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International asset pricing with strategic business groups[1]

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ABSTRACT

Firms in global markets often belong to business groups. We argue that this feature can have a profound influence on international asset pricing. In bad times, business groups may strategically reallocate risk across affiliated firms to protect core "central firms." This strategic behavior induces co-movement among central firms, creating a new intertemporal risk factor. Based on a novel data set of worldwide ownership for 2002–2012, we

can pool firm assets for risk-sharing purposes to diversify idiosyncratic risk, a common goal of group treasury management. This strategy resembles portfolio investments and does not change the systematic risk of affiliated firms.[2]

More interesting is the case in which business groups strategically respond to systematic risk or, more broadly speaking, economic situations that could threaten their control of group assets. A business group will not treat all affiliated firms equally because the failure of some can be much more costly to the ultimate owner of the group than others. Because a business group typically relies on a small number of central firms to control a large number of affiliated firms (e.g., Almeida and Wolfenzon, 2006a, 2006b), a failure of central firms could lead to the loss of ownership of the entire business group. In this case, the business group has incentives to reduce the risks to central firms, particularly in bad times, by allowing them to receive more from the group's reserves. This strategy essentially protects the equity value of central firms by reallocating risk to peripheral firms and resources to central firms.

Our key intuition

the firm's market-to-book value. Following the more recent work of Faccio et al. (2021), we find that centrality buffers the adverse impact of commodity shocks, consistent with central firms being protected from such shocks.

A potential concern with the above evidence is that some omitted variables simultaneously drive firm values and observed shocks in our analysis. Hence, we exploit an exogenous shock induced by sovereign downgrades. Almeida et al. (2017) show that the downgrade of a country's sovereign bonds exhibits a negative impact on firms' cost of financing when their credit rating is pose that international asset pricing can differ profoundly from that in the US market due to the strategic behavior of business groups. Regardless of the set of factors necessary to expand the cross section of stock returns for independent firms, the strategic risk reallocation of business groups (to protect their central firms in bad times) is likely to introduce an additional intertemporal risk factor to shape stock returns in the spirit of Merton (1973).[8]

We build on and extend the literature on business groups and pyramids (Johnson et al., 2000; Bertrand et al., 2002). Whereas existing studies mainly focus on either why pyramids exist or the financing implications thereof, we explore the asset pricing implications of strategic business groups. In doing so, we extend the emerging literature on the asset pricing impact of organizational structure (e.g., Eisfeldt and Papanikolaou, 2013).

Our findings can also be compared with studies on institutional (co-)ownership, as the ultimate owner of business groups can be regarded as a common owner of affiliated firms. Both types of ownership can influence asset prices. The economic channel to influence asset prices, however, differs. Bartram et al. (2015) and Anton and Polk (2014) show that co-ownership of institutional investors can propagate crises and create price contagion in the presence of market frictions such as trading impacts. In contrast, we show that group ownership can affect asset prices by altering risk distribution among affiliated firms.

The remainder of the paper is organized as follows. Section 2 presents the data that we employ and the main variables constructed for the analysis. Section 3 examines whether central firms are strategically protected by business groups. The cross-sectional asset pricing implications of such strategic behavior are discussed in Section 4. Section 5 examines whether a centrality factor should be included in international factor models. Section 6 provides additional tests and robustness checks, and a brief conclusion follows in Section 7.

2. Data and main variables

We first describe the data sources and then explain how we construct our identifiers of business groups and our measures of centrality and the other control variables.

2.1. Ownership data

Data on ownership come from the Orbis database of Bureau van Dijk, covering worldwide privately and publicly listed firms over the period 2001–2013. The centrality data are available for some firms in 2001, but we have comprehensive centrality data only from 2002 to 2012. We start with ownership data on 150,343 unique firms, of which 48,461 are unique publicly listed firms from 134 countries and 101,882 are unique private firms from 190 countries. These firms are held by 535,088 unique shareholders. The type distribution is 4612 insurance companies; 9223 banks, 180,648 industrial firms (all companies that are not banks, financial companies, or insurance companies), 58,566 mutual or pension funds, nominees, trusts, or trustees, 40,117 financial companies, 212,337 single private individuals or families, 3275 foundations or research institutes, 2465 employees, managers, or directors, 1058 private equity firms, 4181 public authorities, states, or governments, 884 venture capital firms, 30 hedge funds, and 17,692 for which type is unidentified.

We use this ownership data to determine the controlled firms (as opposed to noncontrolled or widely held firms) and their ultimate owners. From these, we identify the public and private firms that are affiliated with business groups (as opposed to stand-alone firms) by examining common ultimate ownership. We define a business group as an entity with at least two publicly listed firms (and any number of private firms) that are controlled by the same ultimate owner. A detailed description of the methodology is given in Appendix A. The final sample for our tests has 11,298 publicly listed group-affiliated firms and 5443 business groups from 77 countries (46,483 firm-year observations).

Data on accounting variables come from Bureau van Dijk (especially for the private firms), Datastream/Worldscope, and Compustat. Stock market information is from Datastream/WorldScope. To correctly measure the assets and profitability of each individual-affiliated firm, we need to ensure that the reported figures are not affected by equity stakes held by a firm in other firms. Whenever the reported figures are consolidated or are subject to the equity method, we use the equity stakes from Bureau van Dijk and the accounting information of the held firms to back out the exact amount by which these accounting figures have been (see Almeida et al.,).[9]

2.2. Group ownership structure and centrality of control

We rely on the measure of centrality in Almeida et al. (2011), augmented with the game theoretic method of identifying voting power as adopted in Aminadav and Papaioannou (2020), to introduce our own measure of the importance of a firm for group control, which is referred to as "centrality for group control" or simply "centrality" when appropriate. It is based on the structure of the business group and the value of the equity of affiliated firms.[10]

[8] This effect does not apply to independent firms because firms do not have extra assets to hedge in bad states of the economy (or such assets are very costly to obtain). Instead, independent firms use financial instruments, such as derivatives, to manage risk. See, e.g., Pérez-González and Yun (2013) as a recent example. On the theory side, Kim (2003) provides a model of intertemporal production based on the duality theory of Cochrane (1996). However, there is no strategic asset reallocation in the Kim (2003) model.

