Mergers and Acquisitions, and the Propagations in Production Networks

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Abstract

This paper examines whether firm-level idiosyncratic shocks propagate in production networks. We identify idiosyncratic shocks with mergers and acquisitions (M&A). We find that M&A events impose substantial productivities and revenues gains on the target firms. These gains translate into significant output increase and spill over to their customers through input-output linkages. Surprisingly, the indirect effects of M&A on customer firms are much larger than the direct effects on target firms. This comes from the fact that M&As leads to increase of asymmetry in network structure, therefore further amplifies the firm-level shocks.

Keywords: Propagation, Network, Merger and acquisition

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1 Introduction

Most modern macroeconomics abstracts away from network. Standard models wrap all of the intermediate processes into one representative firm. Thus, we neglect the richness of the economy's interconnections. Starting with Long and Plosser [1983], a lot of empirical studies have proved that network structure is very important in understanding the origin of aggregate fluctuations. However, the propagation of firm level shocks remains an open question, both in theory and empirics.

This paper studies how idiosyncratic shocks propagate to aggregate level using firm-level data. Acemoglu et al. [2012] proves theoretically, that only if there exists significant asymmetry in the roles that sectors play as suppliers to others, sizable volatility can be obtained. Sectoral asymmetry, or "influential matrix", can be calculated using input-output table. However, firm-level influential matrix is very difficult, even impossible, to calculate with available data. Then, how can we investigate propagation of firm-level shocks?

In order to answer this question, we focus on shocks that have been proved to correlate with business cycle and explore why they propagate. To identify firm level shocks, different from past literatures, we use mergers and acquisitions (M&A). There are two important reasons why we use it.

First, M&A is pro-cyclical. This validates that M&As indeed propagate.[1] Previous studies, such as Barrot and Sauvagnat [2016] and Carvalho et al. [2016], use natural disasters.[2] Natural disasters are very reliable because of its exogeneity. However, the fact that natural disaster can diffuse from supplier to customer does not mean it contributes to aggregate fluctuations. In fact, Figure 1 indicates that natural disasters are not correlated with business cycles.

[1] It could be the other way around which better economy situation generates more M&A events. We deal with this endogeneity issue with an instrument variable method in Section 4.

[2] Barrot and Sauvagnat [2016] uses natural disasters in US in recent 30 years. And Carvalho et al. [2016] uses the great East Japan Earthquake of 2011.

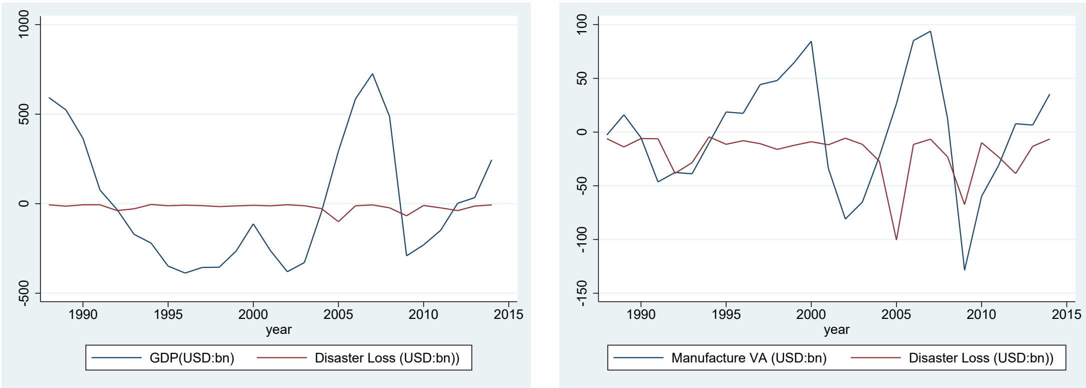

fig1: GDP fig2: Manufacture(VA)

Figure 1: Natural Disaster and Business Cycle

Notes: Data source: Natural Disaster: SHELDUS and National Weather Service of US. Value-Added of Manufacture: World Bank.

Second, M&As increase the asymmetry of network structure. If M&As do not change degree distribution, they will decay along the supply chain, just like natural disasters. It can be spread, but it will die out somewhere in the network, according to Acemoglu et al. [2012]. In other words, it will not cause aggregate fluctuations. How does M&A change network structure? Consider the network depicted in Figure 2. Before M&A, the distribution of out-degree is uniform (2,2,2,2). There is no asymmetry in this network, and every firm is equally important. No shocks will propagate in this network. After M&A, two separate firms are combined into one. The distribution becomes (4,2,2). This makes the new firm far more important than the others. In this paper, we will estimate the importance of changing network structure.

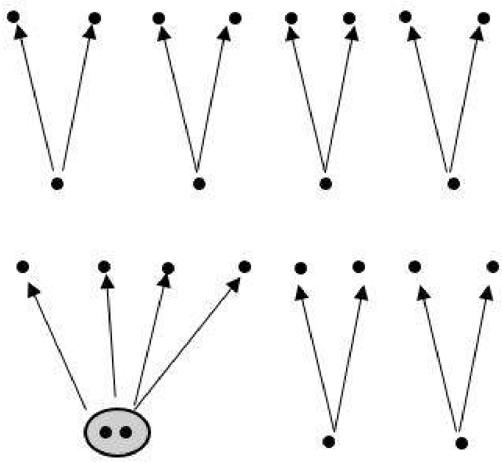

Figure 2: Disaster and Business Cycle

Therefore, we collect firm level data on mergers and acquisitions in the past ten years using Capital IQ database.[3] According to our estimations, we find that M&A has a short-term positive effect on revenues and a prolonged positive effect on productivities of target firms. It increases firms' revenues by around 10%, and productivities by about 3%. Out of consideration on endogeneity issue, we use both difference-in-difference (DID) and instrument variable (IV) method. DID method compares the firms performances ex ante and ex post. The control group is built up by firms having M&As later than the treated group. By doing this, we avoid the potential endogeneity problem that M&A decision depends on unobserved variables of the target firms. However, the endogenous timing of M&As cannot be solved. The instrument variable is constructed as *merger arbitrage spread*. Mergers trade at a discount because there always an uncertainty that a deal will break. The merger arbitrage spread captures this risk of M&A. It is correlated with M&A transactions, while independent of productivities. Productivities can only be changed through long term of reallocating assets or adopting of new technologies. The merger arbitrage spread is a short-term market reaction to the news of M&A. Therefore, they are not correlated.

We then trace the propagation of these shocks in production networks using a giant supplier-customer adjacency matrix which we calculate from Capital IQ data base. We find that almost every firm is connected in the supplier-customer network; and this network indeed has the asymmetry features mentioned in Acemoglu et al. [2012]. It can be approximated by a Type-I Pareto with $\alpha = 1.8$. Here we discriminate self-M&A from supplier-M&A. The supplier-M&A refers to the M&A events happened to a firm's suppliers. Supplier-M&As are more prevalent than we expect, and of higher frequency. About 15% of firms are involved in supplier-M&As. And they have supplier-M&As happening every two years. According to our estimations, supplier-M&A increases a firm's revenues more than self-M&A by almost twice. This is very surprising if we consider that intermediate goods takes only a fraction in production function. This surprisingly large effects come from the fact that M&A combines the connections of these two firms therefore changes the distribution of "influence" of the firms. Firms involved in M&A

[3] A detailed description of data set can be seen in Appendix.

transactions become more important because they asymmetrically supply to more customers. Therefore, the effects are amplified.

Literature and Contribution. Neoclassical theory proposes that vertical mergers may eliminate an existing inefficiency, such as double price markups in successive monopolies (Spengler [1950], Perry [1978]) or input substitution (Vernon and Daniel [1971], Schmalensee [1973], Warren-Boulton [1974]). Another neoclassical motive for vertical mergers is to prevent resale of an input in downstream industries in order to allow price discrimination across different price elasticities of demand (Katz [1987]). As an alternative to the neoclassical theory, transaction costs may lead to vertical integration if the net benefits of internal transactions are larger than those of transacting in a market. The costs of market transactions and the corresponding holdup problems increase with both uncertainty and relationship-specific investments. Thus, firms with complementary assets may merge with each other to overcome incomplete contracts (Thodes-Kropf et al. [2008].)

[To be complete]

2 Model

In this section, we describe a simplistic model which highlights the main mechanisms in the empirical sections. This model is static, and there are two types of agents: consumers and firms. There are K industries in this economy, and each has a mass of N_k firms. The market is monopolistic competition, and each firm produces only one product.

2.1 The Household's Problem

In the economy, there is a mass of unity homogeneous households. The representative household maximizes utility:

$$U(c_1, ..., c_K) = \left(\sum_{k=1}^{K} \alpha_k^{\frac{1}{\sigma}} c_k^{\frac{\sigma-1}{\sigma}} \right)^{\frac{\sigma}{\sigma-1}}$$

where c_k represents the consumption of varieties in industry k. α_k determines households' tastes for goods from industry k. $\sigma > 0$ is the elasticity of substitution across industries. The composition good produced by industry k is given by:

$$c_k = \left(\int_{N_k} c(k,i)^{\frac{\epsilon_k - 1}{\epsilon}} di \right)^{\frac{\epsilon_k}{\epsilon_k - 1}}$$

where $c(k,i)$ is household consumption from firm i in industry k. $\epsilon_k > 1$ is the elasticity of substitution intra-industry k across firms producing different varieties. If $\epsilon_k = 1$, we have the Cobb-Douglas case. If $\epsilon = \infty$, we have the case where all varieties are perfect substitutes, and there is no product differentiation. The household budget is given by:

$$\sum_{k=1}^{K} \int_{N_k} p(k,i)c(k,i)di = wl + \sum_{k=1}^{K} \int_{N_k} \pi_{k,i} di$$

Households both earn working salaries and dividends by supplying their labor and owning the firm. We assume inelastic labor supply l, and normalize labor to be the numeraire so that $w = 1$.

2.2 The Firm's Problem

Firm (k,i) represents a firm i in industry k. This firm has a CES production function. It uses labor and intermediate goods as inputs. Firm (k,i) uses intermediate goods from all the firms in this economy. The production function is:

$$y(k,i) = z(k,i) \left(\gamma_k^{\frac{1}{\sigma}} l(k,i)^{\frac{\sigma-1}{\sigma}} + \sum_{s=1}^{K} \omega_{s,k}^{\frac{1}{\sigma}} m_{s,k,i}^{\frac{\sigma-1}{\sigma}} \right)^{\frac{\sigma}{\sigma-1}}$$

where $\gamma_k > 0$ gives the intensity with which firms in industry k use labor. $z(k,i)$ is productivity. $\omega_{s,k}$ is the share parameter for how intensively firms in industry k uses composite inputs from industry s. The $N \times N$ matrix of $w_{s,k}$ denoted by Ω, determines the network structure of this economy. And we will derive the influential matrix from Ω. The composite intermediate input from industry s sold to a firm i in industry k is:

$$m_{s,k,i} = \left(\int_{N_s} m_{s,j,k,i}^{\frac{\epsilon_s - 1}{\epsilon_s}} dj \right)^{\frac{\epsilon_s}{\epsilon_s - 1}}$$

where $m_{s,j,k,i}$ is the intermediate inputs selling from firm j in industry s to firm i in industry k. Note that elasticities ϵ_s are the same for all firms in a same industry. And elasticity σ is the same for all industries. Intensities of labor and intermediate goods, and productivities of labor are also on industry level. Therefore, we can derive the profits of firm (k, i):

$$\pi(k,i) = p(k,i)y(k,i) - \sum_{s=1}^{K} \int_{N_s} p(s,j)m(s,j,k,i)dj - wl(k,i) - f(k,i)$$

where $f(k,i)$ is the fixed cost of firm (k,i).

2.3 Equilibrium

Definition 1. A general equilibrium is a collection of prices $p(i,k)$, wage w, input demands $x(s,j,k,i)$, outputs $y(k,i)$, and consumption $c(k,i)$ and labor demand $l(k,i)$ such that:

1. The representative household chooses consumption to maximize utility subject to its budget constraint;
2. Each firm maximizes its profits subject to demand for its goods;
3. Markets for each good and labor clear:

$$y(k,i) = c(k,i) + \sum_{s=1}^{K} \int_{N_k} m(k,i,s,j)dj$$

$$\sum_{k=1}^{K} \int_{N_k} l(k,i)di = 1$$

The optimal consumption choice for a representative household, given goods price $p(k,i)$, is that

$$c(k,i) = \alpha_k \left(\frac{p(k,i)}{\mathbb{P}_k} \right)^{-\epsilon_k} \cdot \left(\frac{\mathbb{P}_k}{\mathbb{P}} \right)^{-\sigma} \cdot \mathbb{C} \quad (1)$$

where $\mathbb{P}_k = \left(\int_{N_k} p(k,i)^{1-\epsilon_k} di \right)^{\frac{1}{1-\epsilon_k}}$ is the price index of industry k, and $\mathbb{P} = \left(\sum_{k=1}^{K} \alpha_k \mathbb{P}_k^{1-\sigma} \right)^{\frac{1}{1-\sigma}}$ is the price index of this economy. C is the total expenditure on consumption goods.

The optimal choice for a firm (k,i) yields that:

$$p(k,i) = \frac{\tilde{\epsilon}_k}{\tilde{\epsilon}_k - 1} \cdot MC(k,i)$$

$$p(k,i)\left(\frac{\gamma_k y(k,i)}{l(k,i)}\right)^{\frac{1}{\sigma}} \cdot z(k,i)^{\frac{\sigma-1}{\sigma}} = w$$

$$p(k,i)\left(\frac{y(k,i)\omega_{s,k}}{m(s,k,i)}\right)^{\frac{1}{\sigma}} \cdot \left(\frac{m(s,k,i)}{m(s,j,k,i)}\right)^{\frac{1}{\epsilon_s}} = p(s,j), \quad \text{for } \forall s,j$$

where $\tilde{\epsilon}_k = -\frac{\partial y(k,i)}{\partial p(k,i)} \cdot \frac{p(k,i)}{y(k,i)}$. This elasticity is constant inside industry k. Without intermediate goods, $\tilde{\epsilon}_k = \sigma$, this is the case of Dixit-Stiglitz model. And $MC(k,i)$ is the marginal cost of firm (k,i), which equals to $z(k,i)^{\frac{1}{\sigma}} \left(\gamma_k w^{1-\sigma} + \sum_{s=1}^{K} \omega_{s,k}\mathbb{P}_s^{1-\sigma}\right)^{\frac{1}{1-\sigma}}$.

