Interfirm Production Linkages and Propagation of Shocks: Evidence from Korean Business Groups*

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Abstract

This note provides a new empirical evidence supporting the postulate that firm-to-firm production linkages are an important mechanism for the propagation of idiosyncratic micro shocks. By exploiting the variation of the share of internal transactions across business groups in Korea, we find that the more internalized business groups tend to exhibit higher covariances of firm-specific shocks among their member firms, implying that the transmission of the shocks are more pervasive in firms with heavier internal production linkages.

JEL Classification: L14

Keywords: Firm-to-firm Linkages, Propagation of Shocks, Internalization in Business Group.

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1 Introduction

Interfirm production linkages have been emphasized as a key channel through which idiosyncratic micro shocks are transmitted to other firms and thereby induces sizeable aggregate fluctuations. In a seminal work, Gabaix (2011) shows, based on Hulten's (1978) argument, that a few granular disturbances can propagate substantially in an economy with input-output (IO) linkages across firms. di Giovanni, Levchenko, and Mejean (2014, hereafter dGLM) supplement the Gabaix's result with an accounting exercise that explicitly measures the magnitude of the linakges effect on the aggregate volatility.[1] Specifically, they find that the majority of the mirco shock-driven aggregate fluctuation is accounted for by the propagation of the shocks through the production linkages, although their direct impacts are still nontrivial.

This paper provides a new empirical pattern that manifests the role of interfirm linkages for the transmission of idiosyncratic shocks. To this end, we employ internal transaction data among member firms in business groups over the period of 2007 through 2015 to measure the group-level (weighted) average of the internal sales share as a proxy for the interfirm production linkages. The heterogeneous levels of internalization are then plotted against the weighted (co)variances of all individual shocks in the corresponding business groups. We find a strong relationship that business groups with higher production linkages tend to display greater total variances of idiosyncratic shocks among their member firms, implying that the shocks are more easily transmitted to other members if they depend more on one another.

Our finding is consistent with and complementary to the aforementioned result in dGLM. Due to the lack of firm-level transaction data, they assume that firm's sourcing and sales structures are the same within a sector and exploit the sector-level IO coefficients to measure the degree to which firms in different sectors are interconnected with each other. We do not require such an assumption. Our finding also relates to more recent studies to identify the effect of localized micro shocks to aggregate economies, all of which consistently find the significant role of rigid supply chains across firms for amplifying the shocks (e.g., Barrot and Sauvagnat, 2016; Boehm, Flaaen, and Pandalai-Nayar, 2016; Carvalho et al., 2017). Finally, we shed some light on the nature of business group as well. In particular, while the prior literature often documents that an important incentive to form a business group is to hedge risks coming from external shocks (Almeida, Kim, and Kim, 2015; Cestone et al., 2016), our empirical result suggests that the heavy reliance on sourcing from or sales to the group members can magnify risks that stem from internal shocks.

In the next section, we briefly explain the decomposition method to isolate the firm individual shocks. Section 3 reports and discusses the main finding after introducing the data we employ. Section 4 concludes.

[1] In the same spirit, some studies estimate the impact of sector-level shocks on the aggregate economy (e.g., Foerster, Sarte, and Watson, 2011; Carvalho and Gabaix, 2013; Acemoglu, Akcigit, and Kerr, 2016). See also Long and Plosser (1983) and Acemoglu et al. (2012), among others, for the theoretical understanding on input-output linkages effect.

2 Decomposition of Shocks

Our decomposition method to identify the firm-level idiosyncratic shocks follows dGLM. The annual sales growth rate of firm f by destination country n at time t, γ_{fnt}, are first decomposed into common shock and idiosyncratic shock. The common shock δ_{jnt} is the average growth rate of all active firms at each destination by sector (j). The idiosyncratic shock ϵ_{fnt} for firm f is simply defined as the residual, i.e., the destination-specific sales growth rate net of the common shock. We assume that both shocks are random variables and allow them to have serial or spatial correlations.

