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Abstract

In our contribution we study how the ownership channel affects the stock price volatility of listed stock markets. In particular, we study how a linkage between a parent company and its affiliates may drive differences in stock price volatility, within and across countries. We exploit a worldwide dataset of stock-exchange listed firms, controlling for several financial dimensions, to assess whether business groups matter to financial volatility. The answer is positive and does not depend on the definition of volatility used. Our results contribute to the corporate finance literature by defining the role of multinational corporate control in financial markets, and to the financial stability literature by assessing corporate control as an undiscovered channel of transmission for financial shocks.

Keywords: corporate control, stock price volatility, multilevel model.

Jel codes: F23, G32.

1 Introduction

One relevant question, for financial stability purposes, regards the volatility and the shock transmission of financial markets. This is the phenomenon by which a stock market subject to a period of high volatility can cause the same instability to spread to other markets. On exchange-traded markets, the volatility of stock prices has been studied through many channels: none of them is related to the ownership structure of the firms issuing the shares, namely parent and affiliate firms, or stand-alone firms. Nonetheless, as stated by Altomonte and Rungi (2013), Multinational Enterprises (MNEs) contribute to a large portion of world-wide added value through the establishment of hierarchies of firms. Therefore, it is credible that there is a potential for multinationals to act as a channel for economic shocks, as intented by Desai and Foley (2006). To the best of our knowledge, what is missing in the literature is a bridge linking multinational companies and business groups to the share price volatility, if such a bridge does exist. With this study, we aim to fill the gap. We find that a connection exists, affiliates have a different behaviour on listed markets compared to their parent, and a business group behavior is well defined also on financial markets. We infer that the existence of such a relationship on financial markets discounts the investors credence that the business group internal strategy and information are passed quickly through the property channel, that goes beyond the nationalities of the companies constituting the business group.

Hierarchies of firms are groups made of a parent and its affiliates, which have a formally autonomous legal status. Among them, a corporate control linkage is established for the joint

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management of productive activities. Both a parent and some of its affiliates may quote some financial activities on stock exchanges. We study how such linkages may affect price volatility across firms that are part of the same hierarchy, possibly crossing national borders. This is particularly relevant in the case of multinational enterprises, when one or more affiliates are located in a country different from the country of the parent company. It is reasonable to assume that shocks occurring within a hierarchy of firms can be transmitted:

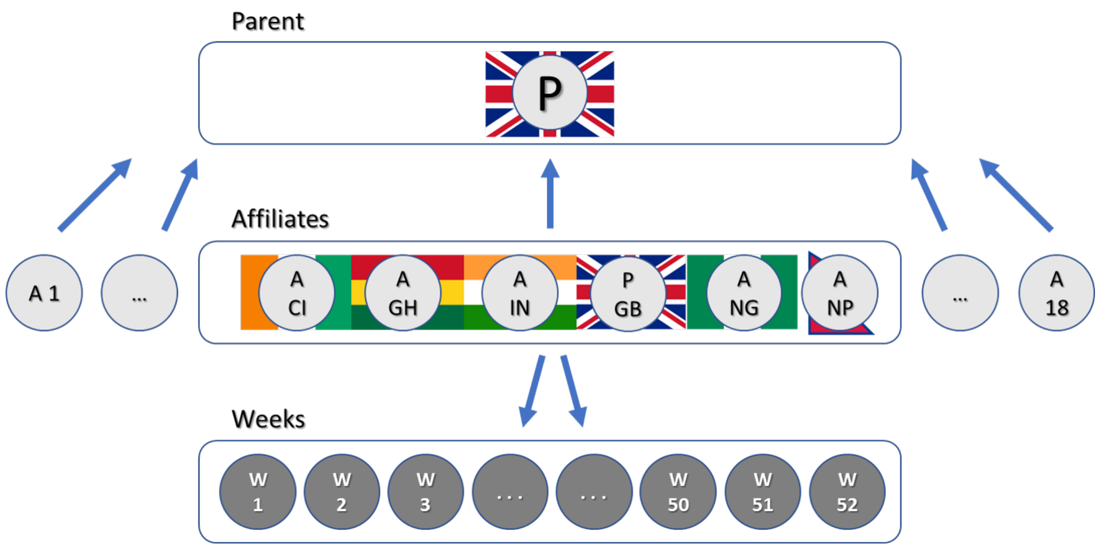
i. in the same country, across firms, when the group is domestic;

ii. across countries, across firms, when the group is multinational.

We find that corporate control matters. Affiliates reveal less volatility than their parent companies in weekly prices of financial activities quoted on the stock exchange. Moreover, after introducing an empirical three-level model for explaining observed variance, we find that there is less variance at a group level than across firms and time. That is, price activities show a narrower range of volatility when a hierarchy of firms is established. We argue that this is likely due to information on the common fundamentals that is passed to investors when they consider all the firms as a unique entity. In this framework, a shock occurring in one affiliate can pass to its co-affiliates faster, within one country in case of a domestic group, and across countries, in the case of MNEs.

Our findings are robust to different metrics of volatility and empirical methodologies. They point to a necessity to include control linkages when evaluating the prices of financial activities of firms belonging to the same corporate entity, albeit formally autonomous from a legal point of view. Take the case of Unilever PLC, located in U.K., with 281 subsidiaries and six branch locations recorded worldwide. Our dataset catches the parent company and five of its affiliates, issuing ordinary shares. Parent shares have GBP currency, while the listed affiliates, located in Ivory Coast, Ghana, India, Nigeria, Nepal trade with XOF, GHS, INR, NGN, NPR currencies respectively. For each of them, as for the rest of firms of the dataset, we observe the share price of 52 weeks. It must be noted that those prices vary across both weeks and firms: we choose not to aggregate in any way the *a priori* variability stemming from the data, not to lose their informativeness.

Figure 1: Example: the hierarchical structure of Unilever PLC



The contribution proceeds as follows: in section 2 some related works are introduced. In section 3 the data are described. Some descriptive statistics, the construction of the financial covariates and the observed preliminary evidence are also provided. In section 4 the methodology is explained. In section 5 the empirical results can be found and section 6 concludes.

2 Literature review

Not many papers questions whether corporate control and business groups matter to financial markets. Restricting the focus on MNEs, one is Choi and Jiang (2009) relative to the smoothing role of operational hedging for the exchange risk. The authors find that MNEs, compared to propensity-score matched non-multinational enterprises, are less exposed to exchange risk and have higher stock returns, thanks to operational hedging. While this paper focuses on the side of business performance and risk, Aggarwal and Kyaw (2010) assess the positive role of the firm's multinationality on its capital structure: they find that multinational companies, compared to domestic companies, have significantly lower debt ratios, with such debt ratios decreasing with increasing multinationality. Keeping in mind that the static trade-off theory predicts an optimal capital structure of the firm (the debt/equity ratio that optimizes its value) the latter finding entails that either all MNEs have a different debt/equity target from domestic companies, or multinationality becomes a discriminant towards the preference for a pecking order theory rather than a static trade-off theory[1]: this could be indeed the case because of an asymmetry of information while acquiring external financing, evidenced by the structure of MNEs, between the inside and the outside group information available to investors. The question is now if this asymmetric information evidenced by MNEs does really depend on MNEs multinationality or if it depends just on its business structure. To this purpose, one could ask whether affiliates' multinationality facilitates corporate control: an evidence according to Sturgess (2016), global diversification premium is positively related to "winner-picking" transfers in internal capital market. For how it regards internal capital market, MNEs result to employ internal capital markets opportunistically to overcome imperfections in external capital markets according Desai, Foley, and Hines (2004) and Desai, Foley, and Hines Jr (2005); Foley and Manova (2015) posits that financial frictions and the use of internal capital markets shape decisions that multinationals make regarding production locations, integration, and corporate governance. Desai, Foley, and Forbes (2008) provides evidence that multinational affiliates also access parent equity when local firms are most constrained. This is the case also for domestic firms: Cai et al. (2016) empirical results on Chinese firms show that group affiliation decreases cash holdings, alleviating the agency costs due to free-cash-flow problem of undertaking low profitable investments[2]. A similar explanation for the use of subsidiaries and internal capital market is that firms use nonguaranteed subsidiary debt as a mean to control the wastage of free cash flows in their cash cows without inducing underinvestment in their growth divisions, according to Kolasinski (2009). Summing up, this literature seems to originate the necessity for a corporate control either from agency problems and informational asymmetry, or from financial frictions and imperfections in capital markets. Baker, Stein, and Wurgler (2003) provides a useful linkage between stock prices and the firm's need of external equity: they find that stock prices have a stronger impact on the investment of firms that need external equity to finance marginal investments. Gul, Kim, and Qiu (2010) suggests that active trading enhances the incorporation of firm-specific information into stock prices, and Gârleanu, Panageas, and Yu (2015) states that the market is subject to contagion: an adverse shock to investors in some locations affects prices everywhere, because small changes in market-access costs can cause a