[9] That is, recording Firm A's share of Firm B's equity as an asset of Firm A and Firm A's share of Firm B's profits as a source of nonoperating income for Firm A.

[10] Almeida et al. (2011) define centrality as the average decrease in voting rights when a focal firm is excluded from the group. They also use critical control thresholds to compute the voting rights. Our measure adopts the same intuition of inferring the importance of a firm on the counterfactual loss when it is excluded from the group. It differs in computing voting rights. We use the game theoretic method adopted in Aminadav and Papaioannou (2020) based on the Shapley and Shubik (1954) voting power index. The benefit of this method is that, as ex-

We define the centrality of an affiliate firm as the fraction of the entire group's (market) value that the owner loses control over if control of that particular firm is lost. Formally, if by losing control over firm F the ultimate owner of group G loses control over the set of firms G_{-F} (which includes F), then

$$Centrality_F = \frac{1}{Value_{UO}} \sum_{i \in G_{-F}} Value_i, \tag{1}$$

where $Value_i$ is the market value of equity of firm i and $Value_{UO} = \sum_{i \in GroupG} Value_i$ is the sum over the values of all the firms in group G.

By construction, the *Centrality* measure of a firm is a number between zero and one (mathematically, $Centrality_F \in (0, 1]$). The centrality of a particular firm represents the counterfactual loss in group value if the business group loses control over that firm. In other words, a higher value of firm centrality means the ultimate owner would lose a greater portion of the group if control over that firm was lost. For instance, if the ultimate owner loses control of a firm with a centrality of 0.5, he or she would lose control over firms that comprise 50% of the entire group value. A hypothetical example of a business group is shown in Fig. 1. Appendix B further describes how we compute the measure of centrality for this case.

The economic meaning of *Centrality* can perhaps be more clearly demonstrated when we compare it with two traditional types of firms in a business group: top and apex firms. The first is a firm in which the ultimate owner has the highest ownership stake. We define a dummy variable called *E1* that equals one for such a firm and zero otherwise (e.g., Almeida and Wolfenzon, 2006a; Almeida et al., 2011). The second is the firm that is entitled to the highest amount of cash flow rights of the group due to its direct or indirect stake in other group firms, which we capture by another dummy variable, *E2 (*e.g., Bertrand et al., 2002; Bae et al., 2002,).Because *E1* is a traditional proxy for business group control, we use it as an alternative centrality measure for robustness tests. *E2* differs from *E1* due to the separation of control and cash flow rights and is often used by group owners as an extractor to receive tunneled assets (i.e., for the purpose of expropriation).[11] It provides a reasonable measure to examine the role of expropriation or other related cash flow