Therefore, we derive the revenues $r(k,i)$ and profits $\pi(k,i)$ for firm (k,i):

$$\begin{aligned} r(k,i) &= p(k,i)y(k,i) \\ &= \psi_k \cdot \delta_k \cdot \mathbb{P}^{\sigma}\mathbb{C}w^{1-\sigma} \end{aligned} \tag{2}$$

$$\pi(k,i) = \frac{\tilde{\epsilon}_k - 1}{\tilde{\epsilon}_k} r(k,i) - f(k,i) \tag{3}$$

where ψ_k is the supply centrality of industry k. It is the k^{-th} element of vector Ψ. And δ_k is the demand centrality of industry k. It is the k^{-th} element of vector Δ.

$$\Psi' = \alpha'\tilde{\Psi}$$

$$\Delta' = \gamma'\tilde{\Delta}$$

where $\tilde{\Psi} = (I - \tilde{\epsilon}^{-\sigma}\Omega)^{-1}$, and $\tilde{\epsilon}$ is the vector which summarizes $\tilde{\epsilon}_k$ in all the industries. Ψ is the *Influential Matrix* with markups as a supplier. Also, $\tilde{\Delta} = (I - \tilde{\epsilon}^{1-\sigma}\Omega)^{-1}$. And $\tilde{\Delta}$ is the *Influential Matrix* as a consumer.

3 Data Description

The data is collected by Standard & Poor Capital IQ (S&P Capital IQ).[4] To investigate the network effect of M&A, we merge three data sets. First is the financial information of the firms. Capital IQ data set covers a majority of the listed firms on the global exchanges. It provides information of 19,160 incorporated firms in 217 countries, compared to a total number of 43,572 listed firms worldwide, according to the data from World Bank.[5] This equals to a coverage of 27.5%. Second is the data about M&A transactions. Capital IQ has high quality of transaction data compared to other sources, especially after year 2005.[6] Third is the data about production network. For each firm, Capital IQ provides the identities of its suppliers and customers along the supply chain. With this information, we can easily extract the connections between firms so that to generate a huge adjacency matrix. This is a directed weighted matrix which summarizes all the information related to production network. By doing so, we end up with a panel data from 2007 to 2015 with financial, network and M&A information.

4 Effects of M&A on Target firms

4.1 Fixed Effect Model

We first use our dataset to look at the effects of M&A through pooled regression model and fixed effect model. The estimating equation have the following form for firm i:

$$log(y_i) = \alpha + \beta_1 MA_i + \beta_2 X_i + FE_{sector} + FE_{country} + \epsilon_i \tag{4}$$

$$log(y_{it}) = \alpha + \beta_1 MA_{it} + \beta_2 X_{it} + \beta_3 Z_i + FE_{sector} + FE_{country} + \epsilon_{it}, \tag{5}$$

Equation 4 is the pooled regression model, while Equation 5 refers to the fixed effect (FE) model. y_{it} is the performance measure of firm i in year t. The key right

[4] A detailed description of the data set can be seen in Appendix A. We show our gratitude to Amy Ding Zhao and Junyao Wang, for their initial help with the data set.

[5] The data is displayed here: http://data.worldbank.org/indicator/CM.MKT.LDOM.NO.

[6] The details can be seen in Section A.

hand side variable is the indicator MA_{it}, which equals 1 for the first year after M&A. X_{it} summarizes time-variant control variables, which includes log level of firm age, log level of firm employment. Z_i summarizes time-invariant control variables. FE_{sector} refers to sector fixed effect, and $FE_{country}$ refers to country fixed effect.

Table 1: Effect of Acquisition

	Pooled Regression			Fixed Effects		
	(1)	(2)	(3)	(4)	(5)	(6)
	Log(Rev)	Log(Prof)	Log(Prod)	Log(Rev)	Log(Prof)	Log(Prod)
$M\&A$	0.0647*	0.0822*	0.0623	0.104**	0.116**	0.0544
	(2.28)	(2.48)	(1.74)	(3.63)	(3.47)	(1.74)
Observations	50761	49656	50761	50761	49656	50761
Adjusted R^2	0.846	0.791	0.231	0.847	0.791	0.231
Country FE	Yes	Yes	Yes	Yes	Yes	Yes
Sector FE	Yes	Yes	Yes	Yes	Yes	Yes
Control Variables	Yes	Yes	Yes	Yes	Yes	Yes

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

In Table 1, the first three columns display the pooled regression results, while the last three columns display the FE result. We choose the log level of three performance measures: revenue, profit and productivity. I extend the Loecker [2013] and Syverson et al. [2015] framework by allowing productivity to evolve endogenously on previous productivities and M&A information. In Appendix C we discuss the estimation algorithm in more detail. By allowing productivity to be endogenous, we avoid sample selection and simultaneity issues. In all the six columns, merger and acquisition induce the target firm to perform better. In the FE model, M&A raises annual revenue by 10.47%, profit by 11.6%, significantly. However, the effects of M&A on productivity are not significant in both pooled regression and fixed effect model. This implies that there are no spontaneous effects on productivity. One conjecture is that it takes time for productivity to respond. Productivity improvements are achieved through reallocation control of productive assets into more able managers' hands.[7] The procedure could take

[7] Maksimovic and Phillips [2001], Jovanovic and Rousseau [2002], Schoar [2002] are more recent examples of work supporting this view.

more than one year, such as in Syverson et al. [2015], the productivity growth becomes significant after three years in Japanese cotton spinning industry. To test whether this is true in our data sets , we investigate the effects of M&A along with time.

In order to achieve this, we look at the time effect of acquisition by adding two dummies: "Early after M&A dummy" and "Late after M&A dummy". The estimating equations have the following form:

$$log(y_{it}) = \alpha + \beta_1 MA_{it} + \beta_2 MA_{it}^{EA} + \beta_3 MA_{it}^{LA} + \beta_4 X_{it} + \beta_5 Z_i + FE_{sector} + FE_{country} + \epsilon_{it}, \quad (6)$$

where MA^{EA} is an "early post-acquisition indicator". It equals 1 for the second year after the acquisition and 0 otherwise. MA^{LA} is an "late post-acquisition" indicator. It equals 1 for all subsequent post acquisition years after the first two and 0 otherwise. The coefficients on these indicators will reflect how acquired firms' performance measures change after acquisitions.

Table 2: Effect of Acquisition: Short Vs Long Term

	Panel A: Log Level			Panel B: Growth Rate		
	(1)	(2)	(3)	(4)	(5)	(6)
	Log(Rev)	Log(Prof)	Log(Prod)	Gr(Rev)	Gr(Prof)	Gr(Prod)
M&A	0.108**	0.102**	0.0339*	0.034**	0.0340**	0.0265
	(3.57)	(3.37)	(2.61)	(3.95)	(6.43)	(1.17)
Early After M&A	0.0941**	0.0921**	0.0470**	0.00663	0.00256	0.0221**
	(2.53)	(3.35)	(3.37)	(0.45)	(0.17)	(3.50)
Late After M&A	0.1070**	0.0925**	0.0573**	0.00236	0.0104	0.0050
	(2.93)	(2.53)	(3.39)	(0.20)	(0.85)	(1.77)
Observations	56853	55526	56853	160101	154791	46877
Adjusted R^2	0.384	0.223	0.240	0.205	0.231	0.214
Country FE	Yes	Yes	Yes	Yes	Yes	Yes
Sector FE	Yes	Yes	Yes	Yes	Yes	Yes
Control Variables	Yes	Yes	Yes	Yes	Yes	Yes

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

Panel A in Table 2 summarize regressions in which dependent variables are in log levels. Merger and acquisition increase revenues and profits immediately after it took place. And the effects are sustainable through time, both in magnitude and significance. The percentage change of revenue is 10.8% directly after M&A, and it becomes 9.41% in early post acquisition years and 10.7% in late post acquisition years. Regarding to profit, the pattern is similar. Profits experience a 10.2% increase in the first year after M&A, then it becomes 9.21% in early post acquisition years, and then to 9.25% afterwards. This gives us a clear picture of substantial effects of M&A on revenues and profits. In contrast, M&A displays increasing effects on productivity with time. The first year after acquisition witnessed a 3.39% increase of productivity. This number climbed to 4.70% in the early post-acquisition years, and then to 5.73% afterwards. Most importantly, the significance is largely improved.

In addition to studying the average level of percentage change, we are also interested in the slope of it. In other words, we are interested in where the large percentage of change come from. Does it come from growing in a constant speed for a long time, or does it come from growing in increasing speed? Panel B in Table 2 shows the effect of M&A on growth rate of all the performance measures. Here, the growth rate in period t is defined as the log difference between productivity in period t and $t-1$. The first two columns display the growth rate change of revenues and profits. There are only significant changes in the first year after acquisition. Later on, the differences of growth rates between target firms and their counterparts are not significantly different from zero. This implies that revenues and profits display a hike in the first year after M&A, and then keep increasing in the same speed afterwards, compared to the firms not involved in M&A. However, productivities display a different pattern. Effect on growth rate of productivity is only significant in the early post acquisition years, which can be seen in the last column of Panel B. This means that in the first year after merger and acquisition, productivities of target firms increase with the speed not significantly larger than their counterparts. Then the speed of growing productivities was boosted in the second year after M&A. That is to say, on top of becoming more productive, the target firms improve their productivities faster.

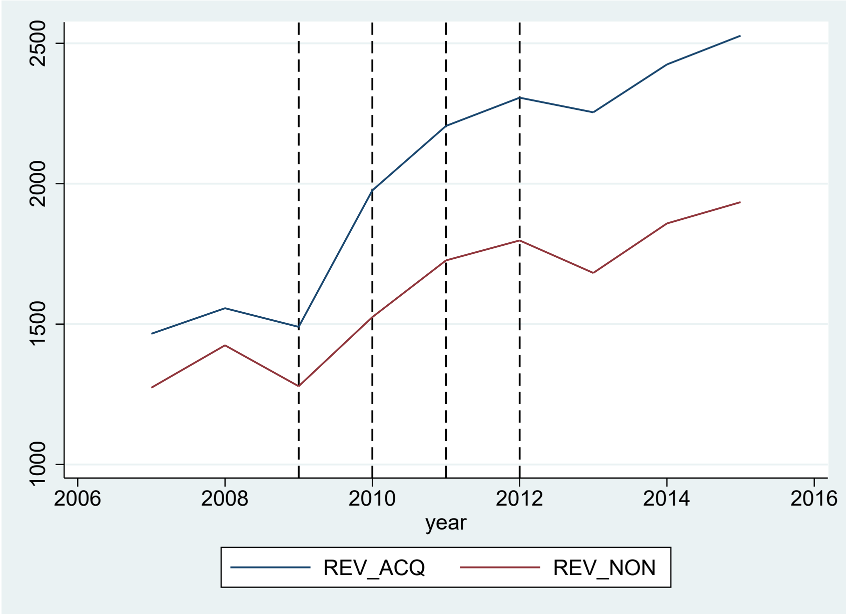

Figure 3: The Effects of M&A on Revenues
Notes: Data source: Capital IQ

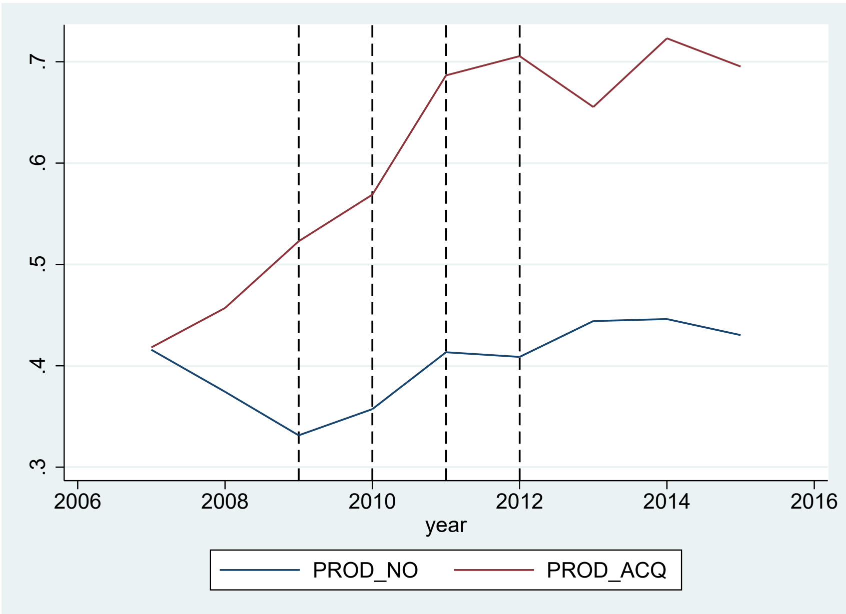

Figure 4: The Effects of M&A on Productivities
Notes: Data source: Capital IQ

4.2 Difference In Difference Method

To explain the results above can be difficult if one considers that the identification of counter-factual is vague. Therefore, to accurately estimate the effect of M&A, we launch similar comparisons using the difference-in-difference (DID) method. The treated group includes firms acquired in a specific year, for example, year 2010. While the control group includes firms which were acquired after that year. In our case, it would be year 2011, 2012, 2013 2014 and 2015. By doing this, we avoid the potential endogeneity problem that M&A decision depend on unobserved variables of the acquired firms. The estimating equations have the following form:

$$\begin{aligned} log(y_{it}) = \alpha + \beta_1 TR_i + \beta_2 MA_{it} + \delta_1 TR_i \cdot MA_{it} \\ + \beta_3 MA_{it}^{EA} + \delta_2 TR_i \cdot MA_{it}^{EA} \\ + \beta_4 MA_{it}^{LA} + \delta_3 TR_i \cdot MA_{it}^{LA} + \beta_5 X_{it} + \\ + FE_{country} + FE_{sector} + \epsilon_{it} \end{aligned} \tag{7}$$

The variable TR_{ij} is a group dummy indicating whether the firm belongs to the treated group or the control group. Parameters of key interests are $\delta_1, \delta_2, \delta_3$. We display these three coefficients and the coefficient of group indicator TR_i in Table **??**. Out of convenience, we only display the effects in year 2010 below. The results of other years can be seen in Appendix B. The results are very robust.

