	0			0,27	25,26
11	6	5	10	0.556	0.106	0	0,28
12	3	0	0			0	0
13	4	1	0			0	7,33
14	4	4	6	0.690	0.075	0	0
15	3	3	3	0.440	0.151	11	0,11
16	5	1	0			0,34	35,38
17	3	2	1	0.720	–	12,28	0
18	8	0	0			0,44	0,1
19	2	0	0			0	2
20	2	1	0			2	3
21	2	1	0			0,43	0,48
22	3	1	0			0,5	0
23	2	1	0			0	0
24	2	2	1	0.860	–	8	0
25	2	1	0	–	–	7	0
26	2	2	1	0.521	–	3	12
27	3	2	1	0.612	–	0,13	0,13
28	2	0	0			15	0
29	2	2	1	0.620	–	0	0
30	3	3	3	0.239	0.234	0	0
31	3	1	0			0	0,21
32	4	1	0			26	0,36
33	2	0	0			24	0
34	3	1	0			0,23	0,23
35	2	1	0			0	27
36	2	1	0			0	0
37	2	0	0			0	0
38	2	1	0			0,29	29
39	2	2	1	0.680	–	25	24
40	2	1	0			4	6
41	3	1	0			0,45	0
42	3	0	0			33	0,34
43	3	1	0			0	0
44	4	1	0			18	17
45	3	1	0			0	0
46	2	0	0			46	50
Total/ Average	205	112	376	0.579			

Table A2
Owner networks—summary statistics

Summary statistics about owner networks in Chile. All firms in a network share at least one owner with at least one other firm in the network. The networks are numbered 1 to 50.

The 457 firms are the firms monitored by the SVS. The 183 firms are those for which we have returns data.

The mean and standard deviation refer to the pairwise returns comovement for all pairs of firms from the 183 firms that are both in the relevant owner network.

Owner network	# Firms in 457	# Firms in 183	# Pairwise observations from the 183	Mean pairwise comovement, detrended	Standard deviation
1	3	0	0		
2	2	0	0		
3	2	1	0		
4	2	1	0		
5	2	0	0		
6	2	1	0		
7	3	0	0		
8	2	0	0		
9	2	1	0		
10	9	8	28	0.629	0.116
11	2	2	1	0.580	–
12	2	2	1	0.521	–
13	3	2	1	0.612	–
14	4	4	6	0.617	0.075
15	4	4	6	0.540	0.233
16	2	1	0		
17	4	1	0		
18	2	0	0		
19	3	2	1	0.480	–
20	2	2	1	0.267	–
21	2	1	0		
22	2	2	1	0.660	–
23	2	0	0		
24	2	2	1	0.680	–
25	2	0	0		
26	2	2	1	0.720	–
27	2	1	0		
28	2	1	0		
29	3	1	0		
30	2	0	0		
31	4	1	0		
32	2	0	0		
33	3	1	0		
34	2	0	0		
35	3	0	0		
36	3	0	0		
37	2	2	1	0.120	–
38	2	1	0		
39	3	0	0		
40	2	0	0		
41	2	1	0		
42	2	0	0		
43	2	1	0		
44	2	2	1	0.920	–
45	2	2	1	0.920	–
46	2	0	0		
47	3	0	0		
48	2	0	0		
49	2	0	0		
50	2	0	0		
Total	125	53	51	0.590	

A.1.1. 1996 weekend stock price data for all firms listed on the Bolsa de Santiago at any point during the year

We use weekly stock price and dividend data from 1996 for 183 firms to construct the dependent variables used in the paper. The Santiago stock exchange had 270 listings during 1996. Of this 270, 52 were secondary listings for a firm that was already listed. We drop these listings from the sample, with the intent of retaining only ordinary shares. Of the remaining 218 firms, 25 were not monitored by the SVS, in most cases because they were financial intermediaries of some kind. This left us with 193 firms. In order to account for comovement

Table A3
Director networks—summary statistics

Summary statistics about director networks in Chile. All firms in a network share at least one director with at least one other firm in the network. The networks are numbered 1 to 46.

The 457 firms are the firms monitored by the SVS. The 183 firms are those for which we have returns data.

The mean and standard deviation refer to the pairwise returns comovement for all pairs of firms from the 183 firms that are both in the relevant director network.