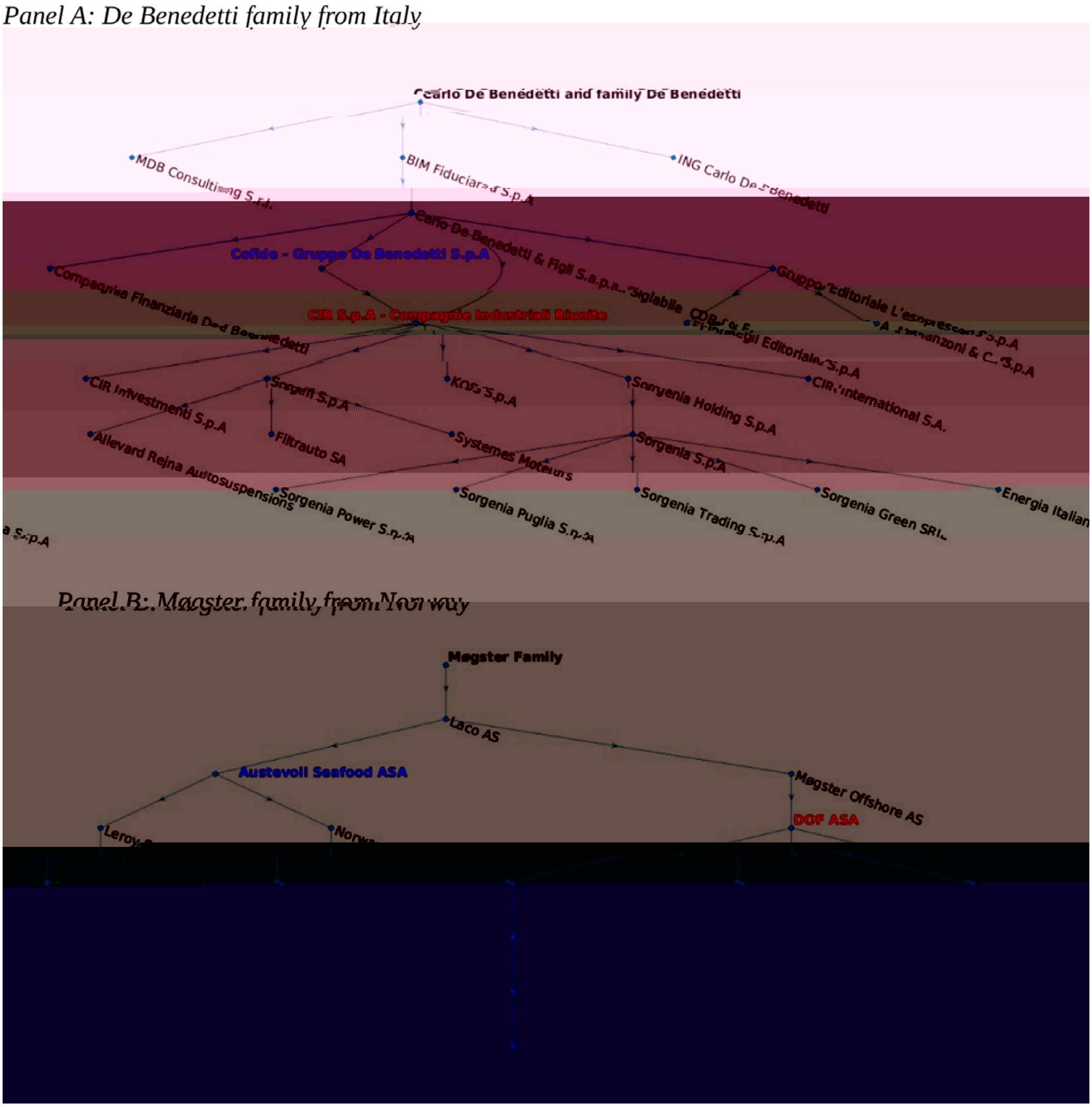

Fig. 2. Two real examples of apex firms versus central firms This figure illustrates two real examples of business groups for which the listed central firm (in red) differs from the listed *E1* and *E2* firms (in blue). In Panel A, the *E1* and *E2* firm is Cofide—Gruppo De Benedetti SpA with ultimate owner direct and indirect cash flow rights (voting rights) of 38% and centrality measure of 20%. The central firm is CIR SpA–Compagnie Industriali Riunite with cash flow rights (voting rights) of 35% and centrality measure of 56%. Even though the firm Cofide is part of the controlling concert of shareholders that controls CIR SpA–Compagnie Industriali Riunite, it is not a critical shareholder for control. The reason is that CIR Spa–Compagnie Industriali Riunite is jointly controlled by two shareholders of the firm Cofide and the firm Carlo de Benedetti & Figli S.a.p.a. Siglabile Cdb & F. Both controlling shareholders are ultimately controlled by the De Benedetti family. If the family losses control over Cofide, it would not lose control over CIR SpA–Compagnie Industriali Riunite as it still holds a stake of 24% via Carlo de Benedetti & Figli S.a.p.a. Siglabile Cdb & F, which allows it to maintain control over CIR Spa–Compagnie Industriali Riunite. Consequently, it would not lose the part of the group that is below CIR SpA–Compagnie Industriali Riunite. This is not the case if the family loses control over CIR SpA–Compagnie Industriali Riunite, when it would lose control over everything below that firm. This explains why CIR SpA–Compagnie Industriali Riunite has a higher centrality than Cofide—Gruppo De Benedetti SpA, even if Cofide—Gruppo De Benedetti SpA has higher cash flow rights and is one of controlling shareholders of CIR SpA–Compagnie Industriali Riunite. In Panel B, the *E1* and *E2* firms are Austevoll Seafood ASA with ultimate owner direct and indirect cash flow rights (voting rights) of 56% and centrality measure of 9%. The central firm is DOF ASA with cash flow rights (voting rights) of 48% and centrality measure of 39%. (For interpretation of the references to color in this figure legend, the reader is referred to the web version of this article.)

Between the two firms, CIR SpA plays a more critical role for the family to control group assets. It subsequently has higher centrality. The other firm, Cofide, has higher cash flow rights because it receives cash flows from the central firm and other firms (and, hence, is

Table 1
Summary statistics.
The table reports the summary statistics for the main variables used in the paper. Panel A shows the mean, standard deviation, 5th, 50th (median) and 95th percentiles, and number of observations for the

Table 2
Sensitivity to shocks.
This table reports the results of how unexpected shocks influence the valuation and returns of central and noncentral firms. In Columns 1–3, we report how yearly industry return on asset (ROA) shocks influence the valuation of central firms. Following Anderson et al. (2012), unexpected industry shock is measured by the residuals of an AR(3) process of industry ROAs. We then regress market-to-book on unexpected industry shock as well as its interaction with *Centrality*. We control for log assets, log number of group firms, and lag capital expenditures, as well as *E1* and *E2*. In Columns 4–6, we report how weekly firm-level commodity shocks influence the idiosyncratic returns of central firms. Following Faccio et al. (2021), we match commodities to industries using a statistical matching method. We then regress the weekly idiosyncratic firm-level stock returns on unexpected commodity shocks as well as its interaction with *Centrality* using a Fama-MacBeth specification. We control for log market value equity, log book-to-market equity, and momentum, measured by past twelve-month stock returns, leaving out the most recent month. ***, **, and * represent the significance level at 1%, 5%, and 10%, respectively, using robust standard errors with *t*-statistics given in parentheses.

Variable	Market-to-book (1)	Market-to-book	Market-to-book (3)	Idiosyncratic return (4)	Idiosyncratic return (5)	Idiosyncratic return (6)
Centrality	0.26***	0.26***	0.23**	−0.17***	−0.16***	−0.08**
	(2.92)	(2.91)	(2.56)	(−3.80)	(−3.49)	(−1.91)
Shock	0.081***	0.11***	0.10***	1.84**	3.15***	2.51***
	(3.27)	(4.03)	(3.78)	(2.21)	(3.07)	(2.55)
Centrality *Shock*		−0.37**	−0.35**		−3.97**	−3.27**
		(−2.45)	(−2.38)		(−2.82)	(−2.27)
Controls	Yes	Yes	Yes	No	No	Yes
Firm fixed effects	Yes	Yes	Yes	–	–	–
Time fixed effects	No		Yes	–	–	–
R-squared	0.011	0.012	0.037	0.012	0.014	0.058
Number of observations	9,405	9,405	9,405	200,127	200,127	200,127

sales). Our results are robust to these alternative measures of unexpected industry shocks.

The results are reported in Columns 1, 2 and 3 of Table 2. Central firms appear to be much less vulnerable to shocks as the interaction term between centrality and industry shock has a significantly negative coefficient. In Model 2, with firm fixed effects, for instance, a one standard deviation increase in centrality could offset approximately 12% of the negative impact (i.e., $\sigma \times \frac{\beta_3}{\beta_1} = 12\%$, where $\sigma = 0.40$ is the magnitude of the one standard deviation change in centrality), and, in the case of both firm and time fixed effects, the effect is around 11%. The economic magnitude estimated from the first model is about the same (though slightly smaller). This observation is consistent with the notion that central firms are highly protected by business groups in bad times. These results should be considered suggestive given the non-normality in the distribution of the centrality variable. While not affecting the results of the portfolio analysis, it may make more difficult the economic interpretation of the results of this section.