1. For a review on this topic, see Myers and Majluf (1984), De Haan and Hinloopen (2003), and Shyam-Sunder and Myers (1999).

2. On agency costs and the free-cash-flow problem, see Jensen and Meckling (1976).

change in the type of equilibrium, leading to discontinuous price changes. From a macroeconomic perspective, not only there is no strong evidence that group-level firms are better insured against times of adverse macroeconomic shocks (see Khanna and Yafeh (2005)), but full integration of global financial markets may be not very desirable for financial stability, as risks were spread around the world: even if financial globalization provides a reduction in transaction costs and boosts both trade and foreign direct investment, the price is in terms of more exposure of the real economy to financial shocks; international linkages can propagate economic shocks and rise the default probabilities of firms from different areas (see Stiglitz (2010), Poelhekke (2016) and Al-Haschimi et al. (2014) respectively). Increased connectivity among firms plays a role in financial stability: Desai and Foley (2006) claim is that "multinationals act as a channel of economic shocks: high correlations of country-wide returns and investment within multinational firms suggest that shocks that occur in one part of the world may be transmitted across borders because of a multinational firm's world-wide network of subsidiaries". Eden (2017) shows that financial integration amplifies shocks in relatively distorted economies; Cravino and Levchenko (2016) assessed a non-negligible impact of foreign shocks on productivity shocks, transmitted by all foreign multinationals combined; Giovanni and Levchenko (2009) study the mechanisms through which output volatility (the volatility of aggregate output growth) is related to trade openness, with sectors more open to international trade being more volatile. So, even if business groups have been studied from both a micro and a macroeconomic perspective, there are still some open questions such as: do markets and investor recognize that it exists a group-level financial volatility? Are business groups trying to minimize their financial volatility using their subsidiaries? Vice versa are increasing business groups becoming themselves sources of financial instability, by bringing more connections into the world-wide financial system?

3 Data construction and preliminary evidence

The dataset can be broadly described as consisting of two main components: a static and a time-dependent part. The parent-affiliates dataset includes all financial information of parent, affiliates and stand-alone companies; it is relative to the year 2013 and retrieved from Orbis. The 52-weeks addendum sourced from Bloomberg links the firm's share prices to each firm with its kit of corporate information. A parent company is a firm that owns more than 50% equity of another company, the "affiliate", in respect to which it will become the "parent". An affiliate is thus a firm having at least (and exactly) one parent company. In our dataset only listed firms are included: all non-listed affiliates of the parent companies are excluded from the dataset. The set of all affiliate with their uniquely defined parent is what we call a business group. A stand-alone firm is a company with no parent. The world-wide dataset that takes into account the volatility measure consists of $43'374$ firms: $26'644$ parent, $2'638$ affiliates and $14'092$ stand-alone[3] firms. The average number of affiliates per parent is 1.88, with peaks of 64 and 131 affiliates per parent at the 95% and at the 99% frequency percentile respectively. Table 1 shows the regional distribution of firms into the dataset split by parent, affiliate, and stand-alone firms. The most populated regions of the final dataset are the U.S.A., the E.U., and China, followed by Asiatic and Indian regions, Japan and Canada. The number of affiliates is relevant even though less than parent companies.

It could be the case of financial volatility being dependent on the firm structure main indicators rather than the business structure of the group. We assess the dependence of volatility from several financial variables of the firms that account for the firm's structure, productivity, financial leverage, and credit constraint. We construct four indicators: *financial assets* and *fixed*

3. See data appendix A for details on the data and on the financial variables constructed.

Table 1: Geographic coverage by type of firm

Region	Affiliates	Parent	Stand-alone	Total
Africa	97	431	143	671
Asia - other	418	1'965	2'031	4'414
Canada	191	1'835	1'057	3'083
Central America	76	630	197	903
China	158	3'536	907	4'601
Europe - EU	526	5'260	1'825	7'611
Europe - Non EU	27	348	32	407
India	177	1'024	2'570	3'771
Japan	262	2'654	551	3'467
Korea	86	658	987	1'731
Middle East	232	1'083	917	2'232
Oceania	43	1'338	243	1'624
Russia	69	121	24	214
South America	146	325	139	610
USA	130	5'436	2'469	8'035
Total	2'638	26'644	14'092	43'374

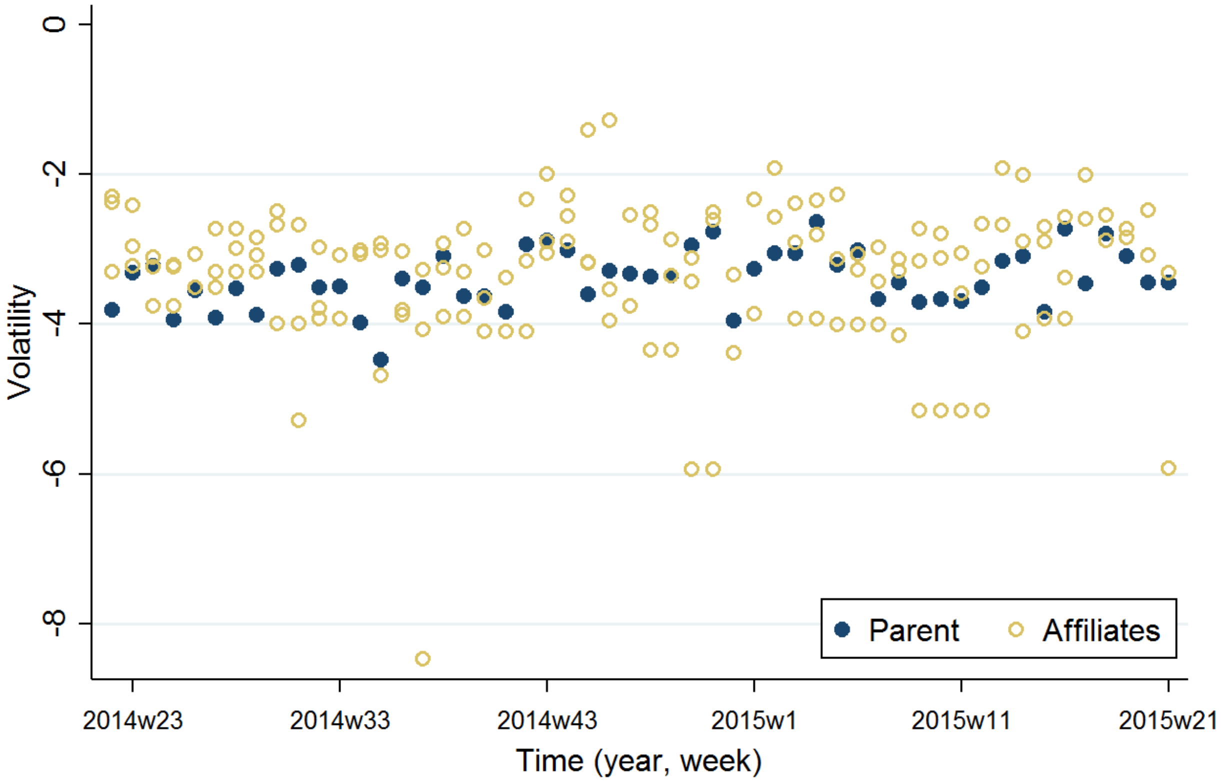
The most populated regions of the final dataset are the U.S.A., the E.U., and China, followed by Asiatic and Indian regions, Japan and Canada. The number of affiliates is relevant even though less than parent companies.

