Do acquisitions improve efficiency? Evidence from Chinese steel industry

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Abstract

Using firm level data from 2006 to 2018, we investigate the effect of acquisitions led by the government in Chinese steel industry. We find reduction in cost and increase in profitability among the acquired firms after acquisitions. However, these effects are totally driven by within-province acquisitions. Following a within-province acquisition, manufacturing costs of acquired firms decrease by 5% on average, while there is no significant change in output prices. As a result, profits increase. These efficiency gains don't stem from reductions in labor forces or increases in labor productivity. But instead, we find evidence consistent with improvements in production process and inventory management. By contrast, we find no significant change in prices, costs, or profits following cross-market acquisitions. Our findings indicates that acquisitions led by the government result in efficiency gains, but the effects can differ by the geographic scope of acquisitions.

Keywords: Acquisition, Steel industry

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1 Introduction

China is the largest steel producer in the world, accounting for more than half of the global steel production. Despite rapid growth in domestic construction, infrastructure projects and manufacturing sectors, Chinese steel manufacturers grapple with surprisingly low profit margins, due to high energy consumption, low labor productivity, overcapacity and low concentrations.'[1] Identified as a pillar industry essential to national interest, the central government has initiated a set of policies to improve efficiencies, integrate capacities and encourage the formation of large enterprise groups through consolidations.

In this paper, we investigate acquisitions in the Chinese steel industry between 2006 and 2018, highlighting the distinction between within-province and cross-province acquisitions. We find cost decreases and profit increases in acquired firms after acquisitions. However, the decrease in cost and increase in profit is totally driven by within-province acquisitions. Following a within-province acquisition, manufacturing costs of acquired firms decrease by 5% on average, while there are no significant changes in price or output. As a result, profits increase. Our analysis reveals that the cost reduction is not driven by within firm resource or product reallocation. But instead, we found evidence consistent with improving technical process efficiency. By contrast, we find no significant changes in prices, costs, or profits following cross-province acquisitions. Our results underscore the existence of cross region barriers that may hinder the policy goals.

Understanding the trade-off between efficiency gains and market power is the fundamental issue in merger analysis. While many studies have focused on the price effect of merger (e.g., Kwoka & Shumilkina, 2010; Calton et al., 2019), relatively little attention is directed at the trade-off between efficiency gains and market power, partly due to data limitation. What's more, the underlying mechanism of efficiency change is seldom discussed. Our data on Chinese steel manufacturers provides detail information on both product and firm level input output choices. This allows us to distinguish true efficiency gains from changes in market power and product quality. Furthermore, by introducing emission data in our analysis, we are able to construct a measure of technical efficiency using sulfur dioxide (SO2) emission per ton of steel output. This allows us to evaluate the effect of consolidation on process efficiency.

While most merger analysis have focused on firms competing in the same (geographic or product) market, there is a growing literature on the price effect cross-market mergers. They found that hospitals might gain market power from cross-market mergers through (i) enhancing bargaining power with downstream insurers (Lewis and Pflum, 2017) (ii) eliminate competition in some high value services (Dafny et al., 2019)[2]. However, the efficiency gains from cross-market mergers have not been well studied. Our paper is among the first to understand efficiency and the geographic scope of merger. Making the distinction between cross- and within-province

[1]For example, the average C4 is 23% between 2006 and 2015. Heibei steel group, the largest manufacturer in China command only 5.9% of domestic production of crude steel in 2015 (Huang et al., 2018).

[2]Hospitals cross market can compete for some high value service

acquisition is particular important in the Chinese steel industry, given that local government (city or province) controls most steel manufacturers. Cross-province acquisition could face strong resistances if, for example, restructuring lowers tax revenue and results in layoffs. On the other hand, within-province acquisitions are much easier to coordinate. This could lead to different efficiency gains in different types of acquisition.

Our paper is also related to the literature on mergers led by government. To save cost and improve efficiency of public service, many political authorities encourage mergers among provider of services, such as hospitals and electricity distributors. However, in these industries, literature finds little improvement in performance (Gaynor et al., 2012) or efficiency (Clark and Samano, 2022) after mergers. In China, the government's support on mergers comes in multiple forms and are widespread in several key manufacturing industries. Existing literature on effects of mergers led by Chinese government mainly looks into Chinese airline industry, which finds mergers increase both productivity (Yan et al., 2019) and market power (Ma et al., 2020). Our paper focuses on acquisitions in another key industry-the steel industry in China, to provide more evidence on impact of mergers and acquisitions led by government.