To examine how general the protection is, we follow the approach taken by Faccio et al. (2021), who match commodities to industries using a statistical matching method and then regress the weekly idiosyncratic firm-level stock returns on unexpected commodity shocks as well as the interaction of unexpected commodity shocks with business group affiliation. While their goal is to assess the degree by which firms affiliated with business groups are sensitive to shocks, ours is to investigate whether, within business groups, certain firms (the central firms) are less sensitive to shocks. Thus, we interact the unexpected commodity shocks with centrality instead of business group affiliation.

We define shocks for a given firm as unexpected weekly returns of the commodity matched to the firm's industry, as in Faccio et al. (2021).[16] We follow their analysis and adopt a Fama-MacBeth specification and regress idiosyncratic returns, defined as the residual of the firm's weekly returns on the local market return, on shock, centrality, and their interaction.

The results reported in Columns 4–6 show that, again, central firms are much less sensitive to unexpected negative industry shocks. Central firms' returns are less sensitive to industry shocks as the interaction term between centrality and industry shock has a significantly negative coefficient. In Model 5, for instance, a one standard deviation increase in centrality could offset approximately 32% of the negative impact [i.e., 0.40 × (3.15/3.97), where 0.40 is the magnitude of the one standard deviation change in centrality].

In brief, our results show that central firms are protected by business groups in bad times. The message about valuation and default risk is clear. The use of unexpected negative industry shocks could be subject to concerns about a spurious correlation. For instance, if central firms adopt different strategies compared with their industry competitors, then a negative shock to their competitors could directly benefit them.

3.2. *Sensitivity to the exogenous shock of sovereign downgrades*

Sovereign downgrades offer a natural experiment that can help to identify the protection received by central firms in bad times. For example, Almeida et al. (2017) show that a country downgrade has a direct and exogenous impact on companies' (or groups') cost of financing in that

[16] We thank M. Faccio, R. Morck, and M. D. Yavuz for kindly making these data available to us. We use commodity shocks matched using the statistical method.

Table 3
Sensitivity to the exogenous sovereign downgrades.
This table contains linear regression estimates of the differential effect of an exogenous downgrade shock on stock returns between firms with different levels of centrality. The dependent variable is the annual return in year t (in percent). *Bound* is a dummy variable that takes the value of one if a firm has a credit rating equals to or above the sovereign rating in year $t-1$, and *Downgrade* is a dummy variable that takes the value of one if a firm's country rating is downgraded in year t. The control variables are the natural logarithm of firm size, the natural logarithm of book-to-market equity, and leverage. Regressions also include year, country, and business group fixed effects. The sample consists of Wharton Research Data Services FactSet Fundamentals annual fiscal (international) nonfinancial firms in the 2002–2012 period. Robust standard errors clustered by country event are reported in parentheses. ***, **, and * indicate significance at the 1%, 5%, and 10% level, respectively.

Variable	(1)	(2)	(3)	(4)	(5)	(6)
Centrality × *Downgrade* × *Bound*	1.24***	1.20***	1.31***	1.15***	1.67***	1.28***
	(5.84)	(5.70)	(5.57)	(6.18)	(5.63)	(5.01)
Centrality	−0.06	−0.04	−0.04	−0.03	0.01	0.07
	(−1.67)	(−1.29)	(−1.12)	(−1.07)	(0.13)	(0.93)
Downgrade	−0.13	−0.12	0.17	−0.08	0.12	−0.11
	(−1.66)	(−1.67)	(1.04)	(−0.66)	(0.73)	(−0.92)
Bound	0.05	0.04	−0.09*	−0.06	0.02	0.13*
	(0.89)	(0.80)	(−1.93)	(−1.02)	(0.31)	(1.90)
Bound × *Centrality*	0.06	0.06	0.09	0.12*	−0.07	−0.20
	(0.69)	(0.76)	(1.23)	(1.85)	(−0.68)	(−1.52)
Downgrade × *Centrality*	0.04	0.02	−0.04	0.03	−0.01	0.00
	(0.22)	(0.08)	(−0.18)	(0.20)	(−0.03)	(0.02)
Bound × *Downgrade*	−0.62***	−0.59***	−0.71***	−0.63***	−0.88***	−0.54***
	(−6.72)	(−7.25)	(−4.30)	(−4.98)	(−3.13)	(−4.00)
Controls	No	Yes	Yes	Yes	Yes	Yes
Year fixed effects	No	Yes	No	Yes	No	Yes
Country fixed effects	No	No	Yes	Yes	No	Yes
Business group fixed effects	No	No	No	No	Yes	Yes
R-squared	0.52	0.53	0.08	0.57	0.18	0.66
Number of observations	964	964	963	963	842	842

country. We therefore examine whether the downgrade would have a less negative impact on central firms, via a less severe stock price drop than on peripheral firms.

We provide a brief description of the experiment. Details can be found in Almeida et al. (2017). The key intuition is that when a sovereign nation gets downgraded, a firm domiciled therein with a rating higher than the post-downgrade sovereign ceiling (i.e., bound firms) also is downgraded, even when everything about the firm remains the same. In practice, the ratings of bound firms deteriorate after a sovereign downgrade. This introduces a source of exogenous variation into the risk measures of affected firms. Whereas Almeida et al. (2017) focus on a difference-in-differences (DiD) specification to understand the different outcomes of bound firms versus non-bound firms in a downgraded sovereign setting, we use a triple difference specification that measures the differential effect of centrality conditional on this known DiD treatment effect. That is, we want to understand if centrality has a differential effect on a sample of treated firms conditional on an exogenous treatment effect.