Director network	# Firms in 457	# Firms in 183	# Pairwise observations from the 183	Mean pairwise comovement, detrended	Standard deviation
1	2	1	0		
2	2	1	0		
3	4	3	3	0.5556	0.0789
4	2	1	0		
5	2	1	0		
6	3	2	1	0.6200	–
7	3	1	0		
8	2	2	1	0.8600	–
9	2	2	1	0.5918	–
10	4	3	3	0.6267	0.0416
11	3	3	3	0.4400	0.1510
12	2	1	0		
13	2	2	1	0.6122	–
14	4	4	6	0.6167	0.0753
15	2	0	0		
16	3	3	3	0.4733	0.3002
17	3	2	1	0.5600	–
18	4	1	0		
19	3	3	3	0.6000	0.1200
20	2	2	1	0.6000	–
21	2	2	1	0.9000	–
22	2	2	1	0.6600	–
23	2	0	0		
24	2	0	0		
25	2	2	1	0.6800	–
26	4	1	0		
27	2	0	0		
28	3	2	1	0.5400	–
29	2	1	0		
30	2	0	0		
31	2	1	0		
32	2	0	0		
33	3	0	0		
34	3	0	0		
35	2	2	1	0.1200	–
36	2	1	0		
37	2	0	0		
38	2	1	0		
39	2	0	0		
40	4	4	6	0.9200	0.0253
41	2	0	0		
42	2	0	0		
43	2	0	0		
44	4	0	0		
45	3	0	0		
46	2	0	0		
Total	116	57	38	0.610	

attributable to anticipated dividend streams, we want to be able to strip out of each firm's return the value of the share that firm owns in any other firm in the sample. This requires data on the total market value of equity and the number of outstanding shares of any firm that either owned or was owned by another firm in the sample. Of the 193 firms, 123 were involved in equity holdings. We used Economatica data to find the total number of outstanding shares for these 123 firms to allow us to calculate the market value of equity. The idea is that if firm *i* owns 20% of firm *j*, each share in firm *i* contains some value attributable to the value of firm *j*. We subtract 20% of the market value of *j* from the market value of *i*. We then divide the remaining value of *i* between the number of *i*'s outstanding shares to give an adjusted share price for *i*. This is meant to capture the component of *i*'s stock price that relates to the underlying assets of the firm. Economatica did not have the number of outstanding

shares for 10 of the 123 firms for which we needed this data and we chose to exclude these 10 from our analysis, leaving us with all the required data for 183 out of the 193 firms.

A.1.2. Data on industry and business group affiliation during 1996 for the 457 firms monitored by the SVS

The SVS monitored 457 firms during 1996. Under law 18.045, the SVS monitors all corporations or limited partnerships in which at least 10% of the subscribed capital belongs to at least 100 shareholders, or corporations with 500 shareholders or more. This definition included a greater number of firms than the number of firms listed on one of the three national stock exchanges. The SVS data set can also include firms that choose to report voluntarily, but our data do not allow us to distinguish between firms for which reporting is mandatory or voluntary.

A.1.3. Data on all direct equity holdings among the 457 firms in the SVS data set

This data set, also from the SVS, contains 1,438 unique observations on the identity of the owning firm, the firm it owns, and the percentage owned. The original data source includes holdings for 1995 to 1997. We have used observations for 1996.

A.1.4. Pairwise data on the extent of ties of various types between all pairs of firms in the SVS data set

The variables used here include an eight-digit firm identification number for each firm in the pair, the degree to which the two firms share directors, and the degree to which two firms share owners. The data are for 1996.

A.2. Description of ambiguities in equity network classification

The detailed data on equity holdings among the 457 firms monitored by the SVS contain a few small ambiguities. The results are robust to any possible combination of different interpretations of these ambiguities.

Equity Networks 1 and 2 are the biggest networks, containing 29 and 20 firms, respectively. There are three ambiguities about the network allocation of particular firms that could lead us to view these two networks as linked. First, what is referred to as Network 4 in Fig. 1 is linked to Networks 1 and 2 through firm 151, but the SVS data about how it is linked are confusing. Firm 151 is described as 81% owned by firm 65 in Network 2. It is also said to be 100% owned by firm 210 in Network 1. Since at least one of these numbers must be wrong, we have run the analysis with the firms in Network 4 considered as a separate network as the base case. We re-ran the analysis with these firms assigned to Network 1 and then again with these firms assigned to Network 2. The results are robust to these specification changes.