Compared to the results with FE model in Table 2, we would like to highlight two important observations. First, the effects of M&A on productivity is more than twice of the effects in FE model. In Table 2, the post M&A effects are 3.39%, 4.70% and 5.73% for one year, early and late post M&A, respectively. While the DID results in Table **??** display much larger effects on productivities. The post M&A effects are 12.9%, 12.5% and 11.4% for one year, early and late post M&A, respectively. This implies that comparison with the control group indeed improves our estimation. Second, there is an increase in significance. In Table 2, the early post acquisition is significant with 95% confidential level; while in Table **??**, the early post acquisition is significant with 99% confidential level. And the late post acquisition effect becomes significant. In contrast to these, there are no changes in effects on revenues and profits. This implies that M&A decisions correlate with productivities of the acquired firms, not revenues or profits. In our case, this means that when buyer firms choose their targets, the decisions hinge on productivities of the target firms, in stead of profitability. This result echoes Syverson et al. [2015].

Table 3: Effect of Acquisition

	Standard Control			Alternative Control		
	(1)	(2)	(3)	(4)	(5)	(6)
	lrev(t)	lprof(t)	lprod(t)	lrev(t)	lprof(t)	lprod(t)
MA(t-1)	0.013*	0.012*	0.007	0.014*	0.011	0.006
	(0.007)	(0.006)	(0.005)	(0.007)	(0.007)	(0.007)
MA(t-2)	0.062***	0.069***	0.013*	0.043***	0.041***	0.014*
	(0.025)	(0.032)	(0.007)	(0.016)	(0.013)	(0.007)
MA(t-3)	0.067**	0.068*	0.025*	0.041*	0.045**	0.022**
	(0.033)	(0.028)	(0.013)	(0.016)	(0.022)	(0.010)
MA(t-4)	0.027	0.022	0.021	0.031	0.027	0.020
	(0.019)	(0.017)	(0.020)	(0.021)	(0.020)	(0.017)
MA(t-5)	0.013	0.012	0.007	0.014	0.010	0.011
	(0.019)	(0.018)	(0.017)	(0.019)	(0.020)	(0.018)
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
Country FE	Yes	Yes	Yes	Yes	Yes	Yes
Sector FE	Yes	Yes	Yes	Yes	Yes	Yes
Year-Quarter FE	Yes	Yes	Yes	Yes	Yes	Yes
Controls	Yes	Yes	Yes	Yes	Yes	Yes
Observations	541,370	541,370	541,370	541,370	541,370	541,370
Adjusted R^2	0.175	0.189	0.174	0.187	0.219	0.203

t statistics in parentheses

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

Table 4: Summary Statistics I

Variable	**Treated Group**	**Control Group**
Age	18.1	18.5
Latest Revenue	1325.7	1275.8
Latest Profit	432.9	452.3
Size	219	207
Latest Total Enterprise Value	525.1	519.2

4.3 Instrument Variable: Merger Arbitrage Spread

As an alternative identification strategy, we use an instrument variable "merger arbitrage spread" to estimate the unbiased effects of M&A on performance measures. The idea is that mergers trade at a discount because there is always an uncertainty that a deal will break. The merger arbitrage spread captures this risk of M&A. Therefore, it is correlated with merger and acquisition transaction while do not influence productivities. To validate these two conditions, I firstly introduce the time line of an M&A transaction with Figure 5.

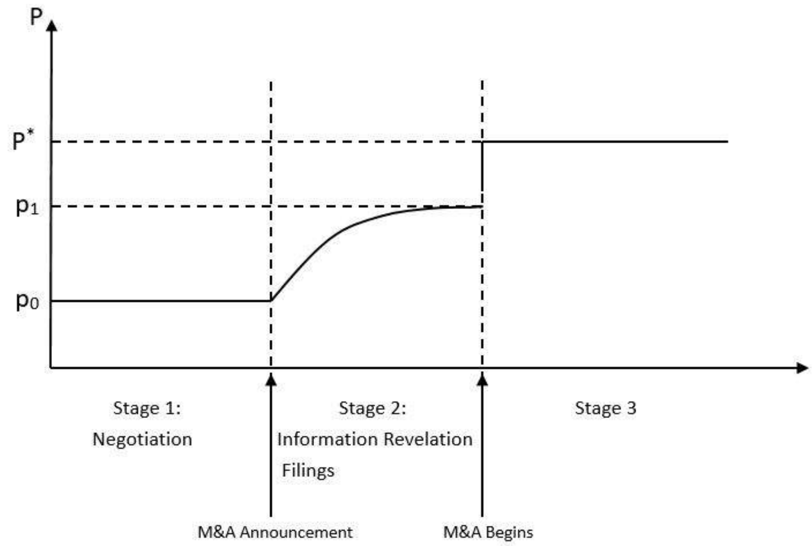

Figure 5: Time Line of M&A

The first step is invariably private, where a buyer firm approaches a target firm and introduces the idea of an M&A. This usually takes place at the Board of Directors level. In other words, information has not been revealed to the market. Typically, approaches end up with an offer price p^* which is definitely higher than the unaffected stock price p_0 of the target firm. The largest M&A transaction in 2016 is Royal Dutch Shell PLC acquiring BG Group PLC. Shell bid an offer price of 10.63 per share when the market price of BG Group is 8.29 which is a big spread.

Once the companies have shaken hands and agreed on a deal, it comes to the second stage: press release. In this stage, the full merger agreement is released. This will contain all of the important terms of the deal, including the conditions necessary for the deal to close, the required governmental approvals, the representations and warranties for buyers and sellers. When the information is revealed to the market, usually, the price of acquired firm increases to p_1, which is smaller than P^*. The spread $p^* - p_1$ is the *merger arbitrage spread*. It reflects the market expectation on the risk of M&A failure. The higher this risk is, the bigger merger spread will be.[8] In the following, I will elaborate why it is a good IV.

Finally, it comes to the last stage when M&A begins.[9] Once the target share holders have approved the deal, it usually closes immediately after. The target firm's stock price will cease trading. While in Europe, where deals are often structured as tender offers, the stock post-tender will still trade. This stock is not eligible for tendering, and it is usually highly illiquid.[10]

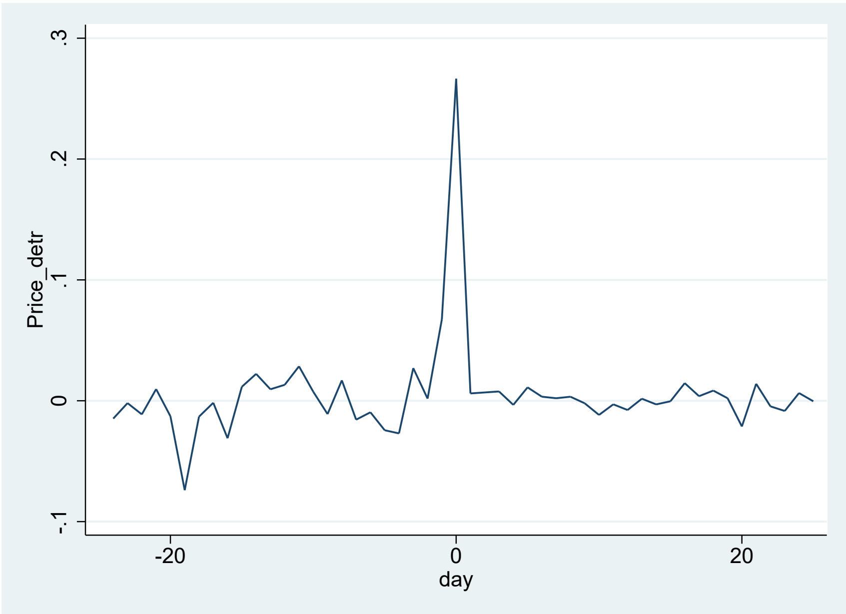

Figure 6: Growth Rate of Stock Price

[8]There are scenarios where $p_1 > p^*$. For instance, On the day of announcement, April 8th 2015, BG Group experienced a hike of stock price: from 8.29 to 11.53, which is bigger than the offer price 10.63. This negative spread implies that market expects a higher offer price to emerge later on.

[9]Before the last stage, there will be a lot of procedures to go through. The parties will make the required regulatory filings. The most common filing is Hart Scott Rodino Act of 1976 (HSR). This is a notification to the government that is required for every deal over a certain threshold. The antitrust investigation will take place in this procedure. In some highly regulated industries, such as banking and utilities, there are other necessary regulatory filings. If the buyer firm is a foreign firm, it need to submit a Committee on Foreign Investment in the United States (CFIUS) file.

[10]In Europe, it is typical for a tender offer to be conditioned on 90% acceptance. In this case, the shareholder would tender their stock and not know if the company has accepted the stock or not.

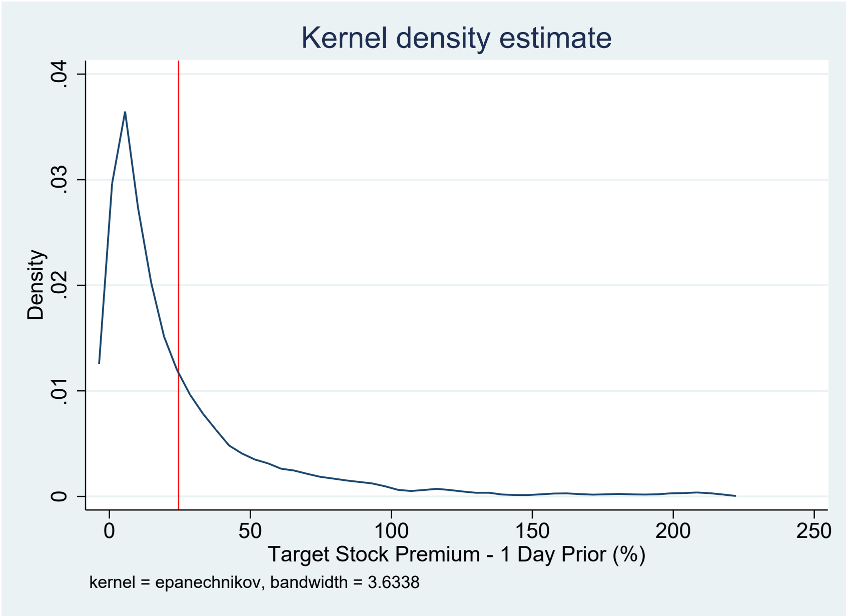

Figure 7: Density of Price Difference

5 Upstream/Downstream/Rebound Effects of M&A on Firms

5.1 Descriptive Evidence

Before any econometric analysis, I display some statistical features about network effects of M&A. The network effect of M&A refers to the indirect effects of M&A on a firm transmitted through production networks. It could be first-order or higher-orders. In this section, we focus on first-order network effects. In the following sections, we extend to higher-order network effects.

First, we display the features of suppliers and prevalence of supplier related M&A. It can be observed from Panel A in Table 6 that 85.39% firms have at least one supplier. This implies that the majority of firms are connected in the production network. Among those 85.39%, 75.83% are connected with firms whose corporate information are available in Capital IQ. The rest are connected with firms out of Capital IQ. For these firms, We have no access to their financial information, however, we know their existences. Then let us investigate the prevalence of supplier related M&A. There are 12.76% of firms which have at least one sup-

Table 5: Effect of M&A

First-Stage Dependent Variable: M&A			
Merger spread	0.022***		
	(0.007)		
F-Statistics	66.64		
Second-Stage Dependent Variable			
	(1)	(2)	(3)
	lrev(t)	lprof(t)	lprod(t)
MA(t-1)	0.012	0.011	0.006
	(0.008)	(0.007)	(0.006)
MA(t-2)	0.042***	0.043***	0.013*
	(0.011)	(0.012)	(0.007)
MA(t-3)	0.039**	0.041*	0.020*
	(0.018)	(0.020)	(0.010)
MA(t-4)	0.023	0.024	0.021
	(0.017)	(0.016)	(0.019)
MA(t-5)	0.015	0.013	0.008
	(0.018)	(0.017)	(0.016)
Firm FE	YES	Yes	Yes
Country FE	Yes	Yes	Yes
Sector FE	Yes	Yes	Yes
Year-Quarter FE	Yes	Yes	Yes
Controls	Yes	Yes	Yes
Observations	541,370	541,370	541,370
R^2	0.215	0.209	0.213

t statistics in parentheses

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

plier being acquired during time window 2007-2013. If we apply the Law of Large Numbers (LLN), this means that the probability of one firm having "Non-Zero Acquired Suppliers" is 12.76%. Together with average supplier number of 2.77 in Panel B, this refers to the probability of getting acquired being 14.57%, which echoes the probability of 15.17% in Figure 34. The last row in Panel A displays that it is almost impossible that a firm has an acquired supplier every year.

Panel B describes the fundamental summary statistics of three important variables: total suppliers, and acquired suppliers in two different samples. The first row tells us that a representative firm in our sample has 2.77 suppliers, which points to an average degree of 2.77. The range of suppliers falls between 0 and 46. Figure 8 display the distribution of suppliers. It can be inferred from moments of the distribution that this density function is very close to a Type I-Pareto Distribution with $\alpha = 1.8$. That is to say, this network has granularity.[11] The second and third row both display the variable of acquired suppliers, however in different samples. The second row picks up firm in the year when supplier-related M&As happen. The third row picks up firms not only in the year M&As happen, but also all the other years during the time window. Therefore, the third row should yield a smaller number. In the year when M&As happen, firms have 1.63 suppliers acquired. While for firms ever involved in supplier-related M&As, they have 0.51 suppliers acquired. That is to say, they have 1 supplier acquired every two years.

Table 6: Summary Statistics

Panel A					
Variable	**Fraction**	**Sample Size**			
Non-zero Suppliers	85.39%	117,159			
Non-zero Acquired Suppliers	12.76%	117,159			
Non-zero Acquired Suppliers	0	117,159			
Panel B					
Variable	**Mean**	**Std. Dev.**	**Min.**	**Max.**	**Sample Size**
Total Suppliers	2.77	15.83	0	46	117,159
Acquired Suppliers	1.63	1.93	1	42	4,635
Acquired Suppliers	0.51	1.32	0	42	14,952

[11] InXXX, they have some distribution in a granular network......