The unit of observation for our tests is firm-year. The dependent variable is the annual return in year t (the year after the downgrade event). (Unreported) results using characteristic-adjusted returns and local market adjusted-returns are similar. *Bound* is a dummy variable that takes the value of one if a firm has a credit rating equal to or above the sovereign rating in year $t-1$. *Downgrade* is a dummy variable that takes the value of one if a firm's country rating is downgraded in year t. Our sample of treated firms contains 36 unique firms that experience shocks to their ability to finance over the period 2002–2012 as a result of exogenous downgrades due to sovereign downgrades.[17] The control firms consist of firms in countries with a sovereign downgrade that are not bound by the sovereign ceiling.

The results are presented in Table 3. The coefficient on the interaction term *Bound* × *Downgrade* is negative and significant, confirming that bound firms suffer negative cumulative annual returns after a sovereign downgrade. The coefficient on the triple interaction term *Centrality*× *Downgrade*× *Bound* is positive and significant, suggesting that central firms are insulated from this exogenous shock. The results are robust to the inclusion of control variables and fixed effects at the year, country, and business group level. The effect is also economically significant. For the last model, which controls for the year, country, and business group fixed effects, a one standard deviation increase in centrality absorbs about 90% of the negative price impact of sovereign downgrades (i.e., $\sigma \times \beta_{tripple} \ / \ \beta_{interaction} = 0.40 \times 1.279 \ / \ 0.544 = 94.0\%$). Consistent with our findings in Section 3.1 central firms are strategically protected in bad times.

4. Centrality and the cross-section of stock returns

If business groups strategically protect central firms in bad times, we expect centrality to affect the cross-section of asset prices. This section examines this

Table 4
The return predictability of centrality in Fama-MacBeth regressions.
This table presents the results of univariate and multivariate Fama and MacBeth regressions of monthly firm-level excess returns on firm-level characteristics. The dependent variable in Panel A is the raw return. The dependent variable in Panel B is the Daniel et al. (1997) (DGTW)-adjusted return, which is the raw return minus the return on the corresponding size, book-to-market, and momentum portfolio. ***, **, and * represent the significance level at 1%, 5%, and 10%, respectively, with *t*-statistics given in parentheses.

Panel A: Predicting out-of-sample stock returns

Variable	(1)	(2)	(3)	(4)	(5)	(6)
Centrality						

degree of centrality across all stocks in the prior quarter. Then, we select the stocks with the 25% highest and 25% lowest degree of centrality (i.e., top and bottom quartile, respectively) and group them in high- and low-centrality portfolios.

Second, we sort stocks into high- and low-centrality portfolios using only the most central firm from each business group. We select the most central firm from all business groups with more than two publicly traded companies and then classify these firms into high- and low-centrality portfolios. This between sort aims to further explore the power of centrality by zooming in on the subgroup of most central firms. This subgroup test could help mitigate the concern that central firms could systematically differ from peripheral firms in characteristics (noticeably, size) instead of group control.[18]

Third, we sort stocks into high and low centrality within each group to control for the potential influence of business groups. Here, we take the most and least central firm from each business group and then classify them into high- and low-centrality portfolios. Because the empirical results of the third methodology are very similar to the first, we focus on the first two sorts in the main text and report the returns of the third sort in the Online Appendix (Table OA3).

In all cases, we define the portfolio returns as the equal-weighted average of the stock returns with the highest or lowest centrality. Next, we take the difference between the high-centrality and the low-centrality portfolios. Then, we regress the returns of such portfolios on factors from an international asset pricing model.

The results are reported in Panels A and B of Table 5 for, respectively, the first and second sorting. Across all the specifications and portfolio sorts, we observe a strong negative alpha. For the four-factor model, the high-centrality portfolios deliver 67 bps per month lower risk-adjusted returns than the low-centrality firms in the case of the unconditional sorting. The high minus low performance amounts to 36 bps per month in

Table 5
Portfolio analysis.
This table presents the results of univariate and multivariate regressions of central minus peripheral portfolios returns on common explanatory factors. Panel A contains the results using the central minus peripheral portfolio construction across all firms (overall sort). Panel B contains portfolios constructed using variation between only the most central firms in each group (between sort). All central minus peripheral portfolios are constructed using a one-quarter lag of centrality for which returns are equal weighted. Columns 1–5 of Panels C and D contain results from Panels A and B with additional control variables for the intermediary capital risk factor, the intermediary value-weighted investment return, the change in Volatility Index (VIX), and the change in default spread, respectively. ***, **, and * represent the significance level at 1%, 5%, and 10%, respectively, with *t*-statistics given in parentheses.

Panel A: Performance of high- minus low-centrality portfolios (overall sort)

Factor	(1)	(2)	(3)	(4)
Intercept	−0.57***	−0.72***	−0.71***	−0.67***
	(−2.87)	(−4.88)	(−4.95)	(−4.67)
Market factor		31.57***	30.90***	28.28***
		(10.37)	(10.48)	(8.74)
Size factor			−29.96***	−27.26***
			(−3.50)	(−3.17)
Value factor			19.65**	18.91**
			(2.27)	(2.21)
Momentum factor				−7.36*
				(−1.87)
R-squared	0.00	0.45	0.51	0.53
Number of observations	132	132	132	132

Panel B: Performance of high- minus low-centrality portfolios (between sort)

Factor	(1)	(2)	(3)	(4)
Intercept	−0.36***	−0.37***	−0.39***	−0.36**
	(−2.62)	(−2.69)	(−2.72)	(−2.52)
Market factor		2.49	2.12	0.35
		(0.88)	(0.73)	(0.11)
Size factor			0.08	1.99
			(0.01)	(0.23)
Value factor			5.15	4.39
			(0.60)	(0.51)
Momentum factor				−5.11
				(−1.30)
R-squared	0.00	0.01	0.01	0.02
Number of observations	129	129	129	129