The variance of the weighted sum of all idiosyncratic firm shocks, or firm-specific volatility in short, is then obtained as

$$\begin{aligned}\sigma_{F\tau}^2 &= Var(\sum_f \sum_n \omega_{fn\tau-1}\epsilon_{fnt}) \\ &= \sum_{f,n} \omega_{fn\tau-1}^2 Var(\epsilon_{fnt}) + \sum_{g\neq f, m\neq n} \sum_{f,n} \omega_{gm\tau-1}\omega_{fn\tau-1} Cov(\epsilon_{gmt}, \epsilon_{fnt})\,. \end{aligned} \tag{1}$$

The weight $\omega_{fn\tau-1}$ in Eq. (1) is the sales of f in country n at time $\tau-1$ where τ is a given fixed year during the sample period so that the weight remains as a constant. We will discuss more about this in the sext section. The main contribution of dGLM is to evaluate the relative size of the firm-specific volatilitiy $\sigma_{F\tau}^2$, which turns out to be about 70 to 80% for the case of France, compared to the aggregate volatility.[2] In addition, since $\sigma_{F\tau}^2$ is composed of the weighted variances of individual shocks and covariances between them as in Eq. (1), they can gauge how each term contributes to the overall firm-specific volatility. Again, at least in France, the second covariances term constitutes a dominant portion of $\sigma_{F\tau}^2$.

The question in this paper is defining what drives such dominance of the covariances term in the overall firm-specific volatility. Particularly, we hypothesize that the production linkages between firms is a key mechanism for the magnification of the initial idiosyncratic shocks. Note that the existence of production linkages by itself do not necessarily create the shock propagation, so long as firms can easily switch their business partners in response to shocks from their customers or suppliers: rigid customer-supplier relationship matters for the propagation of shocks. In addition, the positive correlation between firms' idiosyncratic shocks can arise through other channels such as labor market conditions or local housing prices (Barrot and Sauvagnat, 2016). Thus, a direct firm-level evidence for the hypothesis is desirable.

Our strategy for testing the hypothesis is to exploit the heterogeneous intensity of internalization across business groups. Business groups typically form a production network through vertical integration but at different degrees. Hence, we take the degree of internalization, i.e., the group-level (weighted) average of the internal sales share as the measure for the intensity

[2] Friberg and Sanctuary (2016) implement the same analsis for Sweden to find that the firm-specific volatility explains about half of the Swedish aggregate volatility.

of production linkages as in Feenstra and Hamilton (2006). We then examine how its variation is related to the correlation of idiosyncratic shocks between member firms within business groups.

That said, the firm-specific volatilitiy $\sigma_{F\tau}^2$ can be decomposed into the group level variances as follows:

$$\sigma_{F\tau}^2 = \sum_{i=1}^{I} Var\Big(\sum_{f \in G_{i\tau}} \sum_{n} \omega_{fn\tau-1} \epsilon_{fnt} \Big) + COV_\tau = \sum_{i=1}^{I} GroupVar_{i\tau} + COV_\tau \tag{2}$$

where $G_{i\tau}$ indicates the set of member firms in ith business group at year τ and I is the total number of business groups in our sample. $GroupVar_{i\tau}$ in Eq. (2) is the variance of the weighted sum of all idiosyncratic firm shocks in ith business group, or the (ith) group-specific volatility in short. Just as in Eq. (1), this term includes all variances of individual shocks and covariances between them. COV_τ includes to all the rest of variances and covariances of firm shocks that constitutes $\sigma_{F\tau}^2$.

3 Data and Empirical Finding

We now turn to the implementation with data. Our sample data is drawn from the Survey of Business structure and Activities (SBA) in Korea. Starting from 2006, the annual survey has collected information about corporate activities including sales, investment decisions, and strategic alliances as well as basic firm structures. It includes the total amount of exports, but not distinguished by destination country. Hence, there are two destination countries in our sample: domestic and foreign. Importantly, however, it has information on internal transactions with domestic member firms and foreign affiliates, so we can calculate the internal transaction shares by destination country.

The sample covers all private firms that employ at least 50 full-time workers and have equity values at least 300 million Korean won. Thus, it is truncated below and we observe only about 12,000 firms in each year, which accounts for 2~3% of all corporates in Korea. These top firms, however, accounts for 60~64% of the total output and nearly 100% of the total exports in the economy, indicating the granularity in the firm distribution. Furthermore, the shocks from small-sized firms would have a negligible impact on the aggregate economy as argued in Gabaix (2011), so the truncation issue is not likely a concern.