[12] [13] [14] [15]

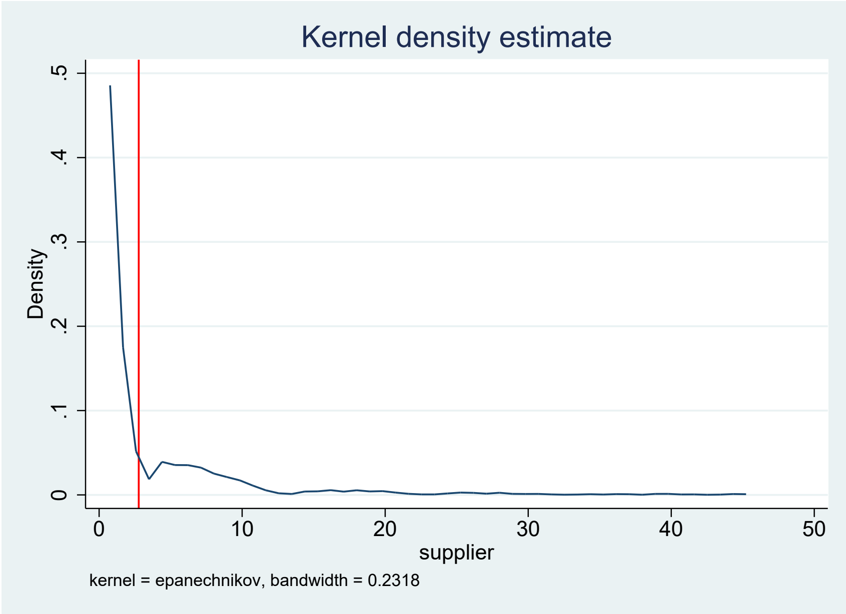

Figure 8: Probability Density Function of Suppliers
Notes: Data source: Capital IQ

Then, before running regressions, I study statistically whether supplier-M&As have an influence on firms' revenues.

Figure 10 displays the business cycle of self-M&As, supplier-M&As and revenues, based on our data set. We detrend all variables using a linear growth model.[12] After that, we project the residuals into space [-1,1], since we are only interested in shapes of the curves instead of their levels. We notice two important features. First, self-M&As and supplier-M&As have very similar pattern. They both experienced a drop in 2008 when the global financial crisis broke out. Then they increased smoothly until they reached a plateau around 2010-2012. After that, they both dropped in 2013. Second, revenues follow the cycle of M&A events, with one-year lag. Revenues had a deep in 2009 and increased afterwards. This indicates that M&As and revenues are correlated. This, without any doubt, is not an

[12] The samples are firms who have at least one acquired suppliers during time window 2007-2013.
[13] The samples are firms who have non-zero acquired suppliers in each of the year from 2007 to 2013.
[14] The samples are firms who have non-zero acquired suppliers in each year.
[15] The samples are firms who have non-zero acquired suppliers in all the seven years, from 2007 to 2013.
[12] Figure 10 displays the residual from running a regression $R_{i,t} = \alpha + \beta \cdot t + \epsilon_{i,t}$, where $R_{i,t}$ stands for revenue of firm i in year t.

argument for causality. But it provides us with a necessary condition to investigate causality .

Figure 9: Self-M&A, Supplier-M&A and Revenues
Notes: Data source: Capital IQ

Next, we would like to explore more about M&As' effects on revenues, statistically. This can be done in many different ways. In this section, we use two methods. With the first method, we compare revenues of firms which are involved in different types of M&As. With the second method, we compare firms' revenues before and after their M&A events. Figure 10 displays the revenues for four groups of firms: the firms which are engaged in both self-M&A and supplier-M&As, the firms which are engaged in self M&As, the firms which are engaged in supplier-M&A and firms without any M&As. It is obvious that firms with both M&As have the largest revenues, followed by firms with only supplier-M&A, then firms with only self-M&As. And the last are firms with no M&As. Therefore, we can roughly draw the conclusion that supplier-M&As and self-M&As both have positive effect on firms' revenues. (We are confident about the effects of self-M&A according to the analysis in Section 4.) And supplier-M&As have larger effect than self-M&As. That is to say, network effects of M&A are larger than direct effects of M&A.

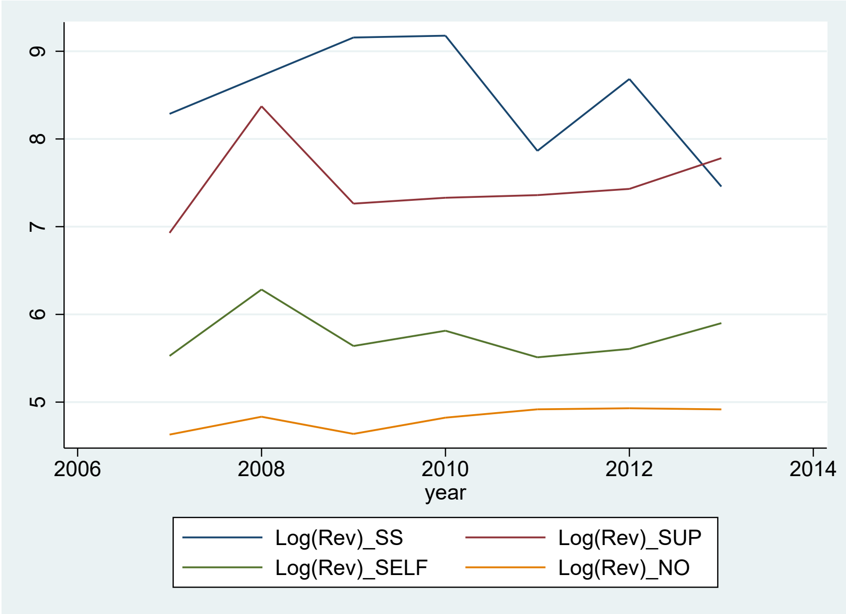

Figure 10: Revenues by Groups: Self-Supplier-M&A, Self-M&A, Supplier-M&A and Non-M&A
Notes: Data source: Capital IQ

Figure 11 displays revenues before and after supplier-M&As take place. The horizontal axis range from [-7,7],[13] and t=0 is the year when M&As happen. Revenues are projected to the space of [-1,1]. We also normalize the revenues of supplier-M&A by its self M&A counterpart in year 0. We can observe from the graph that revenues keep increasing after each type of M&As. Also, firms hit by supplier-M&As have higher revenues than firms hit by self-M&As. This further supports our hypothesis that supplier M&As might have nontrivial positive effects on revenues. And this effect might be higher than that of self-M&As.

[13]There are 14 years because firms have M&A in different years. For firms having M&A in 2007, their t ranges from 0 to 7; while for firms having M&A in 2013, their t ranges from -7 to 0.

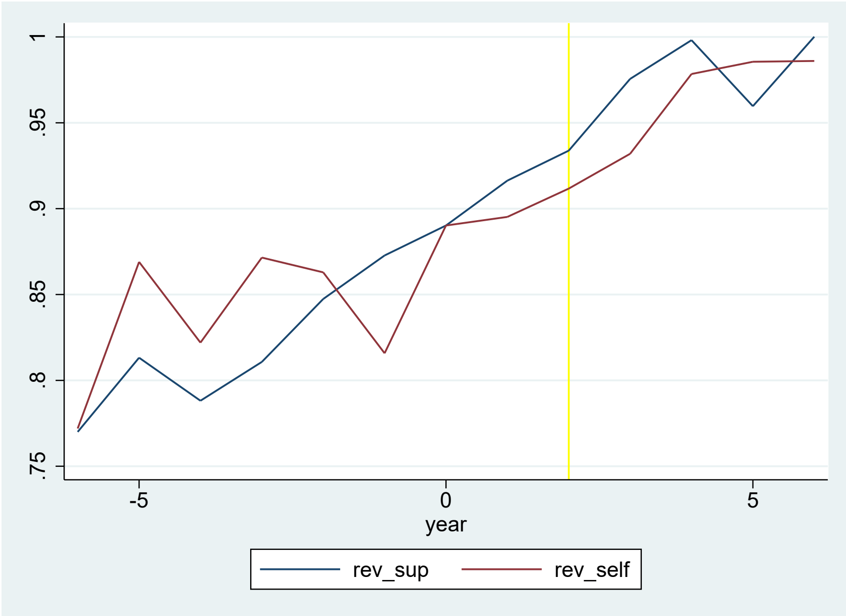

Figure 11: Revenues Across Years

Notes: Data source: Capital IQ

To sum up, a majority of firms are connected in the production network. This network is very likely to have granularity. A distinctive fraction of firms are involved in supplier M&A events, at least once during the time window. Occurrences of self-M&A and supplier-M&A are both correlated with firms' increased revenues. And the firms with supplier-M&As generate higher revenues than those with self-M&As.

5.2 Results

The mechanism is very straightforward. I will illustrate it with Figure 12. Firm A has three upstream firms B1, B2 and B3.[14] They sell intermediate goods to A. Suppose that in year t, B1 is acquired by firm C. According to the analysis in Section 4, B1 will have larger revenues after year t, and higher productivities after year t+1. Either could lead to an increase of intermediate goods that it sells to A. Automatically, it leads to an increase of revenues for firm A. And this shock will propagate through input-output network to other downstream customers, so on and so forth.

[14] We choose three suppliers because the average degree is 2.77, according to Table 6.

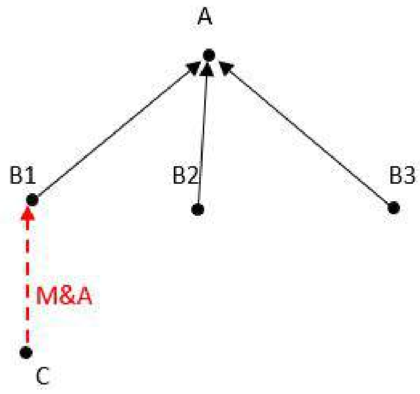

Figure 12: Merger and Acquisition of Firm's Supplier

What we want to test in this section is whether M&As on supplier firms will lead to an increase of revenues for their customers. After that, we investigate the mechanism through which this takes place.

Regressions. In this section, we use FE model, DID model and IV method to estimate this effect. The FE estimating equation takes the following form:

$$\begin{aligned} log(y_{it}) = \alpha + \beta_1 \cdot MA_{it}^{self} + \beta_2 \cdot MA_{it}^{sup} + \beta_3 \cdot N_{sup^{TOT}} + \beta_4 \cdot N_{sup^{MA}} \\ + \beta_5 \cdot X_{it} + \beta_7 \cdot Z_i + FE_{sect} + FE_{country} + \epsilon_{it}, \end{aligned} \tag{8}$$

MA_{it}^{self} in an indicator of whether firm i is acquired in year t. MA_{it}^{sup} is an indicator of whether firm i's suppliers are acquired. $N_{sup^{TOT}}$ is number of total suppliers of firm i. $N_{sup^{MA}}$ is number of acquired suppliers. X_{it} is a set of time-variant control variables, while Z_i is a set of time-invariant variables. FE_{sect} is sector fixed effect and $FE_{country}$ is country fixed effect.

6 Effects of Changing Network Structure

In this section, we investigate how M&A changes the network structure, and how this change contributes to propagation of idiosyncratic shock. According to Acemoglu et al. [2012] and Oberfield [2017], shocks get propagated because the asymmetric structure of network. In other words, there exists some firms who have "granular" influence on others. They play the role of hubs. Shocks move towards these hub firms and then branch out to rest of the economy.

Table 7: Downstream Effects of M&A (IV)

	R&D Group			No R&D Group		
	(1)	(2)	(3)	(4)	(5)	(6)
	lrev(t)	lprof(t)	lprod(t)	lrev(t)	lprof(t)	lprod(t)
SupMA(t-3)	0.027***	0.026***	0.014	0.012	0.014	0.008
	(0.009)	(0.011)	(0.008)	(0.007)	(0.008)	(0.005)
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
Country FE	Yes	Yes	Yes	Yes	Yes	Yes
Sector FE	Yes	Yes	Yes	Yes	Yes	Yes
Year-Quarter FE	Yes	Yes	Yes	Yes	Yes	Yes
Controls	Yes	Yes	Yes			
Observations	218,167	218,167	218,167	323,203	323,203	323,203
Adjusted R^2	0.214	0.218	0.210	0.209	0.223	0.211

t statistics in parentheses

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

Table 8: Downstream Effects of M&A (IV)

	(1)	(2)	(3)
	lrev(t)	lprof(t)	lprod(t)
SupMA(t-1)	0.003	0.010*	0.003
	(0.005)	(0.009)	(0.008)
SupMA(t-2)	0.022*	0.023	0.010
	(0.011)	(0.014)	(0.007)
SupMA(t-3)	0.017*	0.028*	0.025*
	(0.098)	(0.014)	(0.013)
SupMA(t-4)	0.013	0.020	0.011
	(0.019)	(0.017)	(0.017)
SupMA(t-5)	0.011	0.020	0.011
	(0.019)	(0.015)	(0.014)
Firm FE	Yes	Yes	Yes
Country FE	Yes	Yes	Yes
Sector FE	Yes	Yes	Yes
Year-Quarter FE	Yes	Yes	Yes
Controls	Yes	Yes	Yes
Observations	541,370	541,370	541,370
Adjusted R^2	0.201	0.197	0.217

t statistics in parentheses

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

Table 9: Rebound Effects of M&A (IV)

	R&D Group			No R&D Group		
	(1)	(2)	(3)	(4)	(5)	(6)
	lrev(t)	lprof(t)	lprod(t)	lrev(t)	lprof(t)	lprod(t)
PeerSupMA(t-5)	-0.016**	-0.012*	0.003	0.006	0.004	0.007
	(0.009)	(0.006)	(0.008)	(0.007)	(0.004)	(0.005)
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
Country FE	Yes	Yes	Yes	Yes	Yes	Yes
Sector FE	Yes	Yes	Yes	Yes	Yes	Yes
Year-Quarter FE	Yes	Yes	Yes	Yes	Yes	Yes
Controls	Yes	Yes	Yes			
Observations	201,723	201,723	201,723	339,647	339,647	339,647
Adjusted R^2	0.185	0.198	0.180	0.210	0.221	0.207

t statistics in parentheses

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

6.1 Hub Firms and Periphery Firms

To investigate the propagation, first and foremost, we define hub firms in our sample. According to theory, hub firms should be those sitting on the fat tail of distribution. Figure 13 displays the cumulative density function (CDF), and Figure 8 displays the probability distribution function (PDF) of suppliers. We observe that the distribution of suppliers has large skewness and is close to the power law distribution. Table 13 shows that more than 80% of the suppliers are owned by 30% of the firms. And more than half of the suppliers are owned by 5% of the firms. So we define one firm as a "hub firm" if it has more than 22 suppliers.[15] This leaves us with 5852 hub firms in the sample.

[15] Robustness check can be done with respect to different definitions.