Panel C: Centrality portfolios from Panel A with alternative controls

Factor	(1)	(2)	(3)	(4)	(5)
Intercept	−0.70***	−0.67***	−0.67***	−0.66***	−0.69***
	(−4.76)	(−4.68)	(−4.61)	(−4.60)	(−4.58)
Intermediary capital risk factor	−3.71				−4.17
	(−0.94)				(−0.70)
Intermediary value-weighted investment return		−4.05			−0.32
		(−0.76)			(−0.04)
ΔVIX			−0.02		−0.01
			(−0.47)		(−0.26)
ΔDefault Spread				−0.37	−0.55
				(−0.54)	(−0.76)
Market factor	31.48***	32.64***	26.52***	27.58***	30.18***
	(6.72)	(4.94)	(5.35)	(7.88)	(3.67)
Size factor	−28.31***	−28.67***	−26.75***	−29.14***	−31.04***
	(−3.26)	(−3.25)	(−3.08)	(−3.13)	(−3.15)
Value factor	22.25**	23.26**	19.54**	19.20**	23.82**
	(2.40)	(2.25)	(2.24)	(2.23)	(2.26)
Momentum factor	−9.36**	−9.35*	−7.49*	−7.18*	−9.56**
	(−2.10)	(−1.97)	(−1.89)	(−1.81)	(−2.00)
R-squared	0.53	0.53	0.53	0.53	0.53
Number of observations	132	132	132	132	132

(*continued on next page*)

Table 5
(*continued*)

Panel D: Centrality portfolios from Panel B with alternative controls

Factor	(1)	(2)	(3)	(4)	(5)

Table 6
Model comparisons.
This table contains pairwise tests of equality of the squared Sharpe ratios of nine asset pricing models. The models are the capital asset pricing model (CAPM) (MKT), the Fama and French (1993) three-factor

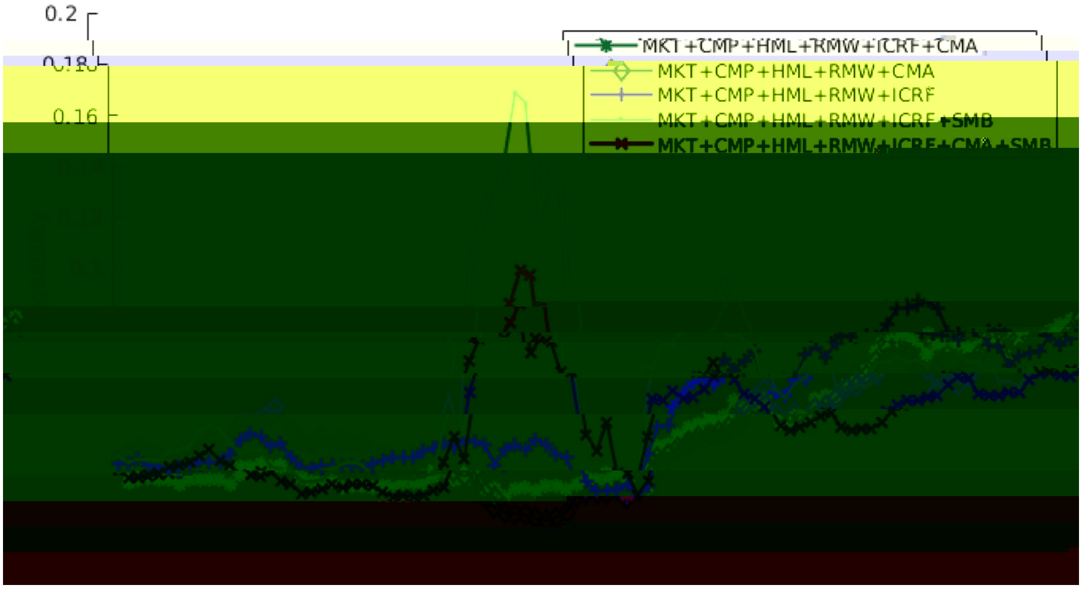

Fig. 3. Model probabilities. This figure presents the results of the time series of posterior model probabilities for the five models with highest probability (ranked at the end of the sample). The sample periods are recursive, beginning in January 2004 and ending each month up to December 2012. We require a minimum of three years of data. Models are based on a set of seven factors. The factors include the five factors of Fama and French (2012) (MKT = market, HML = high minus low book-to-market, SMB = small minus big size, CMA = conservative minus aggressive investment, RMW = robust minus weak profitability), the Carhart (1997) momentum factor (WML = winner minus loser), the He et al., 2017 intermediary capital risk factor (ICRF), and our centrality factor (CMP = central minus peripheral). The probabilities are calculated using the method of Barillas and Shanken (2018) with an alternative prior on the nuisance parameters, as suggested by Chib et al. (2020).

Table 7
Relation with different states of the economy.
This table presents results of multivariate Fama and MacBeth regressions of monthly firm-level excess returns on firm-level characteristics split by above and below median levels of uncertainty. Columns 1 and 2 contain results for the Volatility Index (VIX). Columns 3 and 4 contain results for the default spread. Columns 5 and 6 contain results for high and low intermediary capital ratio defined as the end-of-period ratio of total market capitalization to (total market cap + book assets - book equity) of Federal Reserve Bank of New York primary dealers' publicly traded holding companies. Columns 7 and 8 contain results for high and low intermediary investment return, which is the value-weighted investment return to a portfolio of NY Fed primary dealers' publicly traded holding companies. ***, **, and * represent the significance level at 1%, 5%, and 10%, respectively, with *t*-statistics given in parentheses.