assets retrieved from the *Asset* side and *equity/debt* and *long/short* term debt from the *Liability* side of the balance sheet. *Financial assets* approximates the relevance of financial activity *vis à vis* the productive activity. This ratio provides a control for financial share price volatility by revealing the percentage of financial expenditure in financial investments over the characteristic activity of the firm. The percentage *fixed assets* of total assets monitors the investment decisions as a way to improve productivity. The inverse of the leverage ratio *equity/debt* is intended to capture a premium of not recurring to external funding and at the same time it can reveal the health status of the firm, since highly indebted or less capitalized firms are likely to be less resilient during crisis time. The maturity composition of financial sources reflected by long term debt over short term debt ratio provides an insight into the financing choice of the firm: e.g., a high amount of short term debt compared to long term debt may indicate suffering financing needs. We consider also the indicators of *labour productivity* and *financial pressure*. The latter, defined similarly to the borrowing ratio of Nickell and Nicolitsas (1999), is used to assess the premium on borrowing costs and the probability of credit being rationed. In the post-estimation of section 5.3, we use the *Tobin's q* to assess the dependence of the estimated parameter for the parent on its investment opportunities.

Volatility is defined as the logrange between maximum and minimum price in a fixed amount of time; for the purposes of this article, that amount of time corresponds to a week. The measure defines a dispersion of the price fluctuations around the traded stock price; the exact definition of volatility is reminded to formula 4 of section 4.1. Volatility values are negative and in line with the results of mean estimation of Alizadeh, Brandt, and Diebold (2002) that they obtain via Monte Carlo simulation.

Figure 2 plots the volatility values for Unilever PLC and its affiliates and helps depicting what we are going to assess. In blue, we can distinguish the behaviour of the parent company

Figure 2: Volatility of Unilever PLC and its listed affiliates



The behaviour of the parent company (blue) and its affiliates (amber) over one year. The parent seems to dictate a trend to its affiliates.

over one year. It seems clearly to represent a trend for its affiliates, even though the latter show a more widespread volatility. If every parent company with its affiliates were like this case, the chart would tell the following:

1. the business group listed affiliates show a group behaviour in terms of volatility, of which the parent seems to dictate the trend;

2. the affiliates behaviour is clearly discernible from the parent one and adds variability;

3. the group structure does not decompose or disappear through the weeks, even though some outliers.

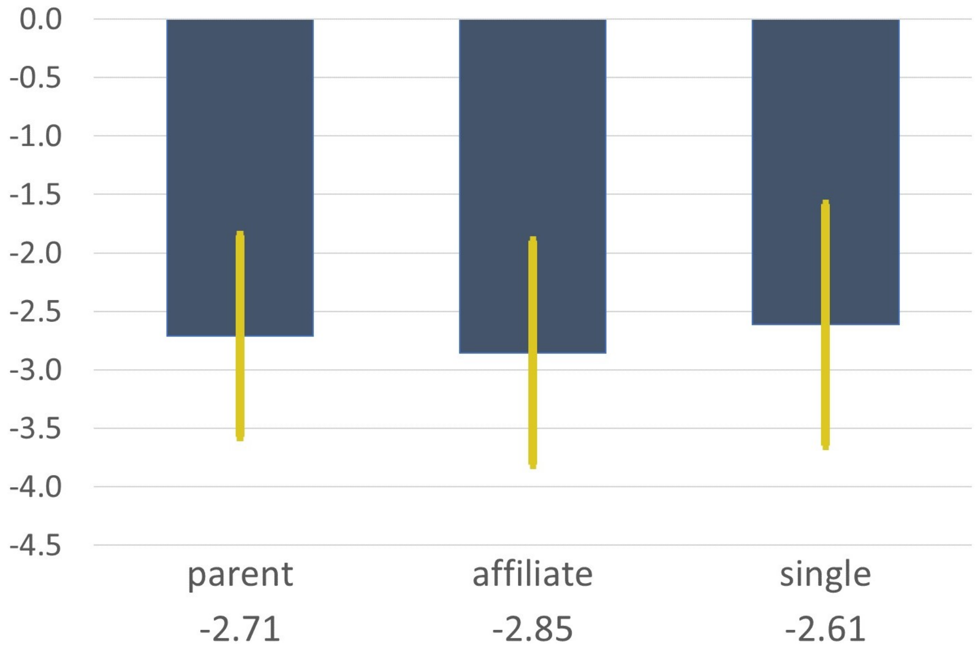
The first item postulates the existence of a group-level decision taking able to influence investors on the stock markets. This is likely due to information on the common fundamentals that reaches investors considering the business group as a unique entity. Also, this could reveal unnoticed sources of systemic risk, when the property channel acts as a chain for the propagation of instability on financial markets. In terms of methodology and expected results, the observations translate into the following hypotheses:

1. a multilevel random model is preferable to OLS since there is a considerable overlap of volatility among a business group;

2. a dummy for affiliate should be significant and with an higher dispersion compared to the one of the parent company;

3. the snowflake structure depicted by figure 1 is robust across the weeks, that is the standard deviation coefficients from the multilevel regression are expected to be significant.

Figure 3: Volatility (mean and standard deviation) by type of firm



Listed affiliate firms are slightly less volatile compared to their parent.

Figure 3 displays mean values and standard deviations by type of firm[4]. Listed affiliate firms are slightly less volatile compared to their parent. The expected negative premium to volatility by the dummy affiliate is confirmed in table 2, both on the parent and affiliate dataset only and by regressing on the whole dataset. In absolute terms, the premium further increases once we standardize the measure of volatility and we control for cluster on the population of firm identifiers (id). The preliminary evidence suggests that the parent and affiliates show distinguishable volatility behaviours, even with the same common trend. This could signal a strategy of the parent company to build a hierarchy of firms to stabilize its volatility on financial markets, thanks e.g. to different trade currencies.

4 Methodology

The methodology applied can be easily split into two main modellings: the mathematical framework for the definition of financial volatility and the econometric model for the build-up of the results.

4.1 The measure of volatility

We use a stochastic model for financial volatility based on stock prices. Following Alizadeh, Brandt, and Diebold (2002), we apply a first-order parametrization to a stochastic volatility model, in which the price S of a security evolves as a diffusion process[5] with both instantaneous

4. Other descriptive tables can be found in the appendix.

5. A diffusion process is a Markov process, i.e. a random process whose future probabilities are determined by its most recent values, such that, under several regularity assumptions, is completely determined from its first two moments. See Itô (1974) for its mathematical definition.