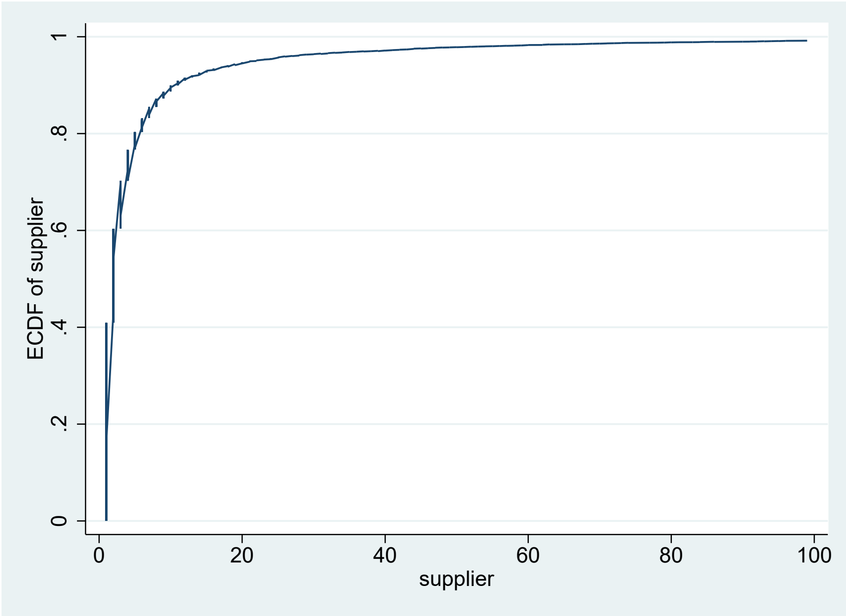

Figure 13: Revenues by Groups: Self-Supplier-M&A, Self-M&A, Supplier-M&A and Non-M&A
Notes: Data source: Capital IQ

Table 10: Distribution of Suppliers

Firms	Percentiles	Share of Suppliers
Top 1%	57	28.64%
Top 5%	22	53.85%
Top 10%	11	64.10%
Top 20%	5	76.76%
Top 30%	3	83.42%

Then, we describe hub firms in this economy. Are they large firms? Are they profitable firms? Are they more volatile? In the following analysis, all firms fall into two groups: the hub firm and the periphery firm. Table 11 displays the average number of suppliers, revenue, profit, size, age and volatility of these two groups.[16] We observe that hub firms are larger and more profitable than periphery firms. They hire more workers, generate higher enterprise value and have longer history. However, they are much less volatile than the periphery firms. This is not counter-intuitive when we consider the fact that larger firms are much less volatile than small firms, proved by a lot of empirical research (XXXXX).

Next, we explore how M&A change numbers of hub firms and structures of

[16]The volatility is defined as the standard deviation of sales' growth rate, following Gabaix [2011] and Kranarz et al. [2016].

Table 11: Hub Firms and Periphery Firms

Variables	Hub Firms	Periphery Firms
Number of Suppliers	69.20	3.20
Revenue (€EURmm)	26183.74	1969.24
Profit (€EURmm)	8125.69	564.37
Total Enterprise Value (€EURmm)	39088.55	3409.69
Size	62919	5482
Age	80.10	52.40
Volatility	0.49	11.33

input-output network.

There are some questions: 1. cross-industry mergers should be more important than intra-industry mergers. 2. Hub firms should be those with numerous connections. More connections leads to more influential on one hand. On the other hand, more connections diversify shocks. How do these two effects work against each other?

6.2 Firm-level Evidence

In this section, we are interested in two questions. First, how merger and acquisition changes network structure. Second, how changes of network structure affect propagation. To investigate the first question, we document how the number of customers change before and after M&A.

Figure 14 displays the number of customers pre-M&A and post M&A, for the combined firms which are buyer firm and target firm. Zero on the time-axis represents the year of M&A. We group M&As into four categories: horizontal M&As, vertical integrations, cross-border M&As, and conglomerate M&As. We observe that right after M&A, the number of customers almost double its size, for the combined firms. And it is true for all the M&A transactions. And the number of customers keep increasing in the second year. And the speed is larger than ex ante. This implies that M&As increase the out-degree of firms by merging them.

However, this does not display the real change of customers for the target firm. Because target firms do not necessarily sell to every customer of its buyer firm. Figure 15 displays the change of customers with whom the target firm actually trade. We observe that there is still a large increase in the number of customers after M&A. The difference to Figure 14 is around 3 customers. This implies that M&A increase out-degrees of firms not only by merging them but also introducing new customers to the target firms. Also, we find that cross-border M&A and horizontal M&A bring much more customer to the target firms than vertical M&A and conglomerate M&A. Conglomerate M&A brings almost zero customer to the target firms. In other words, conglomerate M&A does not change the network structure, and the target firm run as an independent firm.

Then, we would like to understand the sources of these new customers. Table 12 displays the fractions of three sources: new customers who have direct link with the buyer firms, new customer who have indirect link with the buyer firms, and new customers who are not linked with the buyer firms. We define the link as indirect if the two firms reach each other within 3 direct links. Otherwise, we define the link as weak. We observe that for horizontal M&A and cross-border

M&A, most new customers are directly or indirectly linked with the buyer firm. In other words, M&A increase out-degree of firms not only by merging them, but also by developing new customers for them.

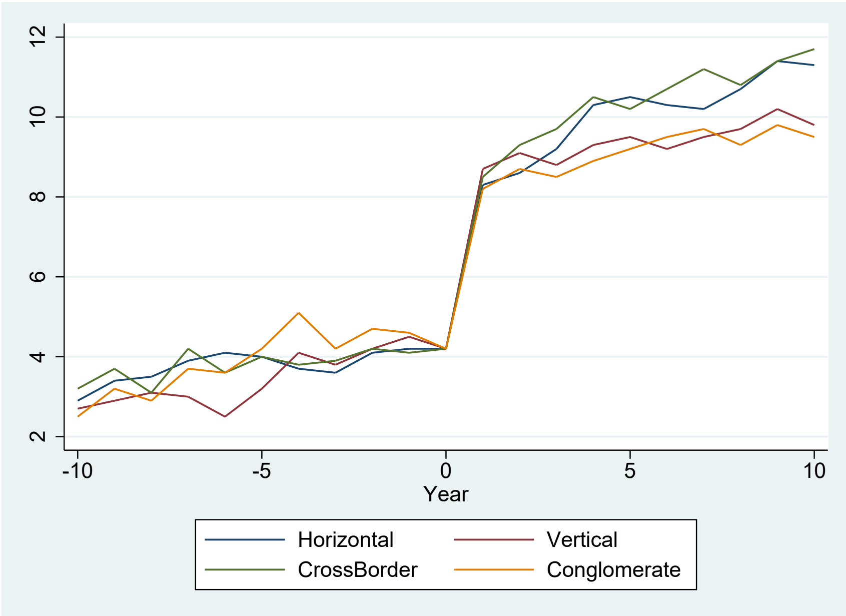

Figure 14: Number of Customers

Notes: Data source: Capital IQ

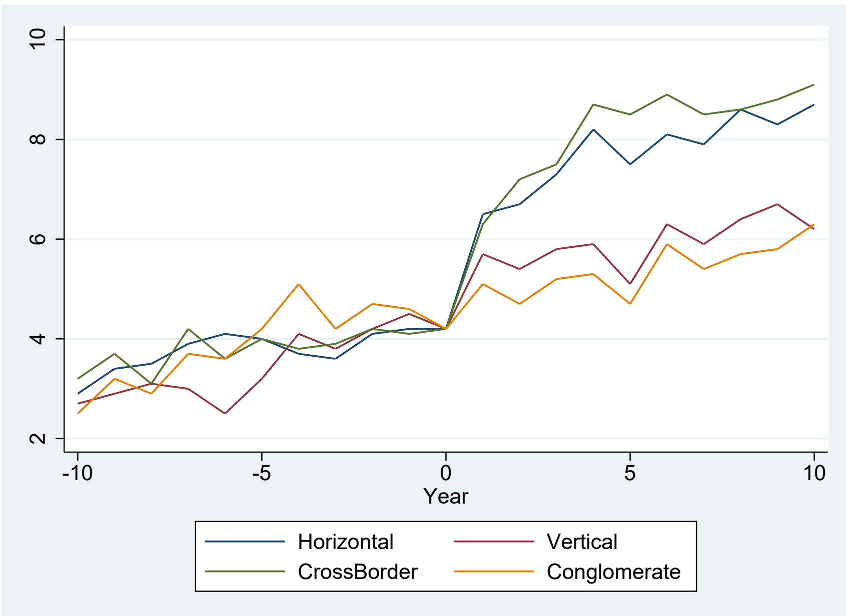

Figure 15: Number of Customers

Notes: Data source: Capital IQ

Table 12: Number of New Customers

	Direct Link	**Indirect Link**	**Weak Link**
Horizontal	2.17	1.38	0.78
Vertical	0.78	0.93	1.34
Cross-Border	2.65	2.31	0.91
Conglomerate	0.59	0.21	1.78

Table 13, 14, 15 and 16 display the features of direct, indirect and weak customers for each type of the M&A transactions.

Types	Number	Degree	Distance	Size	Age	Revenues
Direct	0.78	5.17	1	1,732	32.14	3458.15
Indirect	0.93	5.62	2.31	1,825	27.81	4109.32
Weak	1.34	4.48	7.86	538	28.39	3890.70

Table 13: Features of New Customers: Vertical Integration

Types	Number	Degree	Distance	Size	Age	Revenues
Direct	2.17	14.17	1	1,638	35.46	3598.23
Indirect	1.38	2.62	1.97	1,603	31.26	4290.73
Weak	0.78	3.48	6.92	792	29.41	3920.12

Table 14: Features of New Customers: Horizontal M&A

Types	Number	Degree	Distance	Size	Age	Revenues
Direct	2.65	13.17	1	1,412	33.41	3672.01
Indirect	2.31	4.62	1.37	1,510	32.70	4012.56
Weak	0.91	1.48	8.57	937	28.36	3812.37

Table 15: Features of New Customers: Cross Border M&A

Types	Number	Degree	Distance	Size	Age	Revenues
Direct	0.59	2.31	1	1,708	32.71	3983.01
Indirect	0.21	1.43	1.52	1,631	35.80	3945.92
Weak	1.78	1.51	7.12	912	30.16	3712.57