	VIX		Default spread		Intermediary capital ratio		Intermediary investment return	
Variable	High (1)	Low (2)	High (3)	Low (4)	High (5)	Low (6)	High (7)	Low (8)
Centrality	−0.79***	0.06	−0.51***	−0.22	−0.20	−0.53***	0.02	−0.75***
	(−4.44)	(0.29)	(−2.71)	(−1.14)	(−1.04)	(−2.83)	(0.12)	(−3.82)
Log market value of equity	−0.11*	−0.02	−0.07	−0.05	−0.09	−0.04	0.09*	−0.22***
	(−1.94)	(−0.41)	(−1.33)	(−1.10)	(−1.64)	(−0.75)	(1.78)	(−4.29)
Log book-to-market	0.21	0.56***	0.25	0.52***	0.74***	0.03	0.67***	0.09
	(1.23)	(4.90)	(1.52)	(4.16)	(5.45)	(0.21)	(5.18)	(0.61)
Momentum	−0.89	0.91***	−0.92	0.94***	1.06**	−1.05	−1.34	1.36***
	(−0.97)	(3.13)	(−1.00)	(3.63)	(2.61)	(−1.21)	(−1.56)	(3.44)
Lag return	−4.30**	−1.30	−5.35***	−0.25	−2.09*	−3.51**	−5.18***	−0.41
	(−2.56)	(−1.27)	(−3.14)	(−0.27)	(−1.67)	(−2.29)	(−3.24)	(−0.38)
R-squared	0.06	0.04	0.06	0.04	0.05	0.05	0.05	0.04
Number of observations	147,359	144,877	145,674	146,562	128,270	163,966	143,013	149,223

ods of high (low) uncertainty if VIX and default spread are above (below) their median values. Models 1 and 2 show that the negative risk premium of centrality is more prominent in such high uncertainty periods. For instance, during periods of high VIX (default spread), a one standard deviation increase in centrality is related to 31 (21) bps lower returns, in contrast to the analogous effect of just 2 (−6) bps during low VIX (default spread) periods.

Furthermore, high external funding uncertainty can enhance the importance of internal resource reallocation in protecting group control. We follow He et al. (2017) in using two measures of intermediary capital to proxy for funding uncertainty: the end-of-period ratio of total market capitalization to total assets (measured as total market cap + book assets − book equity) of Federal Reserve Bank of New York primary dealers' publicly traded holding companies and the value-weighted investment return on a portfolio of NY Fed primary dealers' publicly traded holding companies. We find consistent empirical results when we split the sample at above and below median values of the intermediary capital measures. A one standard deviation increase in centrality is related to 17 (29) bps lower expected return in periods with low intermediary capital (low intermediary investment return), compared with the effect of −10 (2) bps when the opposite market funding conditions prevail.

Collectively, these results suggest that the negative risk premium of centrality reflects the strategic behavior of business groups, which lends support to the notion that centrality represents an intertemporal risk factor in the global market. These state variables of uncertainty do not absorb the asset pricing impact of centrality in the cross section. Hence, they provide coarse information about bad states to induce more intertemporal hedging but are not the main target of business groups in conducting strategic resource reallocation.

6.2. The influence of top and apex firms: group control versus expropriation

Thus far, we have focused on the asset pricing implications of the strategic incentives of business groups to protect their central firms. Two issues remain to pin down this economic interpretation. First, if the protection of group control is the main economic incentive for strategic reallocation, our results should be robust using alternative measures of group control. Second, a further consideration, given that the sophisticated organizational structure of business groups also could allow ultimate owners to tunnel assets from peripheral to core firms, is whether the effects could be related to, if not driven by, the expropriation incentives of affiliated firms and business groups.

To explore the potential difference between group control and expropriation, we can resort to the traditional definitions of "top" and "apex" firms in the literature (e.g., Bertrand et al., 2002; Almeida and Wolfenzon, 2006a). As discussed in Section 2 top or *E1* firms are those in which the ultimate owner has the highest stake. Although these firms may not be as closely related to the strategic incentives of business group owners as centrality, they provide a reasonable alternative measure to test group control–motivated strategic behavior. In contrast, *E2* firms are extractors used by group owners for expropriation, i.e., to receive tunneled assets and cash flows. The potential return impacts of these two variables can shed further light on the economic ground of our findings.

We revisit the cross-sectional return predictability test as reported in Table 4 by replacing centrality with *E1* and *E2*. Because both variables are dummies and may not be directly comparable with our (continuous) centrality measure, we also construct a centrality dummy to gauge our interpretation. The centrality dummy takes the value of one if a firm has the highest centrality in the business group. In other words, the centrality dummy identifies firms that business group owners have the highest incentives to protect in bad states. Consistent with the notion that central firms can differ from *E1* and *E2*, out of 17,120 business group-year observations around the world between 2002 and 2012, the most central firm in the group differs from *E1* in 3938 cases and from *E2* in 9073 cases.

The results of the Fama-MacBeth return predictability tests are presented in Table 8. When used alone (i.e., Models 1 and 3), both *E1* and the centrality dummy variable predict returns. The magnitude of the effects for the centrality dummy is larger, consistent with our

Table 8
Alternative measures.
This table presents results of multivariate Fama and MacBeth regressions of monthly firm-level excess returns on firm-level characteristics and alternative measures for centrality. *E1* is a dummy variable for highest stake of ultimate owner that equals one for such a firm and zero otherwise. *E2* is a dummy variable for highest cash flow rights that equals one if a firm is responsible for the highest amount of cash flows or value of the group and zero otherwise. *Centrality Dummy* is a dummy that is equal to one if a firm has the highest centrality in the group. The dependent variable is the raw return. ***, **, and * represent the significance level at 1%, 5% and 10%, respectively, with *t*-statistics given in parentheses.

Variable	(1)	(2)	(3)	(4)	(5)	(6)
E1	−0.40***			−0.29**		
	(−2.99)			(−2.56)		
E2		−0.06			−0.06	
		(−1.09)			(−1.12)	
Centrality Dummy			−0.69***			−0.59***
			(−6.07)			(−6.14)
Controls	No	No	No	Yes	Yes	Yes
R-squared	0.01	0.01	0.00	0.05	0.05	0.05
Number of observations	292,236	292,236	292,236	292,236	292,236	292,236

Table 9
Idiosyncratic volatility and centrality.
This table reports the results of regressing yearly estimated *Idiosyncratic volatility* on lagged centrality and control variables. In Columns 1–4, we control for serial correlation and heteroskedasticity using the Huber-White sandwich estimator (clustered by group-level identifier) for the standard errors on the coefficient estimates. In Column 5, we report the results using the Fama-MacBeth methodology with heteroskedasticity and autocorrelation consistent Newey and West (1987) standard error estimates with four periods lags. ***, **, and * represent the significance level at 1%, 5%, and 10%, respectively, with *t*-statistics given in parentheses.