Second, what is referred to as Network 5 in Fig. 1 is linked to both Networks 1 and 2 through firm 62. This firm is 15% owned by firm 297 in Network 1. It is also 1% owned by firm 80 in Network 2. We have run the analysis with Network 5 as part of the Network 1 and also as part of Network 2. The results are unchanged.

Third, the network assignment of firm 22 is somewhat unclear when attempting to draw a line between Networks 1 and 2. It is 5% and 16% owned by firms 144 and 80, respectively, which are both in Network 2. It is 23% and 20% owned by firms 92 and 210, respectively, which are both in Network 1. Since this is the only means by which the two networks are joined (subject to the two previous ambiguities), we have decided to use firm 22 as the dividing point. Firm 22 is assigned to Network 2 in the base case but running the analysis with it assigned to Network 1 does not alter the results.

The rationale guiding these decisions is that whenever there is uncertainty about the network assignment, we have drawn the boundaries to include as few firms in each network as is feasible. This rationale explains, too, how we resolve a final ambiguity about a possible link between Networks 2 and 3. Firm 110 in Network 3 is 1% owned by firm 80 in Network 2. This is the only link between the two networks and joining the two has no effect on the results.

A.3. Decomposition of variance analysis

Morck, Yeung, and Yu (2000) decompose the variation in firm returns across countries into that which is explained by total market variation and that which is firm specific. The extent of variation common to all firms in the market is a measure of market synchronicity. We extend this approach by examining how much of the firm-specific variation within one country is shared by firms within the same industry and firms within the same equity network and individual networks. We find that a share of overall variation is indeed attributable to common effects for equity networks and owner networks. We also find that firms within-director networks also tend to be more synchronous. Including an index of returns for each type of network reduces the firm-specific residuals, improving the overall fit of the regression equation. While we expect some synchronicity between firms with shared ownership due to common cash flow rights, it is more surprising that there is evidence that outside investors find it hard to distinguish between director network-specific and firm-specific information when pricing individual firms' stocks. Variation in returns for a given firm is partly attributable to the effects of equity networks and owner networks and also those of director networks.

One drawback of this approach, and why the pairwise analysis forms the main part of the paper, is that we are forced to reduce the size of our sample in this particular analysis. To enable a sensible comparison of the R^2 output, we only include those firms for which we have an observation for the relevant industry index, as well as for the three network indexes. This means that not only does each firm have to be a part of each of the three types of network, but also each of these networks has to have at least one other firm also present in the sample of 183. For each index we need at least two weeks of data.

This, unfortunately, reduces the data set to only 28 firms, although the returns data for a larger number of firms are included in the calculation of the relevant weekly indexes. Nonetheless, the analysis provides some interesting findings and helps motivate our subsequent analysis using the larger sample.

The benchmark regression equation is

$$r_{i,t} = \alpha_i + \beta_m r_{m,t} + \beta_{SIC} r_{SIC,t} + \varepsilon_{i,t} \quad (4)$$

where $r_{i,t}$ is the return for firm i in week t, α_i can be interpreted as the risk-free cost of capital plus some risk premium, $r_{m,t}$ is the market index for week t, $r_{SIC,t}$ is the relevant industry index for week t, and $\varepsilon_{i,t}$ is the firm-specific residual for week t. To this benchmark ordinary least squares regression we add the index for all other firms in the same equity network and then, in turn, the index for all other firms in the same owner network and director network.

Our focus is on the additional explanatory power provided by each of these index variables. For each regression, we measure

$$R^2 = \frac{\sum_i R_i^2 . SST_i}{\sum_i SST_i} \quad (5)$$

where SST_i is the sum of total variation for each firm, and

$$R_i^2 = \frac{\sigma_{m,i}^2}{\sigma_{m,i}^2 + \sigma_{\varepsilon,i}^2} = \frac{\sum_t (\hat{r}_{i,t} - \overline{r_{i,t}})^2}{\sum_t (\hat{r}_{i,t} - \overline{r_{i,t}})^2 + \sum_t \varepsilon_{i,t}^2}. \quad (6)$$

We expect a significant increase in R^2 once the additional indexes are included in the regression if network effects have explanatory power.