Table 16: Features of New Customers: Conglomerate M&A

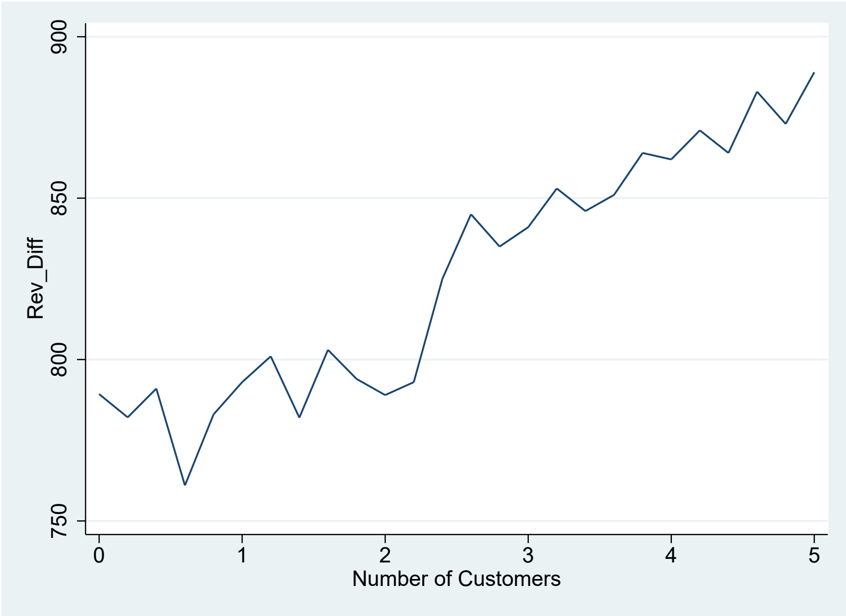

Figure 16: Revenue Differences of Target Firms
Notes: Data source: Capital IQ

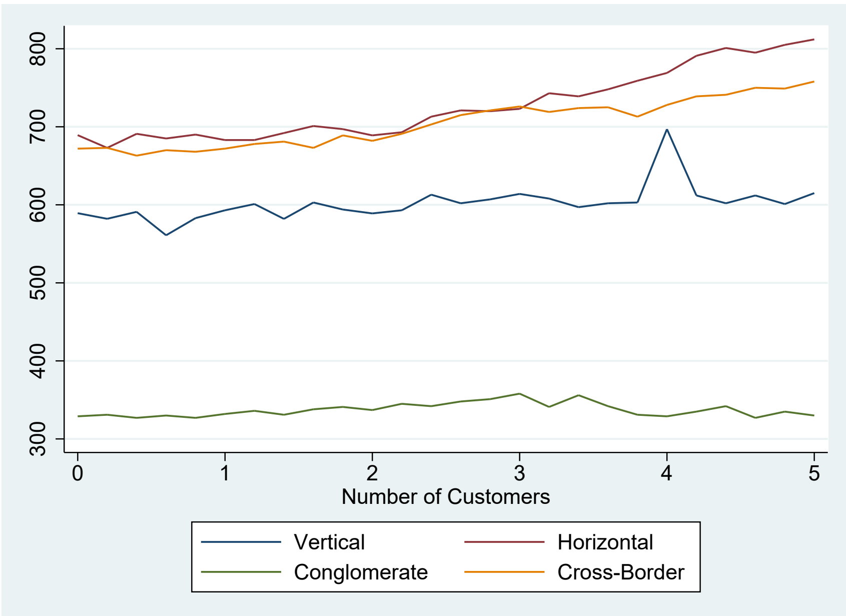

Figure 17: Revenue Differences of Target Firms
Notes: Data source: Capital IQ

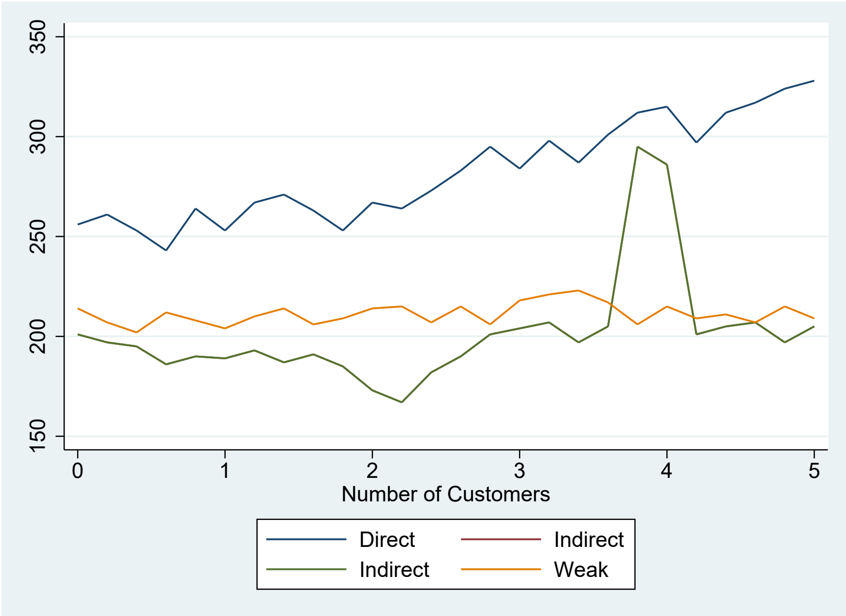

Figure 18: Revenue Differences of Target Firms

Notes: Data source: Capital IQ

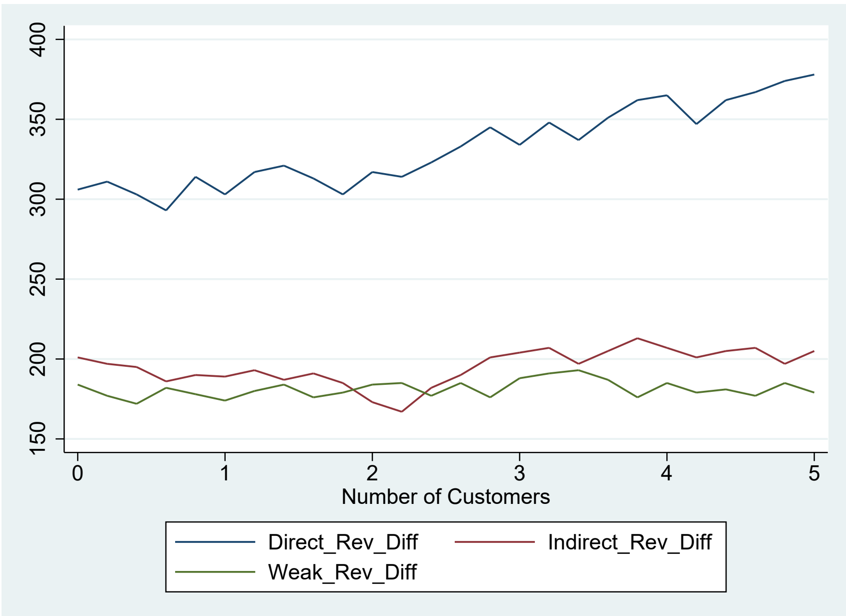

Figure 19: Revenue Differences of Target Firms

Notes: Data source: Capital IQ

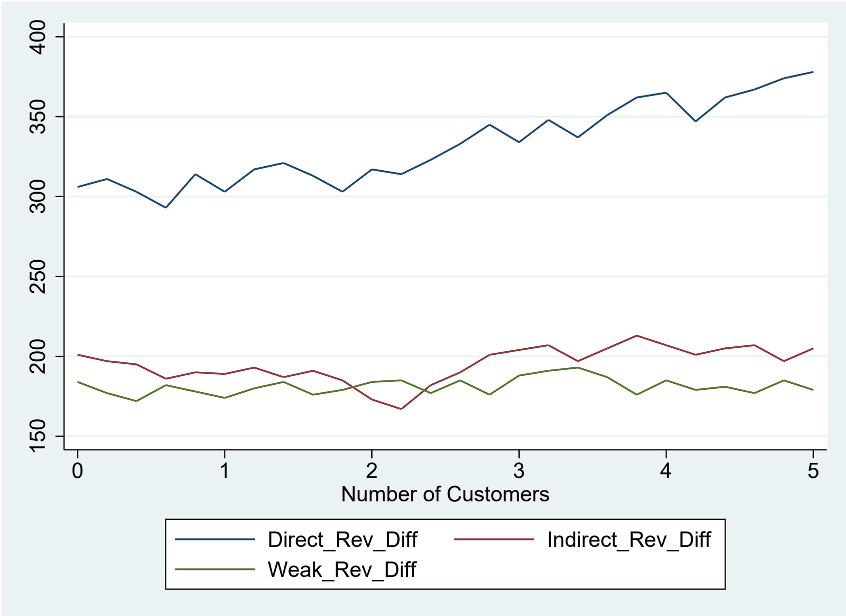

Figure 20: Revenue Differences of Target Firms

Notes: Data source: Capital IQ

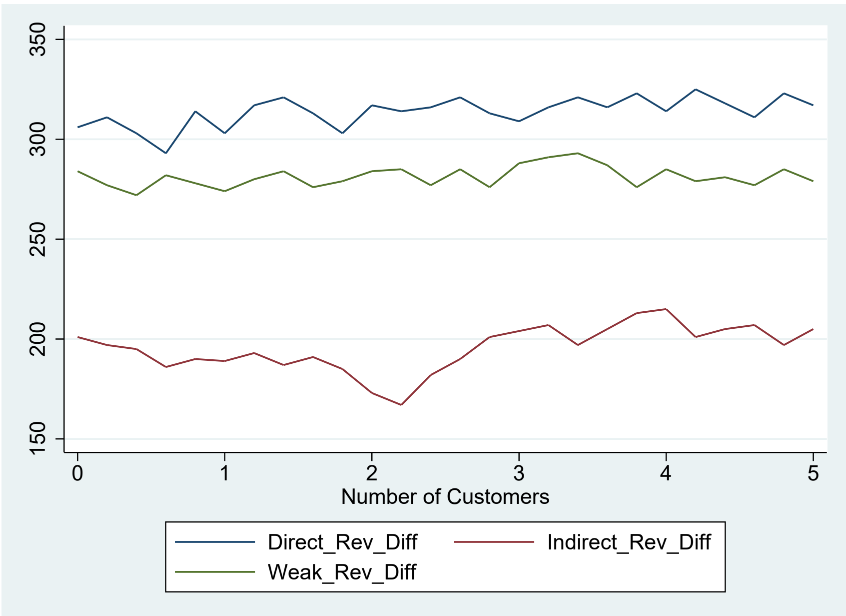

Figure 21: Revenue Differences of Target Firms

Notes: Data source: Capital IQ

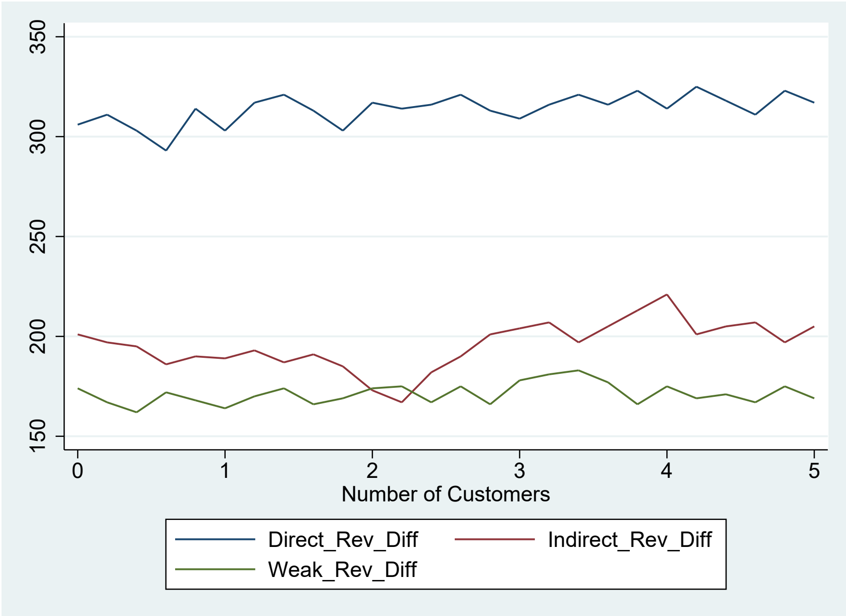

Figure 22: Revenue Differences of Target Firms

Notes: Data source: Capital IQ

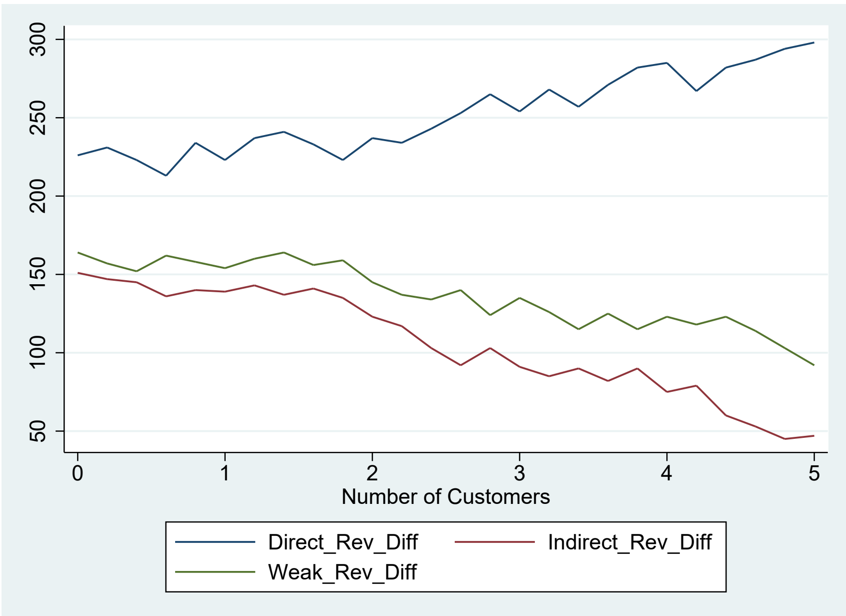

Figure 23: Revenue Differences of Target Firms

Notes: Data source: Capital IQ

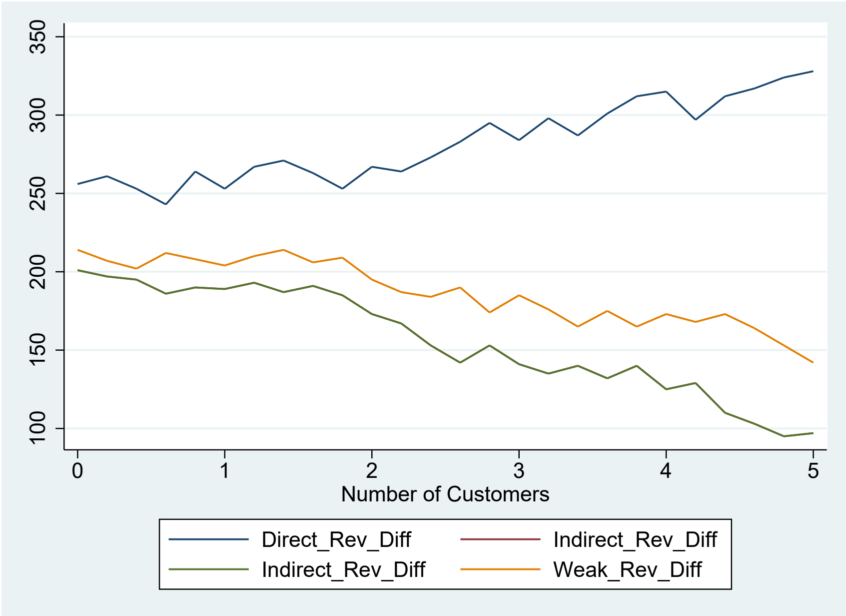

Figure 24: Revenue Differences of Target Firms

Notes: Data source: Capital IQ

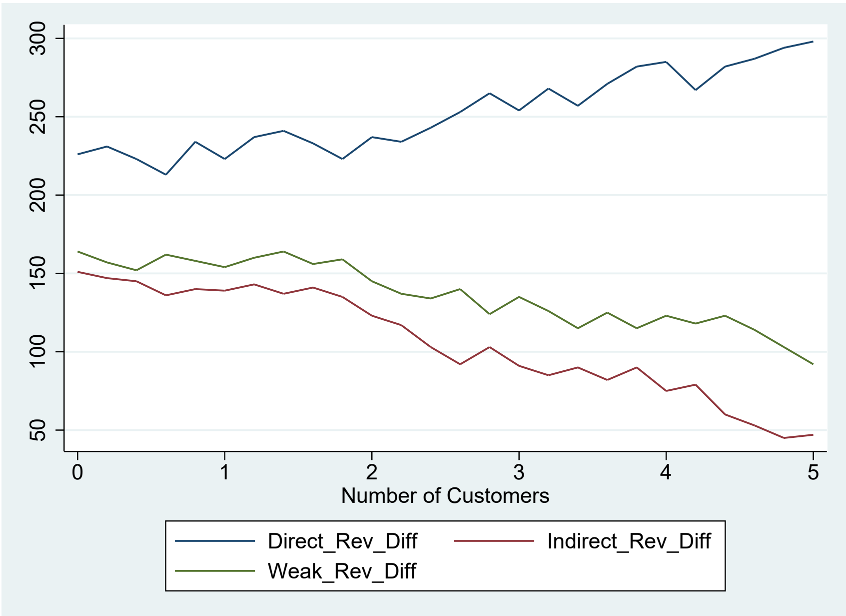

Figure 25: Revenue Differences of Target Firms

Notes: Data source: Capital IQ

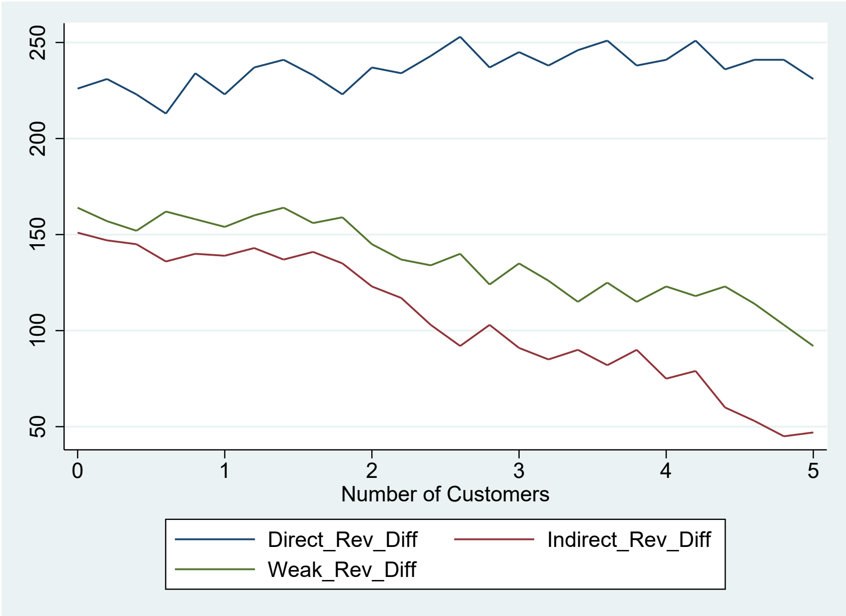

Figure 26: Revenue Differences of Target Firms

Notes: Data source: Capital IQ

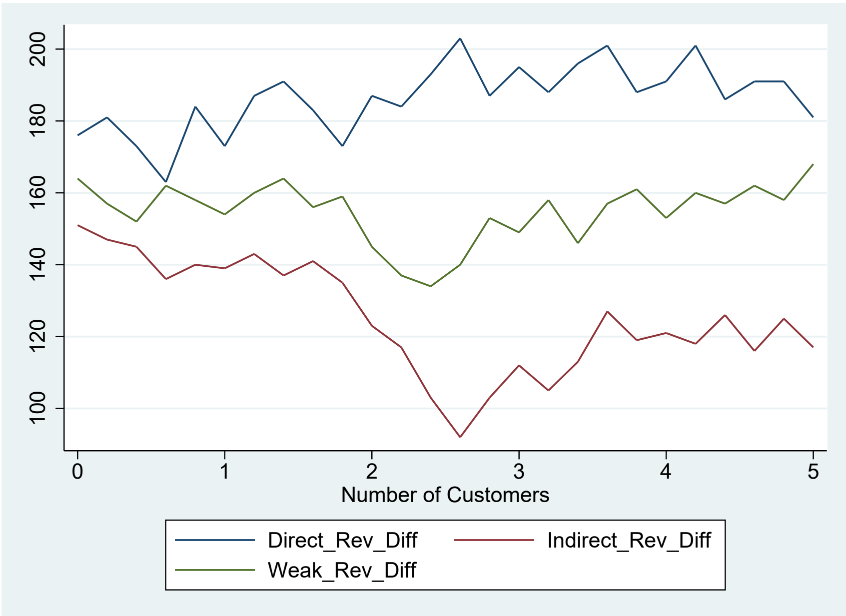

Figure 27: Revenue Differences of Target Firms

Notes: Data source: Capital IQ

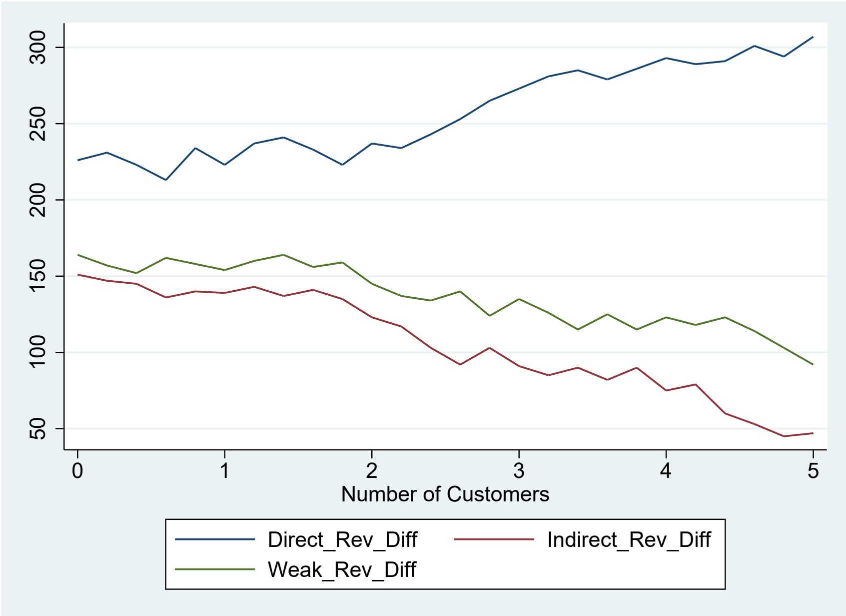

Figure 28: Revenue Differences of Target Firms
Notes: Data source: Capital IQ

[To be Complete]

7 Conclusion and Discussion

[To be Complete]

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A Data Description

A.1 Capital IQ

The firms are seminated among 8 main sectors: energy, materials, industries, consumer discretionary, consumer staples, health care, information technology and utilities, according to the classification of S&P.[17]

The available information of each firm can be summarized into three categories: general information, balance sheet information and business relationship information.

General information:
The country in which the firm operates;
The country in which its headquarter locates;
The age of the firm;
Total employment;
The exchange on which it is listed;
Company type;
Company status;
Ownership structure.

Balance sheet information:
Balance sheet information is available in each month for the past 5 years.
Market value of the firm (in $mm);
Total revenue;
EBIT;
Asset debts structure.

Business relationship:
It provides the information of supplier-customer, licensee-licensor and strategic

[17]The 8 sectors are further fined to 159 smaller sectors. The detail can be seen in the Data Appendix.

alliance connections. This information is collected by S&P Capital IQ from the firm's annual report submitted to Securities and Exchange Commission. [18]. For each firm, we are able to observe:

The identity of its trading partners.

For instance, IBM has 200 *suppliers, among which there are Apple Inc., AcBel Polytech Inc., Beijing Camelot Technology Co., Ltd. and so on. And it has* 344 *customers, among which there are Apple Inc., Australian Broadcasting Inc., Bank of China Ltd., and so on.*

The year in which this relationship is built. However, the volume of each transaction is beyond reach.

[18] In United States, it is the $10-K$ form

A.2 Firm Characteristics