The rest of our article is organized as follows. Section 2 gives background of mergers and acquisitions in Chinese steel industry. Section 3 introduces our data. Section 4 presents some descriptive evidence. Section 5 shows our main results. Finally, we conclude.

2 Background

Like many other pillar industries in China such as automobile and cement industry, steel industry has a large production capacity but has relatively low technical level, low concentration and low utilization of capacity. The central government hopes to improve the concentration and competitiveness of steel industry through mergers and acquisitions (M&A). In "Development Policy for the Iron and Steel Industry" (2005), the government set "*establishing large enterprise groups through M&A*" as an important goal in the industry. In "Blueprint for the Adjustment and Revitalization of the Steel Industry" (2009), the government encourages both cross-region and within-region M&As. In "Steel industry adjustment and upgrading plan (2016-2020)" (2016), the government encourages "*cross-industry, cross-region, cross-ownership mergers and acquisitions of leading enterprises in the industry*" as well as *"mergers and acquisitions of steel enterprises within the same region*".

Although both within-region and cross-region M&A are encouraged by the government. The difficulties and motivations in these two kinds of M&A are quite different. Expected for steel enterprises owned by the central government such as Bao Steel, Wu Steel and An Steel, most steel enterprises are owned by the regional (province or city) government. Although within-region M&As are usually much easier with the coordination of the regional government, cross-region M&As face more resistances because steel firms are important sources of local tax revenue and

employment. Nevertheless, cross-region M&As are still quite common. Because the industrial policy regulates establishment of new capacity in the industry since 2005[3], cross-region M&A is the only way for enterprises in mega cities (e.g. Bao Steel in Shanghai city, and Capital Steel in Beijing City) to expand its capacity.

The government's role in M&A can come in multiple forms. Although in most cases the government only provide financial and non-financial supports to M&A (For example, the government may provide special funds to subsidize the cost of M&A, or help to coordinate related municipal agencies to shorten the process of M&A), in some early case the government directly intervenes the M&A. The government's intervention also differs across mergers and acquisitions. Usually, the merger involves more interventions from the government while the acquisitions are more market-driven.

3 Data

Product Specific Data. The revenue, output and cost information on each product category of large and medium size steel firms comes from compilation of financial statements (CFS) on metallurgical enterprises collected by Chinese steel industry association (CSA). We focus on firms that manufacture steel as final output and exclude those with only intermediate products such as billet or raw iron. We also exclude alloy or special steel manufacturers. All together, our sample account for 77% of total steel production in China in 2018.

Steel can be divided into twenty-one different product categories, such as wires, reinforcing bars, seamless steel pipe etc. Each product serves different uses in different markets. For example, reinforcing bars are used in construction while seamless steel pipe are primarily used for transporting liquids and gases. Eight product categories (e.g., heavy steel plate, steel for railway, seamless steel pipe, etc.) are considered high value-added, whose production involves specialized equipment and technical barrier. The rest of sixteen product can be easily added to or removed from a manufacturer's product line. In our analysis, we exclude categories of seamless steel pipe and steel for railway where the market have strong monopsony power, and include only rest nineteen product categories.

For each firm, we can observe the product specific output (both in tons and in revenue) and manufacturing cost. The manufacturing cost is a variable cost that sums up all expenses directly attributable to the production of a product (e.g., materials, intermediate inputs, labor, energy, etc.). Product specific price and cost are defined as revenue per ton and manufacturing cost per ton respectively. Industry experts consider profit per ton of output as the key measure of product profitability. As such, we define the product specific profit as the difference between

[3] "Development Policy for the Iron and Steel Industry (2005)" required no significant improvement in steel capacity, the regulation is more strictly in later industry poliy