Table 2: Preliminary evidence, excluding and including single firms

Dependent variable: Volatility	Parent and affiliates	All firms
Affiliate	-0.155***	-0.189***
	(0.003)	(0.003)
Constant	-0.023***	0.011***
	(0.001)	(0.001)
R squared	0.002	0.002
N	1'281'413	1'841'890

* p< 0.050, ** p< 0.010, *** p< 0.001, standard error in parentheses. Standardized variables, clustered by firm. The dummy for affiliates is significant and shows a negative premium to volatility.

drift μ and volatility σ dependent on a latent diffusion process ν with constant volatility β and no correlation between the Wiener processes of the price and the latent variable equation:

$$\begin{aligned} dS_t &= \mu(S_t, \nu_t)dt + \sigma(S_t, \nu_t)dW_{S_t} \\ d\nu_t &= \alpha(S_t, \nu_t)dt + \beta(S_t, \nu_t)dW_{\nu_t} \end{aligned} \tag{1}$$

where:

$$\begin{cases} dW_{S_t}dW_{\nu_t} = 0 \\ \sigma(S_t, \nu_t) = \sigma_t S_t \\ \sigma_t = exp(\nu_t) \\ \alpha(S_t, \nu_t) = \alpha(ln\overline{\sigma} - ln\sigma_t) \\ \mu(S_t, \nu_t) = \mu S_t \\ \beta(S_t, \nu_t) = \beta. \end{cases} \tag{2}$$

By combining equations 1 and 2, we have that returns dS/S follow a geometric Brownian motion:

$$\begin{aligned} \frac{dS_t}{S_t} &= \mu dt + \sigma dW_{S_t} \\ dln\ \sigma_t &= \alpha(ln\overline{\sigma} - ln\sigma_t)dt + \beta dW_{\nu_t}, \end{aligned} \tag{3}$$

and therefore, by Itô's lemma, the log security price process $s_t = ln\ S_t$ follows a Brownian motion. Alizadeh, Brandt, and Diebold (2002) prove that the univariate range, defined as the interval between the maximum and the minimum log stock price over a period, is an efficient volatility estimator, nearly log-normal, and robust to market microstructure noise induced e.g. by the bid-ask bounce. The latter can cause an overestimation of the measured price volatility that is increased instead by the transactions bouncing between buy and sell[6]. Therefore, in case we had chosen the *realized volatility* instead of a range-based estimator, the realized volatility could have accumulated a large bias by summing up upward biased squared returns, since it is the sum of squared returns over a given sampling period[7]. Thanks to the result of Alizadeh,

6. On market microstructure noise, see e.g. Bandi and Russell (2008), Bandi and Russell (2006).

7. For further estimation of stock volatility with range-based estimators, historical evolution and comparison with other methods, see e.g. Christensen and Podolskij (2007) Jacob et al. (2008), Martens and Van Dijk (2007), Christensen and Podolskij (2007).

Brandt, and Diebold (2002) we build the weekly volatility proxy[8] as:

$$vol_t = ln(high_t - low_t), \tag{4}$$

where $high_t$ and low_t represent the observed weekly high and low prices respectively of the process of log prices s_t[9]. Notice that this dispersion measure does not depend on the series of opening nor closing prices, thus it is independent across weeks, since it is function of non-overlapping increments of a Brownian motion.[10]

Our methodology will not proceed further by aggregating this measure across weeks. Although several price-based estimators can serve well as standard deviation volatility measures (see e.g. Martens and Van Dijk (2007)), the benefit of our approach consists in a very low mathematical manipulation of the data: since we do not calculate any aggregated measure across the weeks, we are able to translate time variability genuinely into the model. That reduces some numerical noises, but comes at a price: the econometric model able to reflect the longitudinal-nested dataset is one-level more complex than it would be by using an aggregate measure for volatility across weeks, and it is described below.

4.2 The econometric model

Our strategy is to exploit Maximum Likelihood Estimation (MLE) - based multilevel models, that should be compared to the Ordinary Least Square (OLS) regression. Multilevel or random-effects models allow for the most accurate estimation of the regression parameter when there are several layers inside a variable. Hierarchical, nested or time–dependent dataset would generally require such an approach to avoid unpleasant fallacies that lead to estimation biases, such as interpreting associations at the higher level as pertaining to the lower level. Instead of having to make a decision regarding the unit of analysis, the use of multi–level modeling will avoid the fallacies by considering all levels simoultaneously. All the cases in which we have clusters among the data are better studied through this kind of methodology: any within–cluster dependence violates the assumption of ordinary regression models and consequently ordinary regression produces incorrect standard errors. Furthermore, multi–level models represent the only way to assess an intra–layer dependence. In our case the main layers are the population of firms and the parent companies on top of them. We will adopt both the two–level in the case of volatility measure aggregated over time and the three–level model when using our definition of volatility whose value changes over time[11].

The intuition that we want to test is whether belonging to the same business group creates a discrimination at a group level among the population of affiliate companies. This group specific bias will be determined by a group common pattern through, e.g., vertical integration, knowledge sharing, internal capital markets, group management decisions. We use a three-level random intercept model instead of a two-level model in order to keep the time variable for the reasons exposed in the previous paragraph. The most granular level is given indeed by the time-variable financial volatility. A middle level is represented by the whole population of firms and it is nested into the upper level of parent companies. Therefore, our model has both a longitudinal design between first two levels and a cross-sectional or hierarchical design between parent and

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8. The equation 4 referring to observed prices is also dependent on the index i for each firm in the population; we omit this subscript for simplicity, minding however the important dependence.

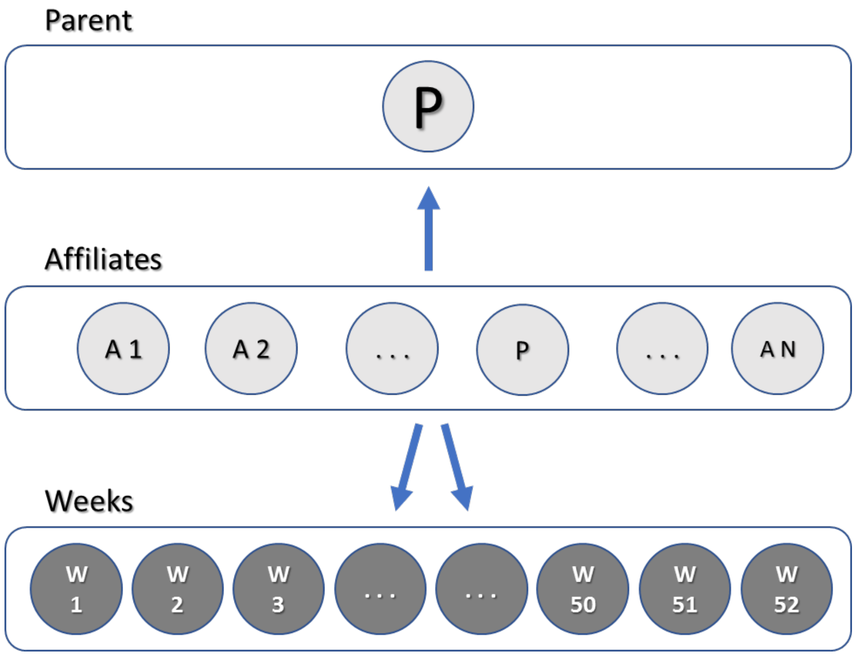
9. Both the $sup_{t=weekj} s_t$ and the $inf_{t=weekj} s_t$ are realized into the $high_t$ and low_t respectively, in every closed interval represented by weeks $j = 1, 2, ..52$.