Each of the indexes is calculated as follows: for each firm i, we construct matrices of prices, dividends, and outstanding shares for all firms other than firm i belonging to the same industry or equity network or individual network as firm i. The market value of equity for these firms is then calculated for each week.[5] Returns are weighted for each firm by its market value of equity, and find the weekly return index for the group of firms (using the Center for Research in Security Prices definition of firm returns).

The results of this analysis are as follows. The benchmark R^2 of the regression (when only the market index is included as a dependent variable) is 0.1529, and adding the industry index for each firm increases the R^2 to 0.1767. Almost 18% of total variation in stock price returns is attributable to market and industry effects.

Next, each network index is added to the regression in turn. Including the equity network index, along with the market and industry indexes, produces an R^2 of 0.3104. That is, adding the equity network index almost doubles the extent of return variation explained by the regression for these 28 firms. Including the owner network index composed of the returns of all other firms with at least one owner in common, along with market and industry indexes, leads to an R^2 of 0.3113. Replacing the owner network index with the director network index gives an R^2 of 0.3091. These results suggest that membership of the individual role-based networks explains almost as much variation as does equity network membership.[6]

We next include the equity network index together with each of the individual network indexes in turn. When both the equity network and owner network indexes are included as dependent variables, the R^2 is 0.3778 . The R^2 for the regression including equity networks and director network indexes is 0.3736. Since each of these R^2 values is larger than for each of the individual regressions, the results suggest that both equity networks and individual networks are important factors in explaining variation in returns.

A.4. Pairwise comovement analysis using returns data adjusted for anticipated dividend streams

As mentioned in the Introduction, anticipated future dividend streams from the owned firm to the owning firm can be expected to cause synchronicity in the movement of the firms' stock prices. We expect the returns of firms with equity interlocks to be more synchronous in the absence of any other reason for firm-boundary opacity. Cash flows could well be reallocated efficiently within an internal capital market or be extracted as rents for a controlling shareholder. We want to establish that synchronicity is not due only to the latter effect in our data. We address this issue by examining which pairwise measures are associated with synchronicity, after we have removed returns comovement attributable to expected dividend flows while acknowledging that these flows could in themselves reflect efficient intrafirm coordination of resources. We construct a set of returns measures that strip out the share of each firm's weekly return that is attributable to dividends and denote these adjusted measures $f_{i,j}^a$ and $C_{i,j}^a$.

We base the adjusted pairwise comovement measures on the change in stock price plus dividend that represents the underlying value of each firm's equity. To find the underlying firm returns we appeal to the following logic: In any week, a firm's observed stock price represents the value of a share ownership in the value of the operating assets of that firm, minus all forms of debt, plus the value of the share owned by the firm in the value of the operating assets less the debt of all other firms. It is important to note that the data contain several levels of indirect holdings. The value of both direct and indirect equity holdings is bundled into the returns data for each firm. Our goal is to strip out synchronicity due to all of the equity links.

Algebraically, we note that the total market value of firm i's equity and its debt must equal the value of its operating assets plus the value of the equity it holds (Fedenia, Hodder, and Triantis, 1994):

$$V_{it} + B_{it} = V_{it}^* + \sum_{j \neq i} h_{ijt} V_{j,t} \quad (7)$$

$$V_{it} = (V_{it}^* - B_{it}) + \sum_{j \neq i} h_{ijt} V_{j,t} \quad (8)$$

[5] The market value of equity of firm i in week t is estimated to be: $(price_{i,t} + dividend_{i,t}) * (number\_of\_outstanding\_shares)_{i,t}$.

[6] It is worth recalling that the owner and director networks tend to include fewer firms than the equity pyramids. This may impact how well an index captures the relevant network effects.

The observed total market value of firm i's equity is denoted as $V_{it} = p_{it}N_{it}$ where N_{it} is the number of outstanding shares. B_{it} is the firm's outstanding debt and h_{ijt} is the share of firm j owned by firm i in period t. $(V^*_{it} - B_{it}) = MV_{it}$ is the market value of the underlying assets. Then $MV_{it} = p^*_{it}N_{it}$, where p^*_{it} is the per-share price attributable to the value of the firm's underlying operations minus its debt.