Table 1: Summary Statistics

Variable	Definition	N	Mean	SD
	Upper panel: product level variables			
Price	Product specific price (1,000 CNY/ton)	2218	3.39	0.85
Cost	Product specific variable cost (1,000 CNY/ton)	2218	3.21	0.89
Profit	Price-cost (1,000 CNY/ton)	2218	0.19	0.36
Mkup	Price/cost	2218	1.07	0.11
Quantity	Product output in tons (1,000,000 ton)	2218	1.14	1.18
	Lower panel: product level variables			
P_frm	Weighted average unit price of steel product (1,000 CNY/ton)	633	3.27	0.74
C_frm	Weighted average unit variable cost of steel product (1,000 CNY/ton)	633	3.02	0.72
Profit_frm	Weighted average unit profit of steel product (1,000 CNY/ton)	633	0.25	0.26
Mkup_frm	Weighted average markup of steel product	633	1.09	0.09
Labor	Employment (1,000)	704	12.36	13.13
Outperworker	Quantity of steel product/employment	704	380.38	286.72
Inventory	Value of inventory (1,000,000 CNY)	567	2,336.76	3,128.40
SO2perton	SO2 emissions per unit of output (ton/ton)	413	14.61	12.16
Emi_exp	Expense on emission treatment (1,000,000 CNY)	368	123.10	244.71

price and cost. Alternatively, we also calculate the product specific markup as the ratio between price and cost as a unit free measure of profitability.

Upper panel in table 1 presents the summary statistics of product specific variables. With 711 firm year observations in our sample, each firm produces 3 products on average and single product firms are uncommon. The mean price is around 3,462 CNY per ton (or approximate 481 in USD) and the cost is around 3,278 CNY per ton (or approximate 456 in USD). This corresponds to a margin of $25 per ton and the figure is comparable to margins of several segments in U.S. steel corporation in 2019.

While there exists heterogeneity across firms, most variations in price and cost come from the change in market conditions over time. The steel market is highly competitive and steel firms have little pricing power. As a results, price and cost are highly correlated with industrial wide demand and input supply shocks. Entry and exit at product level is common in our data. On average, margin is negative for about 19.5% of products in the sample. Firms usually drop a product when the negative margin lasts for several years.

Firm characteristics. The Compilation of financial statements (CFS) also reports firm characteristics such as employment (both the number of employees and total payroll), size (as measured by total assets), inventory (value on the stock of both material and finished goods). In addition, we aggregate product specific price, cost, profit and markup by quantity share to obtain firm specific profit and cost variables.

We supplement the CFS data with emission data from the yearbook of Chinese Steel Industry Environmental Protection Statistics from CSA. Coal is the main source of energy for steel production in China used by 90% of crude steel production.[4] It releases Sulfur dioxide (SO2) in the production process. We use the emission of SO2 per ton of output to measure the technical

[4]90% of crude steel production in China is using coal-based blast furnace

efficiency of steel firms.[5] Smaller SO2 emission per ton of steel production indicates a more efficient use of energy in the production process and higher technical efficiency. We also use the expense on emission control to proxy for firms' efforts in treating emission. Because the environmental protection statistics are collected by the department of information and statistics in CSA while the CFS data are collected by the department of finance and asset in CSA, the sample coverage are different. We can only match 59% of observations in the CFS data to the yearbook.

Lower panel in table 1 presents the summary statistics of firm specific variables. Firm level price and cost are slightly lower than the product specific price and cost, but their magnitude are similar. For example, the product level average price is around 3,462 CNY/ton and firm average is 3,282 CNY/ton. This is not too surprising since cheaper products usually sell more, and this gives them higher weights when calculating firm level price and cost. It is also notable that the margin at firm level is slightly higher than product specific margin (e.g., 250 CNY/ton vs. 184 CNY/ton), pointing to firms' effort to manage product line and focus on products with higher margin.

Acquisitions. Our paper focuses on acquisitions in steel market, which are more common occurrence than mergers in our sample. In an acquisition, the acquired firm (target) becomes a subsidiary of the acquirer. Conversely, in a merger, two firms form a new entity. We identify twelve acquisitions from the announcement in the Chinese steel industry yearbook. Although the government supports both acquisitions and mergers, mergers are predominately led by the government. As a result, mergers usually take rounds of under the table negotiations before the formal announcement. Many changes in management or production may have been implemented even earlier to facilitate the effort.