10. E.g., given the series of opening log prices $open_t$, $H_t = ln(\frac{high_t}{open_t})$, $L_t = ln(\frac{low_t}{open_t})$, $ln(H_t - L_t) = ln(\frac{high_t}{open_t} * (\frac{open_t}{low_t}) = ln(high_t - low_t)$.

11. A comprehensive review of multilevel models is provided in Gelman and Hill (2006).

affiliates. An example scheme is given in figure 4. It fully reflects the preliminary snowflake structure evidenced by the example in figure 1.

Figure 4: Nested and longitudinal structure of the three-level model



The three-level model in the base case takes the following form:

$$y_{tij} = \beta_1 + \varsigma_{ij}^{(2)} + \varsigma_j^{(3)} + \epsilon_{tij}. \tag{5}$$

The run can estimate the financial volatility y_{tij} among the weeks $t = 1, 2, ..52$ and the zero means and mutually uncorrelated error components. In our representation:

- the random intercept $\varsigma_j^{(3)}$ for parent group j has variance that represents the *between groups* portion of variance;
- the random intercept $\varsigma_{ij}^{(2)}$ for affiliate i and parent group j has variance that represents the *between affiliates and within groups* portion of variance; and
- the residual error ϵ_{tij} for week t, affiliate i and parent group j has variance that represents the *between weeks, within affiliates, and within groups* portion of variance.

We will estimate the model (5) with several covariates x_{ij}. In the case we have only the dummy for affiliate x_i equal to 1 if the company is an affiliate company and 0 otherwise the formula is:

$$y_{tij} = \beta_1 + \beta_2 x_{ij} + \varsigma_{ij}^{(2)} + \varsigma_j^{(3)} + \epsilon_{tij}. \tag{6}$$

The estimation results by layers will tell if the three-level well captures the time varying dependency of the volatility against the business group structure, without soiling the volatility itself with *a priori* data manipulations imposed by a synthesized mathematical object. The business group structure itself will be also recognized if we obtain significant standard deviations at firm and group levels. In this case corporate control will translate into a well-defined hierarchical object able to play a role for the price volatility propagation.

4.3 The design of the robustness checks

We perform the robustness checks with the most common aggregated measures for standard deviation of the log prices over the weeks[12]. The rationale is that we do not want to choose a specific measure to test against our model. Since no measure has been classified as the best one by the literature, we make a comparison with many measures to see whether any of them shows an opposite behaviour or results are in line among the measure and against ours. If the three-level model depicted by formula (5) served respectively for time, population of firms, and business groups represented by the parents, once we aggregate over time we must drop the time in weeks level and use a two-level model below for the remaining nested part:

$$y_{ij} = \beta + \varsigma_j^{(3)} + \epsilon_{ij}. \tag{7}$$

Several volatility measures are estimated at two-level random intercept regressions. Specifically, given the process of log prices s_t[13], and its observed weekly opening prices $open_t$, closing prices $close_t$, high prices $high_t$ and low prices low_t, and defined the squared return as $r_t^2 = (close_t - close_{t-1})^2$, we test the two-level model against:

i. the standard deviation of the "old" variable *Volatility*;

ii. the *realized variance* =

$$\Sigma_{t=1}^{52} r_t^2; \tag{8}$$

iii. the *realized range*[14]=

$$\frac{1}{4ln2}\Sigma_{t=1}^{52}(high_t - low_t)^2; \tag{9}$$

iv. the *Garman-Klass* estimator[15] =

$$\Sigma_{t=1}^{52}\left[0.5(high_t - low_t)^2 - (2ln2 - 1)(close_t - close_{t-1})^2\right]; \tag{10}$$

v. the *Rogers-Satchell* estimator[16] =

$$\Sigma_{t=1}^{52}[(high_t - close_t)(high_t - close_{t-1}) + (low_t - close_t)(low_t - close_{t-1})]. \tag{11}$$

5 Empirical findings

5.1 OLS regressions

Robust OLS regressions without and with financial covariates confirm the preliminary evidence by showing a negative and significant premium to volatility from the affiliates in all regressions. Both standard regression (table 3) and controlling for country and sector (table 6) show no relevant impact on volatility except for the percentage *fixed assets*. The negative dependence found suggests that firms with a higher percentage of investments are less volatile on financial markets. When controlling on the total population of firms, the impact of the financing structure becomes significant and positively correlated to volatility. This signals that the financing time-structure of the firm matters when no business group is identified and firms are standing-alone. No role seem to play labour productivity and financial pressure. The coefficient of the capital structure

12. Specifically, we refer to estimators tested by Martens and Van Dijk (2007).
13. The same observation of 8 applies here and in all the following formulas.
14. The realized range is based on Parkinson (1980) estimator = $\frac{(high_t - low_t)^2}{4ln2}$.
15. For further reference, see Garman and Klass (1980).
16. This estimator has the merit of being unbiased whatever the drift μ. For further reference, see Rogers and Satchell (1991).

Table 3: **OLS regressions, excluding (P&A) and including single firms (All)**

Dependent variable: Volatility	P&A	All	P&A	All	P&A	All
Affiliate	-0.155***	-0.189***	-0.085***	-0.125***	-0.077***	-0.110***
	(0.015)	(0.015)	(0.022)	(0.022)	(0.025)	(0.025)
Labour productivity			-0.021	-0.026*	-0.012	-0.015
			(0.012)	(0.013)	(0.010)	(0.011)
Financial pressure			0.002	-0.001	-0.001	-0.002
			(0.003)	(0.003)	(0.004)	(0.005)
Financial assets					-0.267	-0.310
					(0.578)	(0.536)
Fixed assets					-0.047***	-0.061***
					(0.011)	(0.009)
Equity / debt					-0.005	-0.003
					(0.006)	(0.006)
Long / short debt					0.084	0.058***
					(0.054)	(0.009)
Constant	-0.023***	0.011***	-0.088***	-0.047***	-0.119***	-0.080***
	(0.004)	(0.004)	(0.007)	(0.007)	(0.012)	(0.011)
R squared	0.002	0.002	0.001	0.002	0.003	0.005
N	1’281’413	1’841’890	324’367	406’751	258’830	311’014

* p< 0.050, ** p< 0.010, *** p< 0.001, standard error in parentheses. Standardized variables, clustered by firm. A negative and significant premium to volatility from the affiliates is shown in all regressions. No relevant impact on volatility from the other regressors except for the percentage *fixed assets*.

equity/debt becomes slightly significant when controlling for country and sector fixed effects (see table 6) and positively correlated to volatility. Firms therefore face some form of credit market imperfections in violation of Modigliani and Miller (1958), and the ones with higher equity are less volatile. In the same table 6 the positive coefficient of long term over short term debt indicates that firms preferring short term borrowing are likely to have lower stock price volatility, probably because of a higher default risk or difficulties in getting longer debt financing. No relevant difference in all regression is found instead when inserting time fixed effects.