	(1)	(2)	(3)	(4)	(5)
Variable					
Centrality	−0.06***	−0.11***	−0.03***	−0.03***	−0.04***
	(−16.92)	(−28.64)	(−6.12)	(−4.87)	(−6.33)
E2			0.00	0.00	−0.00
			(0.65)	(0.44)	(−0.76)
Ownership stake of the ultimate owner			−0.01	−0.01*	0.00
			(−1.24)	(−1.87)	(0.53)
Log assets			−0.03***	−0.01***	−0.03***
			(−23.30)	(−3.48)	(−24.51)
Leverage			0.06***	0.06***	0.05***
			(7.43)	(5.63)	(7.51)
Mean monthly return last year			0.05***	0.07***	0.07***
			(2.86)	(4.81)	(3.08)
Log age			−0.01***	−0.01***	−0.01***
			(−7.72)	(−4.12)	(−4.01)
Market-to-book			−0.01***	−0.00***	−0.00***
			(−7.93)	(−6.04)	(−3.53)
Listed on NYSE			−0.00	0.00	−0.01
			(−0.29)	(0.00)	(−1.06)
Log group total book value			−0.01	−0.01***	−0.00
			(−1.59)	(−2.72)	(−0.30)
Log number of group firms			0.00	0.00*	−0.01
			(0.12)	(1.78)	(−1.05)
Time fixed effects	Yes	Yes	Yes	Yes	No
Industry fixed effects	No	No	Yes	No	Yes
Country fixed effects	No	No	Yes	No	Yes
Group fixed effects	No	Yes	Yes	No	Yes
Firm fixed effects	No	No	No	Yes	No
R-squared	0.08	0.41	0.55	0.16	0.77
Number of observations	51,837	51,837	30,437	30,437	30,437

ject to debate, this result complements our main analysis in suggesting that business groups strategically protect central firms against major risk.

7. Conclusion

Our paper has explored the idea that the strategic behavior of business group ultimate owners in global markets could create a new intertemporal risk factor in the cross section of asset prices. We show that the position of a firm within a business group is important. Central firms play a crucial role in allowing the ultimate owner to control a large share of the entire group. When their control is under threat, business group owners can strategically reallocate group assets to protect central firms in retaining control, thus changing the risk profile of these firms. The ensuing investor hedging demand induces co-movement among central firms and creates a new intertemporal risk factor.

Using a novel data set of worldwide ownership for 2002–2012, we show that central firms are better protected in bad times. We also find lower expected returns for these firms. Overall, centrality helps to explain the cross section of stock returns in the international market, thereby augmenting the explanatory power of traditional models.

Our results suggest that international asset pricing fundamentally differs from that in the US in the presence of strategic business groups. The more complex organizational structure of business groups in the global market allows them to strategically redistribute risk across affiliated firms, which gives rise to a new intertemporal risk factor. They serve to underline the need to pay more attention to the potential influence of strategic behavior by firm owners on asset pricing in the global market.

Supplementary materials

Supplementary material associated with this article can be found, in the online version, at doi:10.1016/j.jfineco.2021.09.002.

Appendix A. Identifying control relations

Our proxy relies on the weighted voting games theoretical framework and the Shapley and Shubik (1954) and Banzhaf power indices measures to determine control rights, as well as on the idea that the level of holdings required to achieve direct control is firm-specific and structure-dependent and cannot be based on a simple 10–20% cutoff rule. The method was first suggested by Aminadav et al. (2011). By simultaneously analyzing both the firm-specific ownership the corporate network in which the firm is embedded, this method provides a refined alternative to traditionally used tests, i.e., with more precise and distinctive identification of corporate controllers in complex ownership structures. One of these tests is a widely used weakest-link principle (WLP) (Berle and Means, 1932; La Porta et al., 1999; Claessens et al., 2002; Faccio and Lang, 2002).

The Shapley-Shubik power index is interpreted as a prior estimate of a voter's expected relative share in a fixed prize available to the winning coalition as a measure of voting power. Intuitively, for the calculation of this index, we assume that, whenever a vote takes place, shareholders join a coalition in a particular order according to their preferences from the strongest supporter to the fiercest objector. A pivotal shareholder for a given ordering is the member whose joining turns a developing coalition from a losing coalition into a winning coalition.

Denote $[q; w_1, \ldots, w_n]$, where q and $w_1, \ldots, w_n$ are non-negative real numbers satisfying

$0 < q \leq \sum_{i \in N} w_i$. w_i can be thought of as the fraction of voting rights, or weight, of shareholder i in the set $N\{1, \ldots, n\}$ of the direct shareholders in a specific firm and q as the threshold, or quota, needed for a coalition to win the game by passing the decision they support in that firm. Thus, $[q; w_1$ . . () / Δ . . o o

In the next stage, we consider concerts of shareholders as one voter, i.e., a bloc whose weight is equal to the sum of the weights of its members. Thus, *Firm characteristics*

Age in years since incorporation—Current year minus year of incorporation.

Idiosyncratic volatility—Sum of squared errors (scaled by total return volatility) from the regression model:

$$R_{i,t} = \alpha + \beta_1 R_{LocalM,t} + \beta_2 R_{GlobalM,t} + \beta_3 R_{I,t} + \beta_4 R_{G,t} + \epsilon_{i,t},$$

where R_i

and Austevoll Seafood ASA for the Møgster family. The firms that guarantee the two families the control of most of their groups are CIR SpA—Compagnie Industriali Riunite for the Carlo De Benedetti family and DOF ASA for the Møgster family. The separate identification of the central firms helps to distinguish the value of control from the value of cash flows that a firm is entitled to.

This issue has been rarely addressed, as the sheer complexity of identifying the controlling entities in the corporate ownership network, wading through the complicated maze of links among private and public companies, and constructing the complete structure of the business groups has made this task very difficult.

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