Table 2 outlines the acquirer, target, and the year of the acquisition. Five acquisitions involve buyers from the same province (within-province acquisition) and seven are cross-province acquisitions. In a within-province acquisition, the acquirer is usually a regional steel group who aims to expand production capacity and create larger regional steel enterprises.[6] In a cross-province acquisition, the acquirers are usually large state-owned enterprises with the goal of entering another regional market.[7]

4 Descriptive Results

Before formal empirical analysis, this section gives some descriptive evidence on the impact of acquisitions. Figure 4 compares profits, as measured by per ton of output, between the acquired

[5]Ideally, we want to use energy consumed per ton of output as the measure of technical efficiency. However, quantity or expense on energy input is not available.

[6]For example, Shandong Steel, Fangda Steel and Hebei Steel are among the leading regional steel group in Shandong, Jiangxi, and Heibei province respectively.

[7]For example, Wu Steel, Bao Steel and Capital Steel, the three largest steel groups in China. Hualing Steel is also also among the top 10 steel companies in China.

Table 2: Acquisitions in Our Sample

Acquirers	Targets	Acquisition year	Acquistion type
Shandong Steel	Zhangdian Steel	2013	within-market
Hangzhou Steel	Ningbo Steel	2014	
Sha Steel	Yong Steel	2007	
Fangda Steel	Ping Steel	2012	
Hebei Steel	Shijiazhuang Steel	2010	
Hualing Steel	Xi Steel	2007	cross-market
Wu Steel	Liuzhou Steel	2008	
Bao Steel	Bayi Steel	2007	
Bao Steel	Shaoguan Steel	2012	
Capital Steel	Shuicheng Steel	2009	
Capital Steel	Changzhi Steel	2009	
Capital Steel	Tonghua Steel	2010	

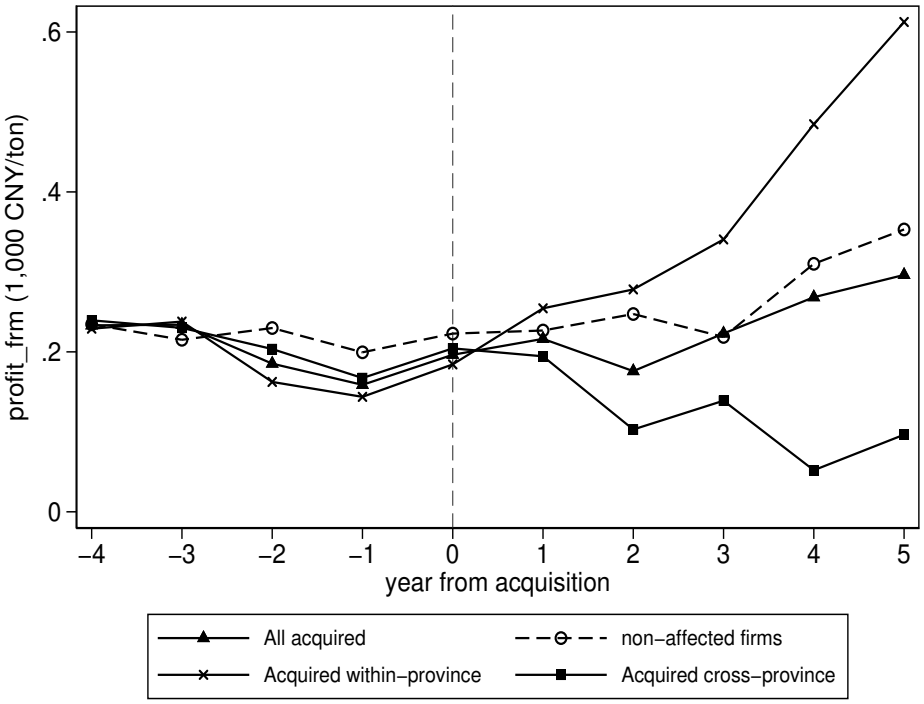
and non-affected firms. The triangles indicate dynamics of average profit of the acquired while the hollow circles indicate those of non-affected firms. Year 0 marks the year of acquisition. Note that the year of acquisition doesn't exist for non-affected firms. To make them comparable to the acquired firms, we follow Anderson et al., (2013) and randomly assign a year of acquisition to all non-affected firms.