5.2 Random-effect regressions

The results of the three-level random intercept regression are shown by table 4. They confirm the OLS results of coefficients sign and significance representing a double-check one of the other. The random-intercept model however is able to show the relative intra-dependence within each business group that the OLS cannot assess, and the low p-values of the Wald chi square statistics indicate the goodness of fit of the overall three-level model. The novel evidence of the existence of a financial management of a business group is well-defined according to the significance of the standard deviation coefficients. The volatility among weeks shows not surprisingly the highest variability, and the standard deviation between affiliates is generally higher than between business groups. While controlling for financial variables, we find that labour productivity

Table 4: Random intercept regressions

Dependent variable: Volatility			
Affiliate	-0.087***	-0.035	-0.056*
Labour productivity		-0.026**	-0.013
Financial pressure		0.002	0.002
Financial assets			0.129
Fixed assets			-0.042***
Equity / debt			-0.006
Long / short debt			0.050
Constant	0.069***	-0.047***	-0.083***
SD (bw. groups)	0.558***	0.451***	0.465***
SD (bw. affiliates)	0.604***	0.490***	0.423***
SD (bw. weeks)	0.626***	0.641***	0.630***
N parent	26'720	6'760	5'344
N affiliate	29'282	7'236	5'676
N of weeks	52	52	52
N of observations	1'281'413	324'367	258'830
Log likelihood	-1279623.4	-329578.7	-258105.1
Wald chi2(2)	24.9	11.3	21.4
Prob>chi2	0.0001	0.0104	0.0033

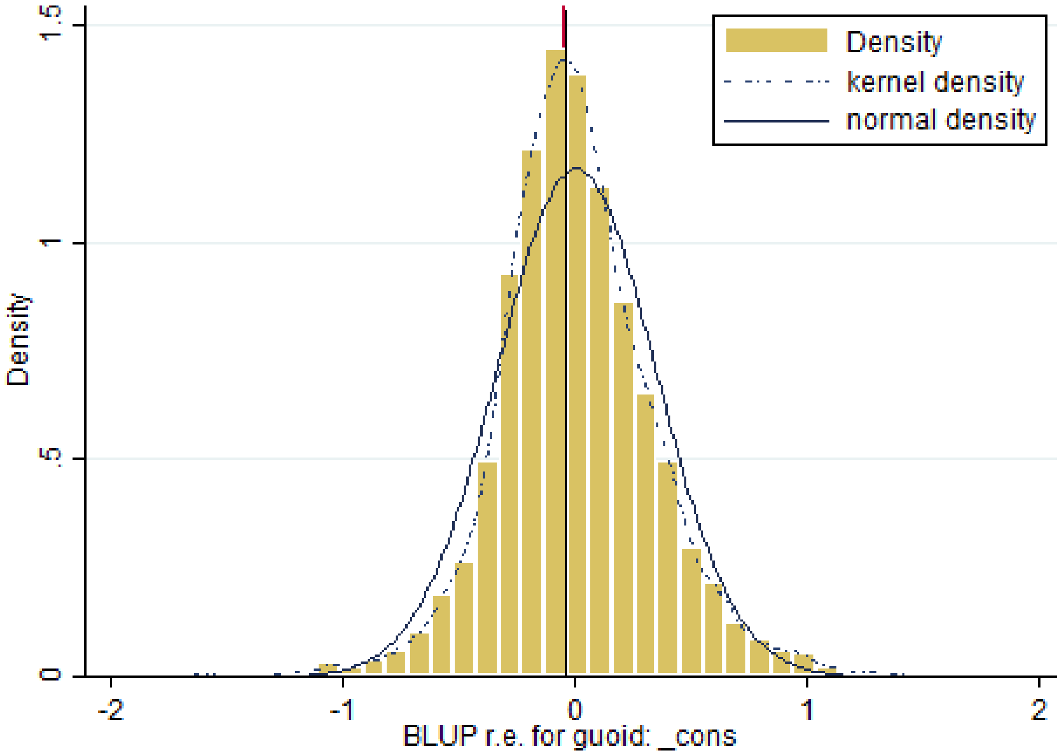
* p< 0.050, ** p< 0.010, *** p< 0.001. Random–effect model confirms OLS results. Financial variables are found to be weakly significant or not significant except again for *fixed assets*. The strong significance of the standard deviation coefficients confirms a solid hierarchical structure across time.

becomes weakly significant despite the financial volatility. While making the full regression, financial variables are found to be weakly significant or not significant except again for *fixed assets*. The behaviour of Unilever PLC is representative of the behaviour of all business group in the dataset; all the hypotheses of section 4.2 are verified. The strong significance of the standard deviation coefficients confirms a solid snowflake hierarchical structure and provides evidence for a well defined financial group-level actor in volatility transmission mechanisms of financial markets, the reason of which we date back to the information on the group-level fundamentals that is available to investors.

5.3 Group level sources of volatility

Financial volatility is possibly driven by hidden aspects of parent firms affecting the whole business group. Indeed, after the three-level model we are left with an an unexplained source of variability that already discounts the control put in the estimate. It is given by the intercept $\varsigma_j^{(3)}$ common to every affiliate belonging to the same parent and it represents the volatility component that is group-specific. We can assess with a prediction the group-level random intercept, obtaining a fixed parameter, slightly negative, for all the affiliates population. We can exploit another advantage of the random-intercept model given by the possibility of inspecting a source of variability lying *outside* of the tested model: the existence of this source of variability indicates that belonging to a group or another makes a difference. A representation of the random-intercept at group level *Parent* and its prediction is given in figure 5.

Figure 5: Graphical representation of the random-intercept at group level



Then we perform a post-estimation regression by testing, for each parent or group[17], some parent-related measures such as size, number of countries in which the group has affiliates, number of sector of product diversification and Tobin's q. The OLS regression takes as dependent variable the estimate of the group-level random intercept. Results in table 5 show that size, Tobin's q and numbers of countries in which the parent has affiliates show significant coefficients. While the firm's size and marketability impacts seem to lower volatility, the group variability is increased with dispersion across many countries. Firm size is expected to be positively correlated with the probability that firms attract external finance under the pecking order theory[18]; therefore, it is reasonable that its share market will be more liquid and therefore the group variability decreases with size. The market value of the firm over replacement costs has the same effect of the firm's size of decreasing the negative value of *Parent*. The impact of sector diversification is not significant.

17. Parent firms balance sheet are consolidated in most of the cases. However, the confusion between parent and group has not to be considered by an accounting perspective, that would be misleading because of lack of harmonized accounting reporting, but rather the group must be intended as per our modelling definition.

18. According to De Haan and Hinloopen (2003).

Table 5: Group-level sources of volatility

Dependent variable: Parent			
Size	-0.135***	-0.137***	-0.141***
	(0.001)	(0.001)	(0.001)
N countries		0.739***	0.816***
		(0.055)	(0.055)
N sectors		-0.017	-0.017
		(0.017)	(0.017)
Tobin's q			-0.178***
			(0.017)
Constant	0.041***	0.713***	0.783***
	(0.001)	(0.048)	(0.048)
R squared	0.109	0.109	0.115
N	265'928	265'928	254'800

* p< 0.050, ** p< 0.010, *** p< 0.001, standard error in parentheses. Standardized variables, robust. Size, Tobin's q and numbers of countries in which the parent has affiliates show significant coefficients; therefore they are correlated to the group–level volatility.