Thus,

$$p_{it}N_{it} = p^*_{it}N_{it} + \sum_{j \neq i} h_{ijt}V_{j,t} \tag{9}$$

$$p_{it}N_{it} = p^*_{it}N_{it} + \sum_{j \neq i} h_{ijt}\left((V^*_{jt} - B_{jt}) + \sum_{k \neq j} h_{ikt}V_{k,t}\right) \tag{10}$$

Substituting in for $V_{j,t}$ gives

$$p_{it}N_{it} = p^*_{it}N_{it} + \sum_{j \neq i} h_{ijt}\left(p^*_{jt}N_{jt} + \sum_{k \neq j} h_{ikt}V_{k,t}\right) \tag{11}$$

and so on.

Solving this equation for p^*_{it} for all i and t gives

$$p^*_{it} = p_{it} - \frac{\sum_{j \neq i} h_{ijt}\left(p^*_{jt}N_{jt} + \sum_{k \neq j} h_{ikt}V_{k,t}\right)}{N_{it}} \tag{12}$$

Since the last term captures the portion of the observed share price that is attributable to both direct and indirect shareholdings in other firms, we need to ensure that the h's used in the above equation are the total shares owned. To this end we use elements of the matrix of *total* shareholdings between firms to calculate the weekly vector of p^*. It can be seen that p^*_j, $j \neq i$ appears in the calculation of p^*_i. For this reason we iterate over p^*_i until there is very little difference between the values of p^*_i produced in each iteration. In this way we ensure that we subtract the value of the underlying operations minus debt of the owned firms, not also the value of that firm's holdings in other firms. This second portion is captured elsewhere since we are using the matrix of direct and indirect holdings. For example, if firm i owns 50% of firm j, and j owns 50% of firm k, i indirectly owns 25% of k. Thus, in our equations, $h_{ij} = 50\%$ and $h_{ik} = 25\%$. When we subtract the fraction of i's share price that is due to its ownership of j, we have to take 50% of the underlying value of j (operations minus debt, $p^*_j N_j$), but if we take 50% of the observed market value of j ($p_j N_j$) we would include the value of the share that j owns in k. Since we are already subtracting the value of i's indirect ownership of k, to include it in the value i owns in j would be double counting. Once we have obtained the adjusted returns, it is straightforward to calculate weekly returns for 1996 in a similar way to that used for the unadjusted returns data.

There are several problems with this methodology—intended to construct returns that represent the underlying value of each firm's operating assets—when applied to our data. It could serve to cloud the very issues we seek to address in the paper. There are firms in the sample that act as holding companies, allocating capital among firms under joint control. Their valuation is based on the shares they hold in other firms. When we strip out the share of their value attributable to the operations of firms they own, their value becomes negative in the adjusted stock price data. This suggests to us that either holding companies trade at a discount or future dividends are not priced efficiently in the market. Both of these suggestions have some grounding in the existing literature. Of course, it also could reflect an expectation of some of the interfirm activities of the type we analyze in the paper.

If the market does not value dividends efficiently, then our adjustment overcompensates for the comovement due to equity holdings. For example, firm i could own a share of j and also experience price changes that are similar in sign to those for j, but smaller in magnitude. A large price increase in firm j in one week, under our adjustment process, could translate into a decrease in the value of firm i's operating assets that same week. Our analysis would now have firms i and j comoving inversely, solely due to the adjustment we have made.

Nonetheless, we repeat all of our analysis using comovement measures adjusted for anticipated dividend flows as described above. Interlocking directorates and membership of the same director network continue to be positively associated with synchronicity, although only significantly so when the count-based measure of comovement, $f^a_{i,j}$, is the dependent variable. Pairwise equity holdings and same equity network membership are now negatively associated with greater synchronicity, suggesting that we have overadjusted for comovement due to dividend flows. The results using the detrended version of the weekly returns data adjusted for equity holdings are given in Table A5.

Table A4

The association between firm-pair ties, network membership, and $f_{i,j}$ and $C_{i,j}$.

This table presents the results of the Tobit analysis using with-trend synchronicity data based on weekly returns data as the dependent variables.

The first row for each dependent variable gives the estimated Tobit coefficient.

The second row for each dependent variable (in italics) gives the percentage of estimates generated under the null hypothesis of no significance that are less than the estimated Tobit coefficient.

If the share of estimated coefficients under the null smaller than the Tobit coefficient is close to 100% (0%), we infer that the variable is significant and positively (negatively) associated with the dependent variable.

To aid interpretation, a significant (at the 10% or lower level) coefficient is shown in bold type.