Prior the merger, the acquired firms are slightly less profitable on average compared to the non-affected firms. This is consistent with the finding of Braguinsky et al. (2015) that underperformed firms are usually the target of acquisitions. Nevertheless, the profit trajectory of acquired firms, closely follows that of the non-affected firms. After the merger, the average of acquired firms are still slightly less profitable than that of the non-affected firms.

The comparison between all affected firms and non-affected firms ignore the fact that buyers in cross-province acquisitions are quite different from those in within-province acquisitions. As a result, they may have preferences over different targets, which may subsequently drive different post-acquisition performances. To investigate this, we further looks into the profit trajectory of the acquired within-province (the crosses) and the acquired cross-province (the squares), and compare them to that of non-affected firms.

In both within-province and cross-province acquisitions, the profit trajectory of acquired firms closely follows that of the non-affected firms. After the merger, the profit trajectories of acquired firms start to diverge drastically. Profit rises significantly among firms in within-province acquisitions and seems to decrease among those in cross-province acquisitions. By contrast, profits of non-affected firms remain relatively stable over time. We found a very similar pattern if we plot markup instead.

The preliminary evidence suggests that while the profit trends of acquisition targets are generally like non-affected firms, the post-acquisition performances are quite different. Profits rise



Note: Following Anderson et al., (2013), year of acquisitions are randomly assigned to non-affected firms.

Figure 1: change in profits of targets and non-affected firms.

Table 3: Effects of Acquisitions at Firm Level

VARIABLES	(1) profit_frm	(2) mkup_frm	(3) log(p_frm)	(4) log(c_frm)	(5) log(q_frm)
acquired_post	0.09**	0.03**	-0.01	-0.04*	-0.02
	(0.04)	(0.01)	(0.02)	(0.02)	(0.12)
Observations	619	619	619	619	619
R-squared	0.62	0.59	0.89	0.86	0.88

Note: all specifications control firm fixed affect, year fixed affect as well as firms' total asset.

among firms acquired within-province and seem to drop among those acquired cross-province. It's also worth noting that the net effect of acquisition may be zero, without the distinction between the geographic scope of acquisition.

5 Results

5.1 Overall Effect of Acquisitions

We formalize the preliminary evidence by estimating the classical DID specifications with TWFE at firm level:

$$y_{it} = \beta_0 + \beta_1 acquired_i * post_{it} + \beta_x x_{it} + \delta_i + \phi_t + \epsilon_{it} \tag{5.1}$$

Where y_{it} are the firm specific outcome variables, i.e., profit, price, cost and output. $acquired_i$ is an indicator for the acquired in an acquisition. It takes a value of 0 when the firms is non-affected by any acquisitions. $post_{it}$ is an indicator for post-acquisition period (year 0 and after). x_{it} are the control variables including total asset. Economies of scale play an important role in the steel industry. Larger producers could often achieve lower costs through purchasing raw materials (e.g., iron ore, coal, etc.) in bulk, or implementing specialized processes and equipment. We use total assets to control the scale of production. δ_i and ϕ_t are firm and year fixed effect.

Table 3 presents the effect of acquisitions at firm level. Although the descriptive evidence indicates no increase in profit after the merger for the all acquired, results in column (1) and column (2) show that the profitability, whenever measured by average profit or average markup, increases significantly after the merger. Results in column (4) show that the increase in profitability is driven by the decrease in cost. Neither price in (3) nor quantity in (5) change significantly. Our estimates suggest that the profit increases by 90 CNY/ton and the cost decreases by 4% following acquisitions.