In this section, we present some general characteristics of the firms in our data set. These include: geographic distribution, sector distribution, summary statistics of the firms' age, latest annual revenue (calendar year), profit, employment and total enterprise value (TEV).

Figure 29 presents the percentage of firms in each of the five regions: Africa/Middle East, Asia/Pacific, Europe, Latin America and Caribbean, United States and Canada. Asia/Pacific takes up more than half of the amount, with the United States and Canada being the second. Europe, the third, has considerable number of firms compared to the United States and Canada. Latin America/Caribbean and Africa/Middle East have very small number of firms in this sample. Moreover, we also display the geographic distribution of firms in terms of their revenues in Figure 30. By comparing the two figures, we can observe that the percentages of Europe and the United States/Canada significantly increase when we change from numbers to revenues. This implies that the firms in Europe and the US/Canada sell more than the firms in China.

We also display the distribution of firms across sectors, in terms of both firm numbers and revenues respectively. The sectors are: consumer discretionary, consumer staples, energy, financial, health care, industrials, information technology, materials, real estate, telecommunication services and utilities.[19]

[19] Details of the industry classifications can be seen in Appendix.

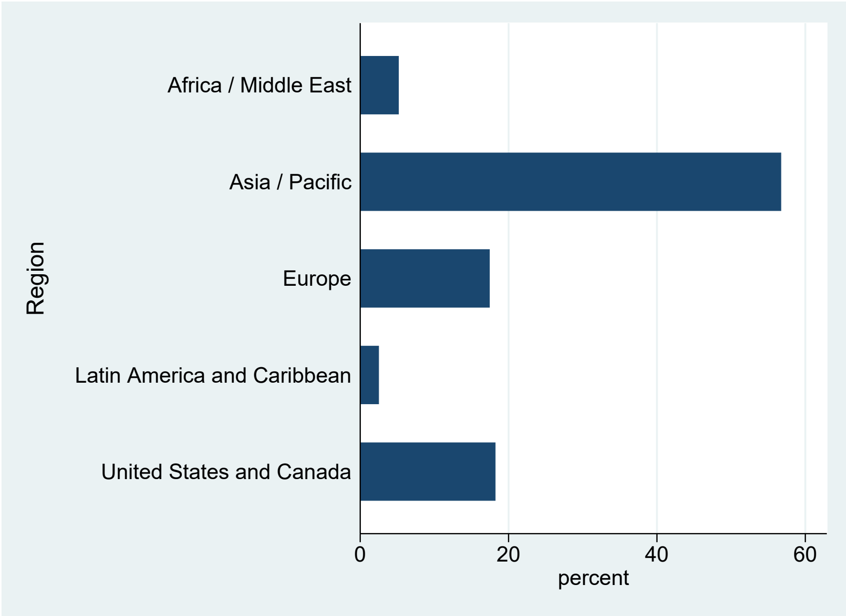

Figure 29: Geographic distribution of firms

Notes: Data source: Capital IQ

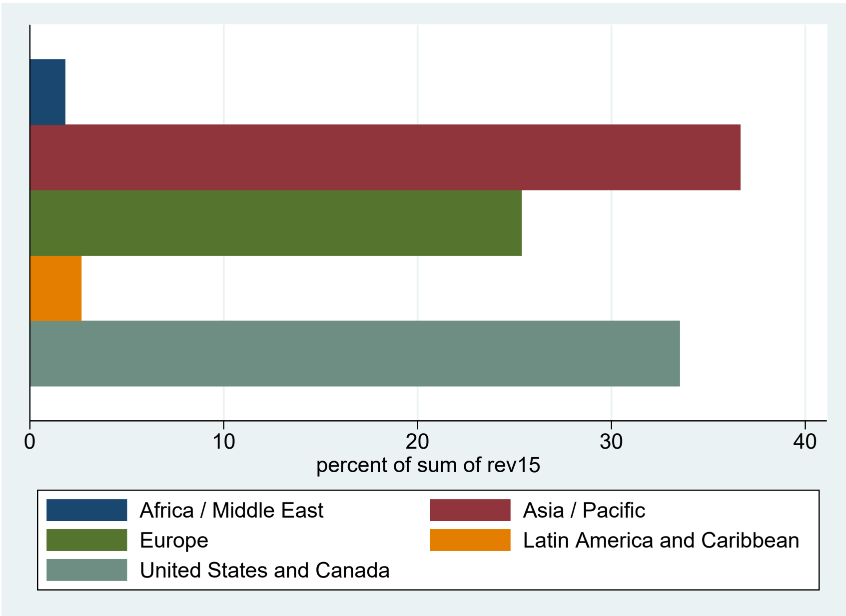

Figure 30: Geographic distribution of firms

Notes: Data source: Capital IQ

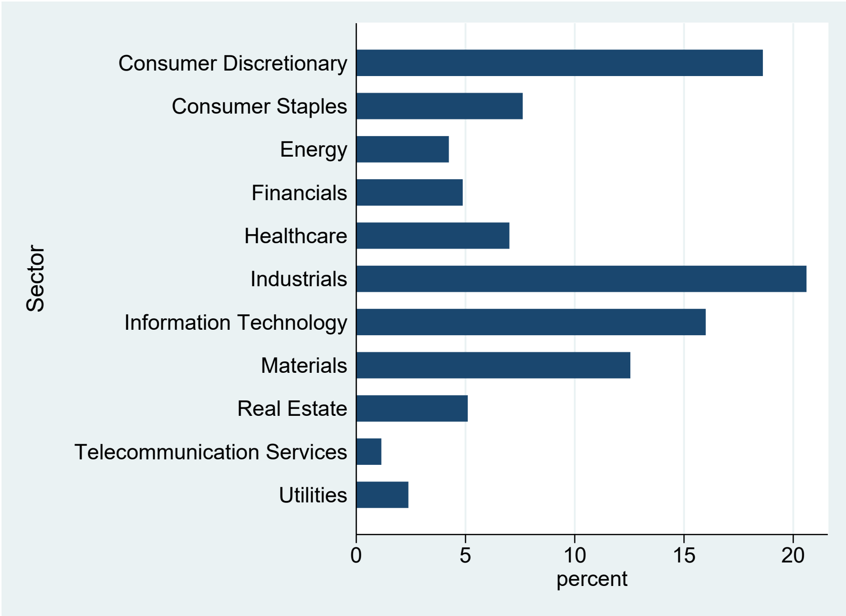

Figure 31: Sector distribution of firms

Notes: Data source: Capital IQ

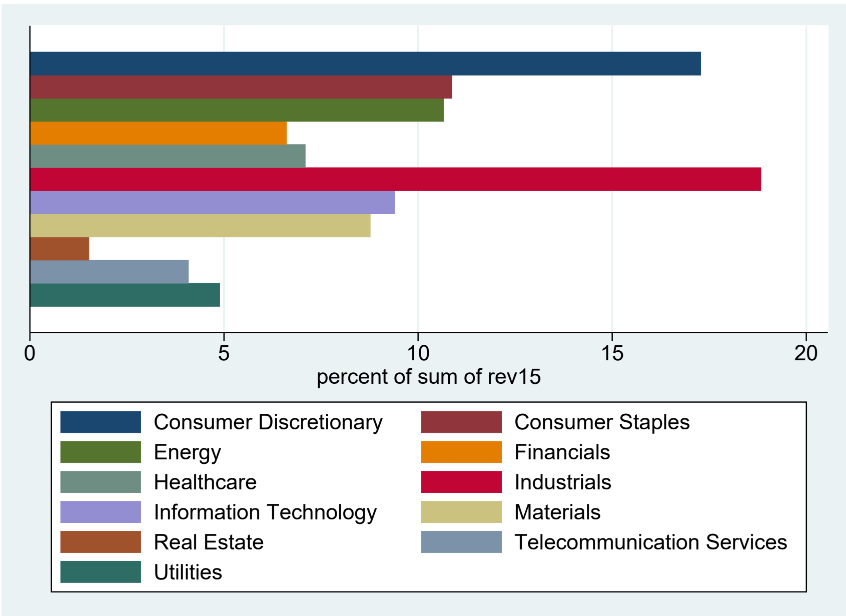

Figure 32: Sector distribution of firms

Notes: Data source: Capital IQ

Next, we display some statistical characteristics of the firms in Table 17: age, size, latest revenue, profit and enterprise value. We include the mean, standard deviation, minimal value and maximal value of these variables. Moreover, we draw the probability distribution function (PDF) of these variables and productivity[20] in Figure 33. We can observe from the density functions that all the variables are fat-tailed distributed.[21]

Table 17: Summary Statistics I

Variable	Mean	Std. Dev.	Min.	Max.	N
Age	17.5	39.3	1	772	19160
Latest Revenue	1756.9	8408.3	0	280289.8	19160
Latest Profit	533.2	2735	-1716.2	94823.8	19160
Size	4067.5	21528.3	0	627150	19160
Latest Total Enterprise Value	1500.2	9298.5	0	583465.3	19160

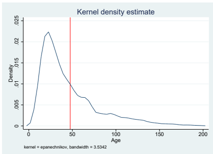

fig1: Age

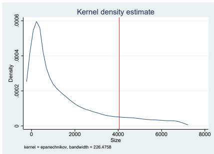

fig2: Size

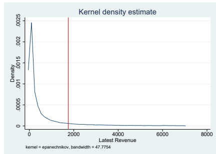

fig3: Revenue

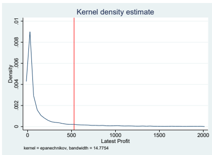

fig4: Profit

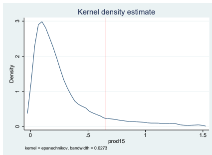

fig5: Productivity

Figure 33: Probability Density Function

A.3 Descriptive Evidence

In this section, we display the features related to merger and acquisition (M&A). Instead of rushing to any of the analysis, we firstly enunciate the identification of M&A. In theory, M&A refers to the transactions in which the ownership of companies, other organizations or their operating units are transferred or combined, see Tirole [2006]. In the data set, we only focus on the transactions which are recorded as "M&A" and also involve a change of ownership. In other words, we neglect those transactions labeled as merger and acquisition, however, do not end up with a change of control.[22] These real "M&A" takes up a percentage of 42.15% in all the "M&A" transactions in 2012.