	1	2	3	4	5	6	7	8
Variable	$f^d_{i,j}$	$C^d_{i,j}$	$f^d_{i,j}$	$C^d_{i,j}$	$f^d_{i,j}$	$C^d_{i,j}$	$f^d_{i,j}$	$C^d_{i,j}$
Total equity holding	0.053	**0.149**					−0.051	0.008
	72.4	*99.0*					*28.4*	*59.0*

Table A4 (*continued*)

	1	2	3	4	5	6	7	8
Variable	$f^d_{i,j}$	$C^d_{i,j}$	$f^d_{i,j}$	$C^d_{i,j}$	$f^d_{i,j}$	$C^d_{i,j}$	$f^d_{i,j}$	$C^d_{i,j}$
Owner overlap, pairwise			**0.164**	**0.212**			−0.065	**−0.191**
			98.6	*100.0*			*32.8*	*3.6*
Director overlap, pairwise					**0.175**	**0.264**	**0.240**	**0.408**
					99.8	*100.0*	*96.2*	*100.0*
Same industry	**0.025**	**0.031**	**0.024**	**0.030**	*0.023*	**0.027**	0.023	**0.027**
	96.4	*99.0*	*95.4*	*97.8*	*94.2*	*96.4*	*93.4*	*96.2*

	1	2	3	4	5	6	7	8
Variable	$f^d_{i,j}$	$C^d_{i,j}$	$f^d_{i,j}$	$C^d_{i,j}$	$f^d_{i,j}$	$C^d_{i,j}$	$f^d_{i,j}$	$C^d_{i,j}$
Same equity network	0.034	**0.065**					0.025	**0.053**
	91.2	*100.0*					*85.6*	*99.2*
Same owner network			0.092	**0.086**			0.033	−0.022
			94.2	*96.8*			*69.8*	*39.0*
Same director network					**0.133**	**0.185**	0.095	**0.154**
					96.6	*100.0*	*89.0*	*99.6*
Same industry	**0.025**	**0.030**	**0.025**	**0.031**	**0.025**	**0.030**	0.024	**0.029**
	97.4	*98.4*	*95.2*	*99.0*	*97.6*	*98.2*	*94.4*	*97.2*

	1	2	3	4	5	6	7	8	9	10	11	12
Variable	$f^d_{i,j}$	$C^d_{i,j}$	$f^d_{i,j}$	$C^d_{i,j}$	$f^d_{i,j}$	$C^d_{i,j}$	$f^d_{i,j}$	$C^d_{i,j}$	$f^d_{i,j}$	$C^d_{i,j}$	$f^d_{i,j}$	$C^d_{i,j}$
Total equity holding			−0.068	−0.030	0.018	**0.123**	−0.052	0.013	0.000	0.080	−0.052	0.008
			25.2	*37.8*	*56.6*	*95.2*	*31.0*	*57.0*	*52.6*	*87.0*	*30.6*	*53.2*
Owner overlap, pairwise	−0.089	−0.227	−0.079	**−0.222**			−0.072	−0.155			−0.064	−0.190
	27.6	*2.4*	*31.0*	*1.6*			*30.2*	*7.2*			*34.2*	*5.4*
Director overlap, pairwise	0.225	0.389	**0.233**	**0.392**			0.237	**0.422**			0.216	**0.399**
	95.4	*100.0*	*95.8*	*100.0*			*94.4*	*100.0*			*92.6*	*100.0*
Same equity network	0.014	0.037	0.017	**0.039**								
	71.2	*95.4*	*72.4*	*95.6*								
Same owner network					0.089	0.066	0.017	−0.076				
					94.8	*94.0*	*57.4*	*15.4*				
Same director network									**0.133**	**0.169**	0.034	0.012
									96.2	*100.0*	*64.8*	*58.6*
Same industry	0.023	0.027	0.023	**0.027**	0.025	**0.030**	0.023	**0.027**	**0.025**	**0.030**	**0.023**	**0.027**
	94.0	*96.6*	*93.8*	*97.4*	*94.4*	*99.0*	*94.6*	*97.2*	*97.4*	*97.6*	*95.0*	*97.0*

Table A5

The association between firm-pair ties, network membership and $f^a_{i,j}$ and $C^a_{i,j}$.

This table presents the results of the Tobit analysis using with-trend synchronicity data based on weekly returns data as the dependent variables.