We also draw the list of firms associated as members of the 58 largest business groups from the Korea Fair Trade Commission, which is combined with the SBA to identify the member firms in each business group. Again, despite the truncation, most firms in business groups satisfy the two criteria and are included in the sample. Our sample period ranges from 2007 to 2015, and τ can be one out of nine years from 2006 to 2014. Rather than choosing one specific year, however, we apply all possible τ's to get as many weights as the number of sample years

($T = 9$) and take the average values of $GroupVar_{i\tau}$.

Once we decompose the annual sales growth rates by destination into shocks and calculate firm-specific and group-specific volatilities, Figure 1 shows the main finding of this paper. It plots (log of) the mean internal sales share against (log of) the standard deviation of the average group-specific variance over the nine years. The figure displays a clear pattern that the more internalized business groups tend to exhibit higher group-specific variances, implying that the transmission of the shocks are more pervasive in firms with heavier internal production linkages. When the (standard deviation of) group-specific variance is regressed on the internal sales share, we obtain 0.419 as the coefficient estimate which is statistically significant at 1% level.

More discussions to come.

4 Conclusion

To be written.

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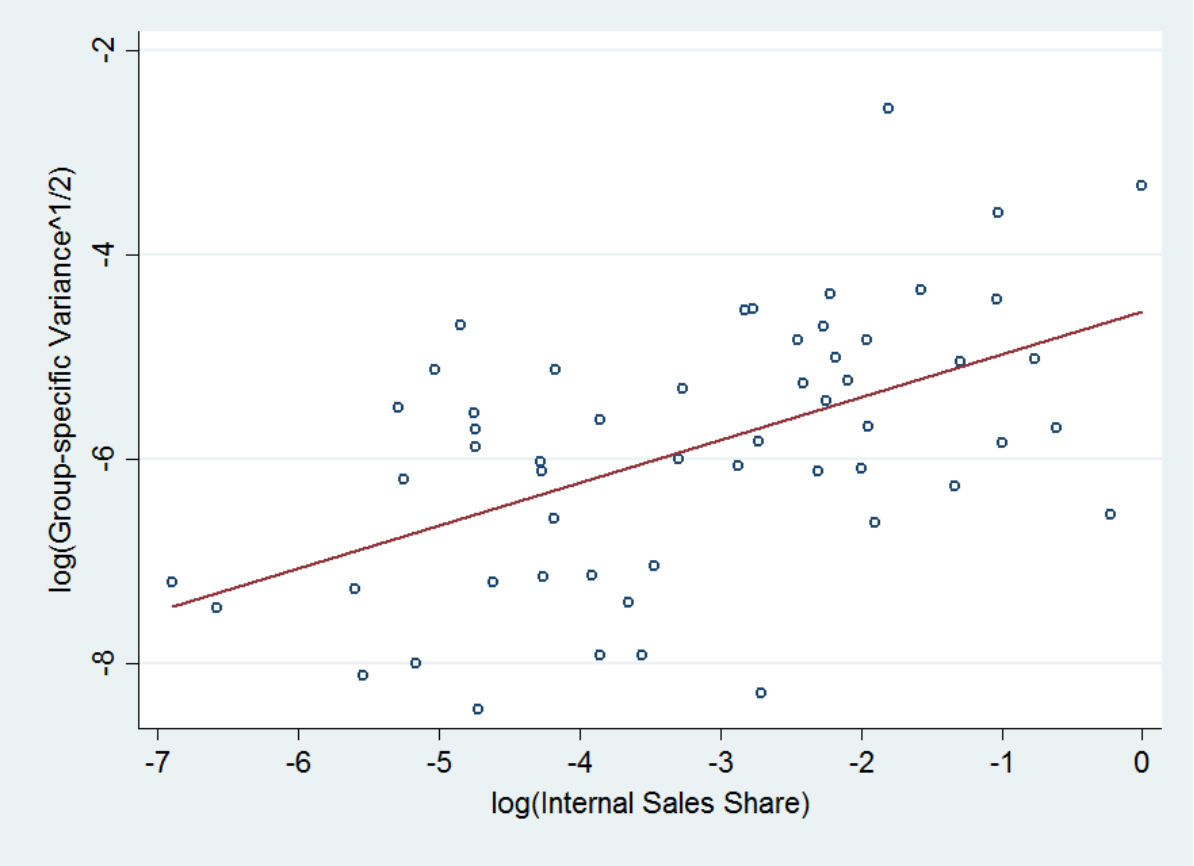
Figure 1: Internal Sales Share and Group-Specific Volatility



Source: Author's calculation.