5.4 The results of the robustness check

The econometric methodology outlined in section 4.3 is interesting *per se*; for how far the study is conceived, it represents also a robustness check. We provide the results of estimation through alternative measures of volatility starting from the closest ones to our volatility measure: the standard deviation of *Volatility* and the *realized range*. Left-hand panel of table 7 shows the behaviour of the OLS results obtained by collapsing the volatility measure over the weeks with the standard deviation operator. We can observe that the magnitude orders between the dummy affiliate effect over the two datasets without and with single firms is the same as in the three-level model: the effect is higher on the largest dataset. Vice versa the effect is higher on the smallest dataset for the realized range (right-hand panel of table 7) and for the other measures of section 4.3 (see the Appendix, table 10). Table 9 shows comparison values for the regression results on the dataset without single firms. All the results reveal a coefficient of the dummy affiliate still negative and strongly significant. Tables 8 and 11 show the results of the two-level model. We see that the behaviour of the alternative measures of volatility is completely in line with the results of section 5.2 and the standard deviations are statistically strongly significant for all the measures.

6 Concluding remarks

We ask whether Multinational Enterprises (MNEs) and, more in general, business conglomerates have an influence on the volatility of financial markets stock prices. While the answer can be intuitively thought as positive, it is necessary to assess what does a financial management of a business group means in case it is well defined. To answer the research question, we build a world-wide dataset of weekly stock prices of quoted firms linked by a parent-affiliate relationship. We develop a methodology to assess whether listed firms show a group behaviour and if there is any relevant difference between parent and affiliates in terms of volatility, and whether the supposed group structure does not decompose through the weeks. If the parent-affiliate relationship has an influence over share prices volatility it can consequently act as a channel for the propagation of financial shocks or imbalances on the financial markets. We find that the parent-affiliate relationship is significantly correlated to financial markets volatility and a hierarchical two-layer model exists on top of the retrieved financial data. The empirical investigation confirms the hypotheses and does not depend on the empirical model chosen. Even adding corporate regressors commonly used to investigate firms structure, productivity and constraints, the business group structure keeps significant over the weeks. We can conclude that corporate control has an impact on financial volatility. The findings provide a robust definition of business group acting on financial markets and open the pave for the investigation of new dynamics through the undiscovered channel of corporate control. The methodology built can be easily generalized to vertically multi-layered hierarchical structures; in particular the same methodology could be used to investigate multi-layered business groups in which affiliates are parent firms themselves.

Appendix A.

Additional information on the data

The initial dataset consists of a 154 countries dataset, with a total of $63'737$ firms, of which $30'550$ parent, $3'664$ affiliate, $29'523$ single companies. Europe, Asia, India, Korea and South America are the regions where we find more stand-alone companies than parent firms; in all the other regions world-wide, we register more companies with at least one affiliate than single firms.

The financial variables described in section 3 are computed at firm level as follows.

- *Size* is proxied by the year sales;
- *Financial assets* is the share of financial assets (other fixed assets plus cash equivalent) over total assets excluding other fixed assets and cash equivalent;
- *Fixed assets* is the percentage of fixed assets over total assets;
- *Equity / debt* is the ratio between shareholders' funds and long term debt;
- *Long / short debt* is the ratio between non-current and current liabilities;
- *Labour productivity* is the value added per employee;
- *Financial pressure* is given by interest payments over the profit before tax plus depreciation;
- *Tobin's q* is computed as the firm market valuation over the accountable value of fixed assets; precisely, it is computed as 1 plus the marginal market value of the firm minus its book value.

Figure 6: Volatility densities by region

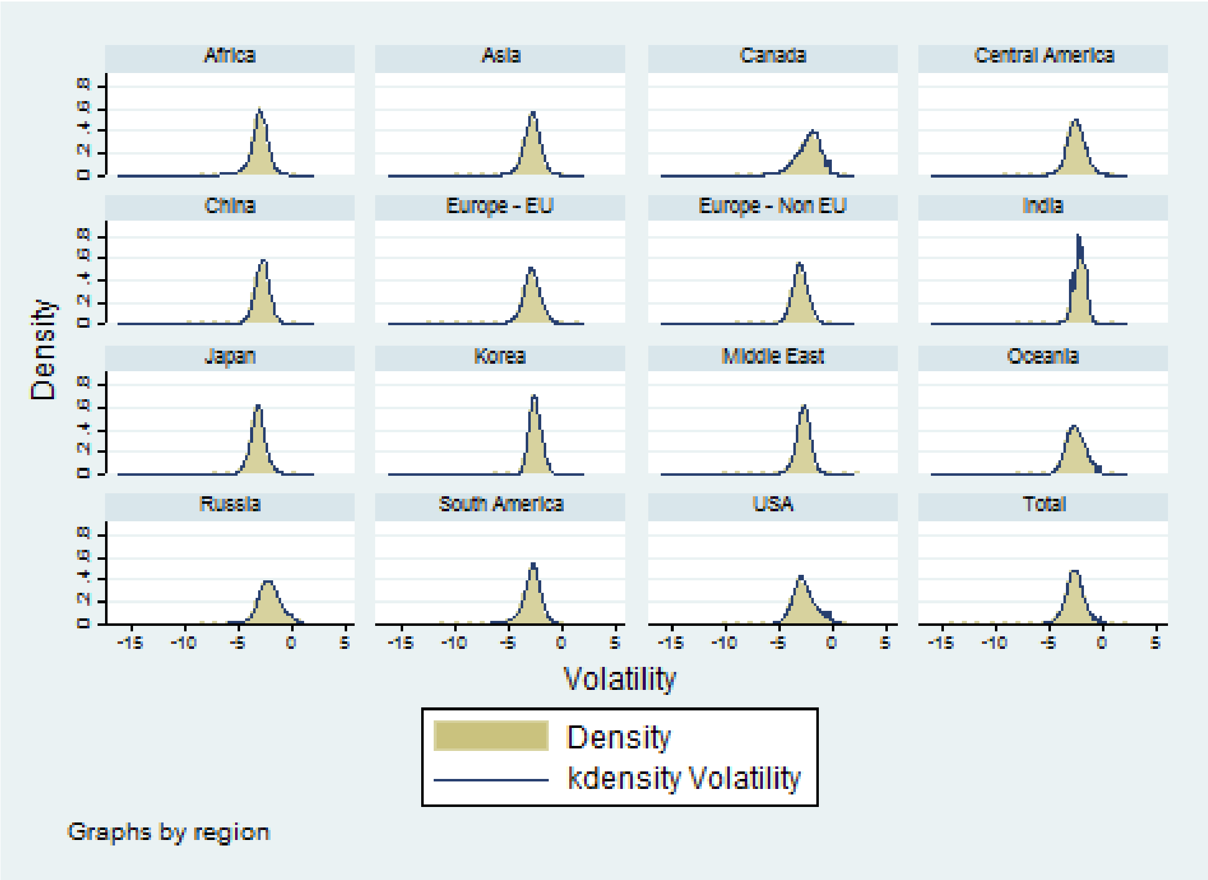
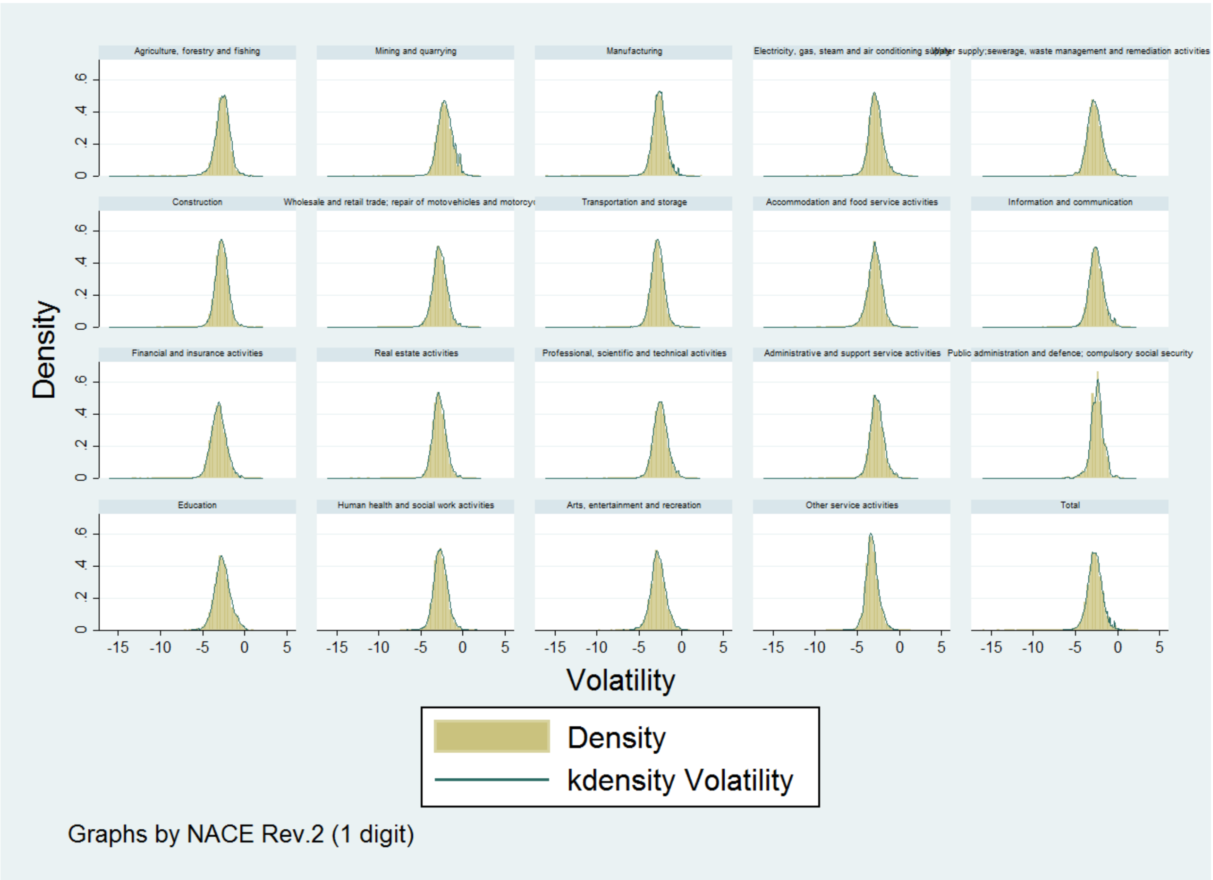