The first row for each dependent variable gives the estimated Tobit coefficient.

The second row for each dependent variable (in italics) gives the percentage of estimates generated under the null hypothesis of no significance that are less than the estimated Tobit coefficient.

If the share of estimated coefficients under the null smaller than the Tobit coefficient is close to 100% (0%), we infer that the variable is significant and positively (negatively) associated with the dependent variable.

To aid interpretation, a significant (at the 10% or lower level) coefficient is shown in bold type.

	1	2	3	4	5	6	7	8
Variable	$f^d_{i,j}$	$C^d_{i,j}$	$f^d_{i,j}$	$C^d_{i,j}$	$f^d_{i,j}$	$C^d_{i,j}$	$f^d_{i,j}$	$C^d_{i,j}$
Total equity holding	−0.063	−0.067					**−0.121**	−0.145
	17.0	*25.2*					*4.6*	*8.8*
Owner overlap, pairwise			**0.095**	0.141			**−0.223**	−0.060
			95.8	*86.4*			*2.4*	*37.2*
Director overlap, pairwise					**0.100**	0.145	**0.288**	*0.218*
					97.2	*91.8*	*98.8*	*92.4*
Same industry	0.005	−0.069	0.003	**−0.071**	*−0.004*	**−0.080**	−0.005	**−0.079**
	69.4	*5.6*	*58.2*	*4.6*	*35.8*	2.8	*37.8*	4.0

Table A5 (*continued*)

	1	2	3	4	5	6	7	8
Variable	$f^d_{i,j}$	$C^d_{i,j}$	$f^d_{i,j}$	$C^d_{i,j}$	$f^d_{i,j}$	$C^d_{i,j}$	$f^d_{i,j}$	$C^d_{i,j}$
Same equity network	−0.002	0.017					−0.010	0.009
	46.8	*61.4*					*32.2*	*50.4*
Same owner network			0.069	0.135			0.038	0.125
			94.0	*91.8*			*81.2*	*87.6*
Same director network					0.097	0.091	0.084	0.148
					86.8	*84.8*	*93.4*	*58.6*
Same industry	0.005	−0.070	0.004	**−0.071**	0.004	**−0.071**	0.004	**−0.071**
	66.2	*5.6*	*69.2*	*3.0*	*66.8*	*2.8*	*65.2*	*4.4*

	1	2	3	4	5	6	7	8	9	10	11	12
Variable	$f^d_{i,j}$	$C^d_{i,j}$	$f^d_{i,j}$	$C^d_{i,j}$	$f^d_{i,j}$	$C^d_{i,j}$	$f^d_{i,j}$	$C^d_{i,j}$	$f^d_{i,j}$	$C^d_{i,j}$	$f^d_{i,j}$	$C^d_{i,j}$
Total equity holding			−0.109	−0.158	−0.067	−0.113	**−0.121**	−0.146	**−0.111**	−0.113	**−0.124**	−0.145
			8.8	*12.2*	*13.6*	*16.0*	*4.8*	*13.6*	*5.0*	*15.6*	*4.4*	*10.8*
Owner overlap, pairwise	−0.215	−0.068	**−0.215**	−0.068			**−0.221**	−0.087			**−0.216**	−0.060
	2.2	*34.4*	*2.6*	*36.6*			*3.4*	*30.2*			*2.8*	*36.6*
Director overlap, pairwise	0.296	0.210	**0.296**	0.210			**0.289**	0.208			**0.256**	0.218
	100.0	*88.4*	*99.6*	*87.0*			*99.6*	*89.4*			*98.8*	*88.2*
Same equity network	−0.013	0.014	−0.013	0.014								
	26.6	*54.4*	*24.6*	*58.8*								
Same owner network					**0.077**	0.145	−0.004	0.060				
					95.8	*94.0*	*47.4*	*71.0*				
Same director network									**0.115**	0.109	0.041	−0.001
									98.0	*91.2*	*70.6*	*48.6*
Same industry	−0.005	**−0.079**	−0.005	**−0.079**	0.004	−0.070	−0.005	**−0.079**	0.004	**−0.070**	−0.005	**−0.079**
	39.8	3.2	*39.0*	*3.8*	*67.2*	*3.8*	*39.6*	*4.4*	*66.2*	*4.0*	*41.0*	*3.0*

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