Then, we display the features of M&A, including the prevalence of M&A in our

[20]Productivity is estimated following the method of Loecker [2013].

[21]We present the right-truncated distribution of all variable.

[22]Some transactions can be labeled by security commission as "'M&A" even though they are not. For instance, tender offers, sometimes labeled as merger and acquisition, do not necessarily lead to a change of ownership. Or, increasing outstanding shares by a big shareholder may also be labeled as "M&A", even though the shareholder does not aim for it. The reason for this broad definition of M&A in reality is to reveal information. By doing so, the other shareholders will receive the message about the emergence of a new big shareholder, who might be a potential buyer of the company.

sample, how it is distributed across regions and sectors, how it changes through time, and the performance of firms *ex ante* and *ex post*.

Among the total number of 19, 160 firms, an average percentage of 21.28% has been acquired by the other firms. Figure 34 represents the change of this percentage from year 2007 to year 2012. We can observe that M&A keeps increasing from year 2007 to year 2012.

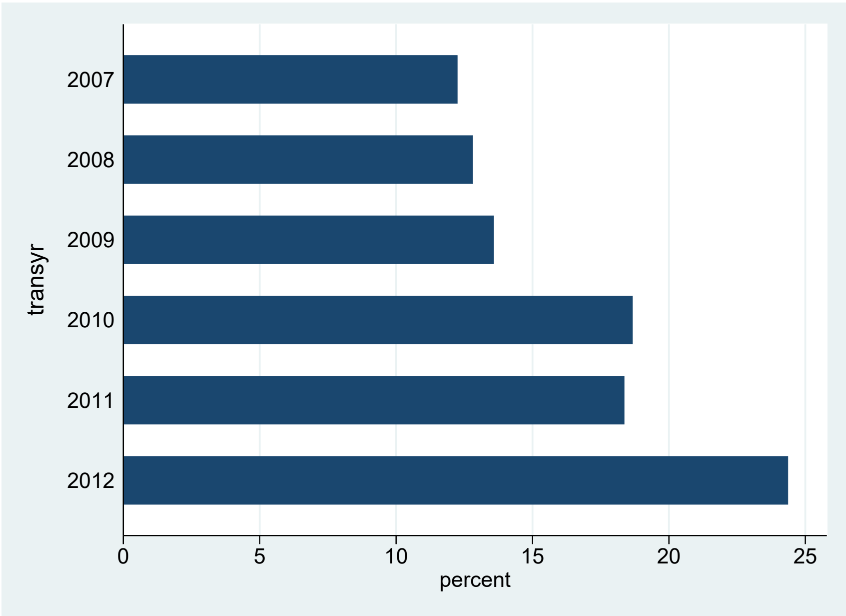

Figure 34: Percentage of the acquired firms

Notes: Data source: Capital IQ

Next, we display the distribution of merger and acquisition transactions across region and sectors. Figure 35 and Figure 36 displays the distribution of mergers and acquisitions across regions and sectors, respectively. It is striking to see that the United States and Canada only takes up less than 10% of the total M&As. In comparison with that, Asia/Pacific takes up more than half of the M&As worldwide.

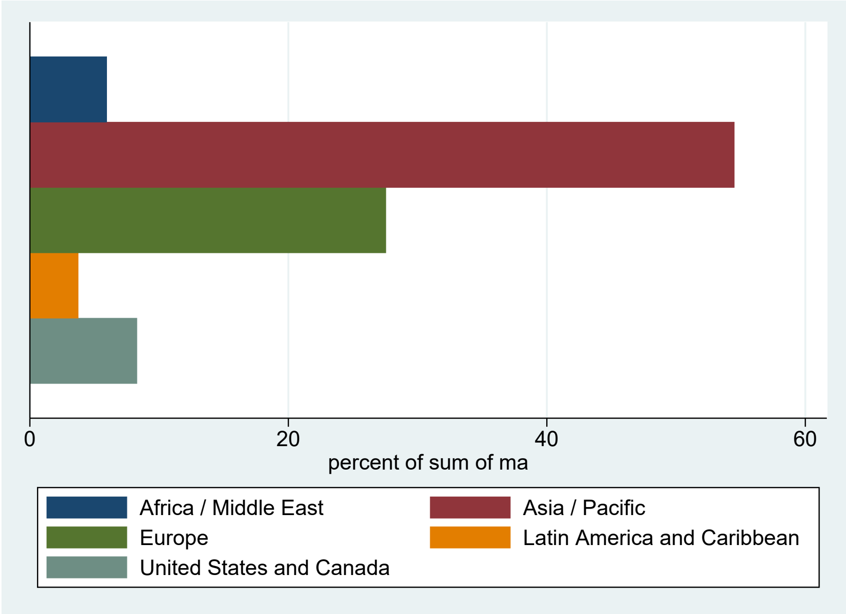

Figure 35: Sector distribution of firms
Notes: Data source: Capital IQ

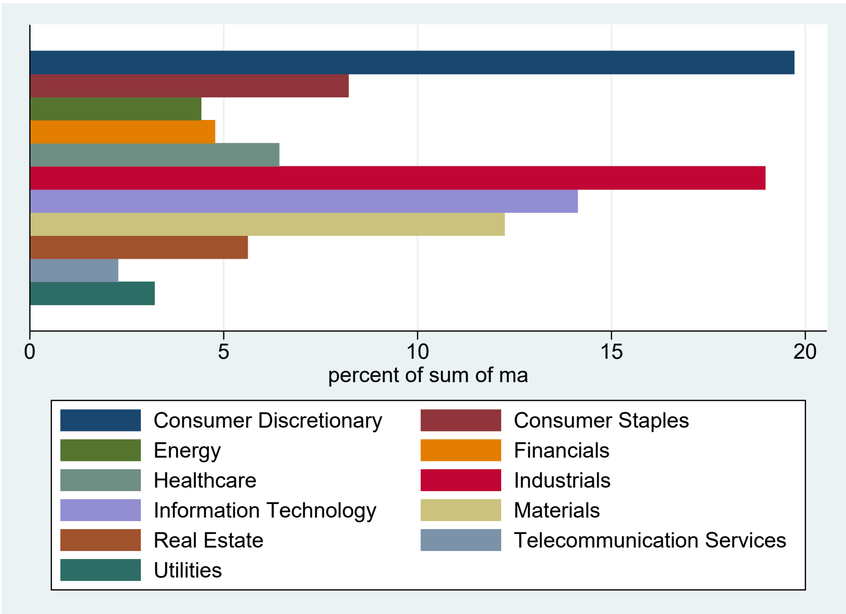

Figure 36: Sector distribution of firms
Notes: Data source: Capital IQ

Then, we display the performance measures of firms *ex ante* and *ex post*, for both treated group and control group. For convenience, we restrict our treated group to firms which were acquired in year 2010, while the control group contains firms that did not involve in M&A in all years. The performance measures include revenue, profit and productivity. What we are interested in are firms' behaviors around 2010 as well as the difference between the two groups. First, let us focus only on target firms. We can observe from Figure 37 that acquired firms experienced boosts in their revenues, profits and productivities in year 2010 on top of the time trend. These three measures keep climbing afterwards, in spite of a mild drop in around 2012 to 2013. Second, let us compare the two groups. No matter *ex ante* or *ex post*, the treated group displays higher revenues and profits than the control group. This means that better firms get picked by the buyer company to be an acquisition target. But there is no obvious sign whether the difference is contracting or expanding *ex post*. However, productivity of the treated group was lower than the control group *ex ante* but surpassed it after three yeas of M&A. This will be further validated by an difference-in-difference (DID) method in Section 4. This result reveals the possibility that target firms might be those with high potential of growth and its buyer takes this into consideration when making the acquiring decision.

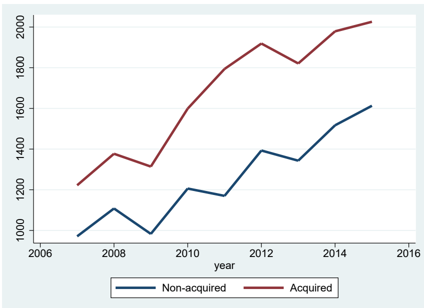

fig1: Revenue

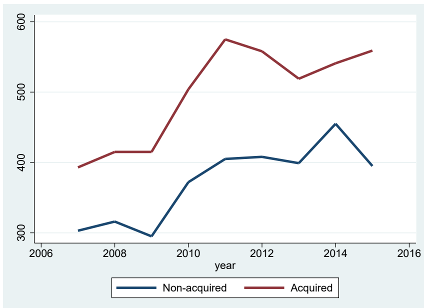

fig2: Profit

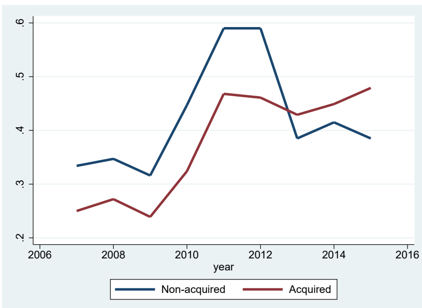

fig3: Productivity

Figure 37: Performance Measures of Acquired and Non-acquired Firms

What is more, we also compare the target firms and its buyer firms in Figure 38. We find that target firms are not less productive than the acquiring firms. However, the acquired firms are much less profitable than acquiring firms. These finding echo an important stand in previous research that emphasized the role played by assortative matching, see McGuckin and Sang [1995], Rhodes-Kropf and Robinson [2008] and Syverson et al. [2015].

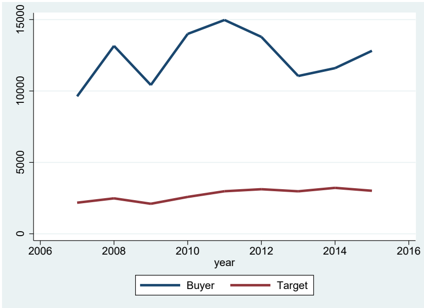

fig1: Revenue

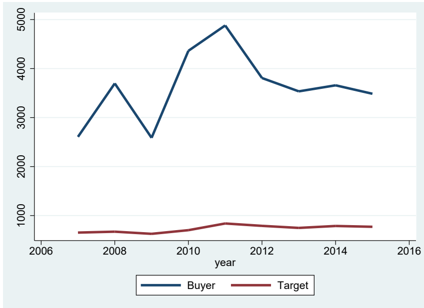

fig2: Profit

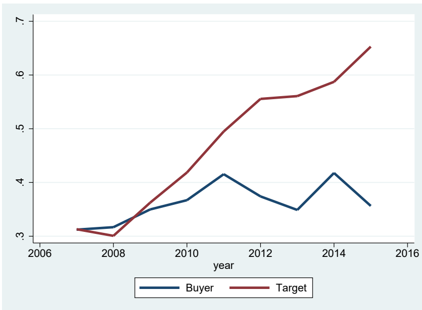

fig3: Productivity

Figure 38: Performance Measures of Acquired and Non-acquired Firms

B Difference-in-Difference Analysis

C Productivity Estimation

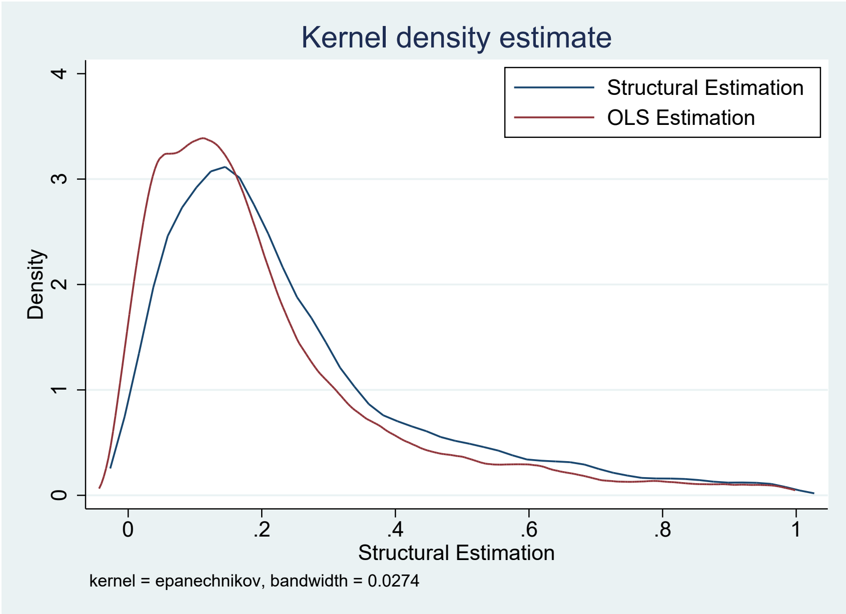

Figure 39: Productivity Estimation

Notes: Data source: Capital IQ

Then we compare the difference of structural estimation result and OLS estimation result for acquired firms and non-acquired firms, respectively. The difference is defined as the following:

$$\frac{\hat{\varphi}_{OLS} - \hat{\varphi}_{structural}}{\hat{\varphi}_{structural}}$$

This difference is -2.75% for acquired firms and -7.52% for acquired firms.