Figure 7: Volatility densities by sector



Appendix B.

Additional tables

Table 6: Regression with country-sector control, excluding (P&A) and including single firms (All)

Dependent variable: Volatility	P&A	All	P&A	All	P&A	All
Affiliate	-0.126***	-0.148***	-0.105***	-0.135***	-0.100***	-0.123***
	(0.013)	(0.012)	(0.021)	(0.020)	(0.022)	(0.022)
Labour productivity			-0.015	-0.019*	-0.008	-0.009
			(0.008)	(0.009)	(0.006)	(0.007)
Financial pressure			-0.003	-0.004	-0.006	-0.007
			(0.003)	(0.003)	(0.005)	(0.005)
Financial activity					-0.207	-0.393
					(0.528)	(0.488)
Fixed assets					-0.050***	-0.055***
					(0.011)	(0.010)
Equity / debt					-0.009*	-0.008*
					(0.004)	(0.004)
Long / short debt					0.083*	0.051***
					(0.040)	(0.009)
Constant	-0.025***	0.019***	-0.086***	-0.047***	-0.116***	-0.083***
	(0.003)	(0.003)	(0.006)	(0.005)	(0.010)	(0.009)
R squared	0.211	0.230	0.164	0.154	0.163	0.156
N	1'274'315	1'809'773	323'707	405'441	258'425	310'214

* p< 0.050, ** p< 0.010, *** p< 0.001, standard error in parenthesis. Standardized variables, clustered by firm.

Table 7: Robustness check results, standard deviation of volatility and realized range

Dependent variable:	SD(Volatility)		Realized range	
	P&A	All	P&A	All
Affiliate	-0.090***	-0.136***	-0.249***	-0.088***
	(0.016)	(0.016)	(0.016)	(0.016)
Constant	-0.038***	0.008	0.166***	0.005
	(0.006)	(0.005)	(0.005)	(0.004)
R squared	0.001	0.001	0.006	0.001
N	29'696	44'446	34'214	63'737

* p< 0.050, ** p< 0.010, *** p< 0.001, standard error in parentheses.

Table 8: Two-level robustness check results for standard deviation of volatility and realized range

Dependent variable:	SD(Volatility)			Realized range		
Affiliate	-0.009	-0.013	-0.007	-0.250***	-0.116***	-0.081***
Labour productivity		-0.176*	-0.006		-0.015	-0.004
Financial pressure		0.001	0.001		0.001	0.003
Financial assets			0.064			0.013
Fixed assets			-0.022*			-0.030**
Equity / debt			0.001			0.004
Long / short debt			0.058			0.128*
Constant	-0.038***	-0.165***	-0.210***	0.166***	0.079***	0.047**
SD (bw. groups)	0.611***	0.398***	0.464***	0.379***	0.438***	0.517***
SD (bw. affiliates)	0.672***	0.526***	0.273***	0.870***	0.587***	0.363***
N parent	27'084	6'760	5'340	30'602	7'486	5'857
N affiliate	29'696	7'242	5'672	34'214	8'063	6'237
Log likelihood	-38883.2	-7222.5	-4387.9	-46672.2	-8878.8	-5860.5
Wald chi2(2)	0.2	4.6	7.7	186.2	20.9	23.3
Prob>chi2	0.6344	0.2025	0.3595	0.0001	0.0001	0.0002

* p< 0.050, ** p< 0.010, *** p< 0.001.

Table 9: Robustness check results, other measures of volatility

Dependent variable:	Realized variance	Garman-Klass	Rogers-Satchell
Affiliate	-0.226***	-0.238***	-0.193***
	(0.015)	(0.017)	(0.017)
Constant	0.157***	0.161***	0.130***
	(0.006)	(0.005)	(0.005)
R squared	0.005	0.006	0.004
N	34'214	33'281	33'858

* p< 0.050, ** p< 0.010, *** p< 0.001, standard error in parentheses.

Table 10: Robustness check results including stand-alone firms, other measures of volatility

Dependent variable:	Realized variance	Garman-Klass	Rogers-Satchell
Affiliate	-0.074***	-0.081***	-0.067***
	(0.015)	(0.016)	(0.016)
Constant	0.004	0.005	0.004
	(0.004)	(0.004)	(0.004)
R squared	0.001	0.001	0.001
N	63'737	61'704	62'964

* p< 0.050, ** p< 0.010, *** p< 0.001, standard error in parenthesis.

Table 11: Two-level robustness check results, other measures of volatility

Dependent variable:	Realized variance	Garman-Klass	Rogers-Satchell
Affiliate	-0.153***	-0.243***	-0.211***
Constant	0.157***	0.161***	0.130***
SD (bw. groups)	0.607***	0.326***	0.316***
SD (bw. affiliates)	0.755***	0.889***	0.891***
N parent	30'602	29'860	30'320
N affiliate	34'214	33'281	33'858
Log likelihood	-47012.2	-43536.5	-46103.1
Wald chi2(2)	70.7	174.7	135.8
Prob>chi2	0.0001	0.0001	0.0001

* p< 0.050, ** p< 0.010, *** p< 0.001.

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