We further investigate the dynamic effects of acquisition by introducing time variables surrounding the window of acquisition:

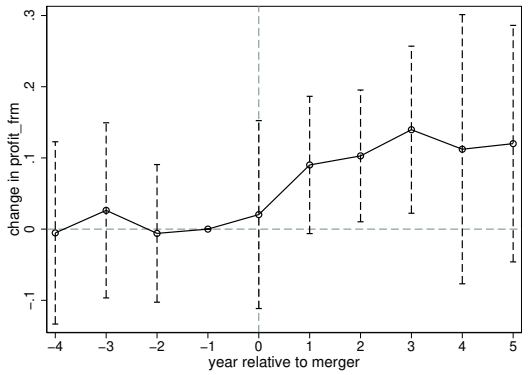
$$y_{it} = \gamma_0 + \sum_{k=4}^{2} \beta_{-k} acquired_i * pre_{k(it)} + \sum_{k=0}^{5} \beta_k acquired_i * post_{k(it)} + \beta_x x_{it} + \delta_i + \phi_t + \epsilon_{it} \quad (5.2)$$

Where $pre_{k(it)}$ and $post_{k(it)}$ is set of indicator variables that take value one if it is the kth year before or after the acquisition. Figure 2(a)-(e) presents the dynamic effect of acquisitions on profit, markup, price, cost and output quantity at firm level respectively. Each figure plots the coefficients of pre- and post-acquisition time variables and confidence intervals in the corresponding regression. The dynamics of profit and markup in (a) and (b) are similar: before the acquisition, the coefficients are close to zero and statistically insignificant, which suggests the acquired are very similar to non-affected firms and the absence of any pre-treatment trends. The profitability begins to rise in the first year after acquisitions. However, the growth is significant only in the second or third year after the acquisitions. Such changes in profitability are not driven by increase in price. In figure 2(c), price dynamics remain quite similar before and after merger. The lack of change in price is corroborated by figure 2(e). Similar to price, we don't find any significant change in output either. But instead, figure 2(d) demonstrates that costs go down significantly following the acquisition.

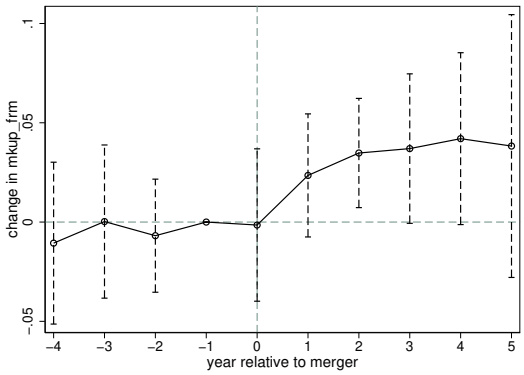
Overall, we find reduction in cost and increase in profitability after the acquisitions. However, the increase in profitability (measured by profit or markup) is significant only in one or two years. The descriptive evidence suggests that this may come from ignorance on heterogenous effects of within- and cross- province acquisitions. In the next section, we look into the impact on within- and cross- province acquisitions separately.

5.2 Within- and Cross-Province Acquisitions

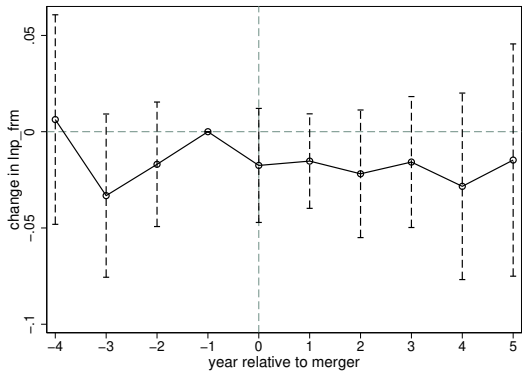
Table 4 presents the effect of within-province and cross-province acquisitions at firm level. Consistent with descriptive evidence, in upper panel, we find profitability increase on average after a within-province acquisition. The results are robust no matter the profitability is measure by average profit in column (1) or average markup in column (2). Results in column (4) show that the increase in profitability is driven by the decrease in cost. Neither price in (3) nor quantity in (5) change significantly. Our estimates suggests that the profit increases by 183 CNY/ton and the cost decreases by 5.2% following a within-province acquisition. Although our descriptive evidence points to drop in profits after cross-province acquisitions, we don't find any significant change in profit, price, cost or quantity after cross-province acquisitions. Overall, the results demonstrates obvious heterogeneity on effects of within- and cross- province acquisitions. The effects of acquisitions on increase in profitability and decrease in cost are totally driven by within-province acquisitions.



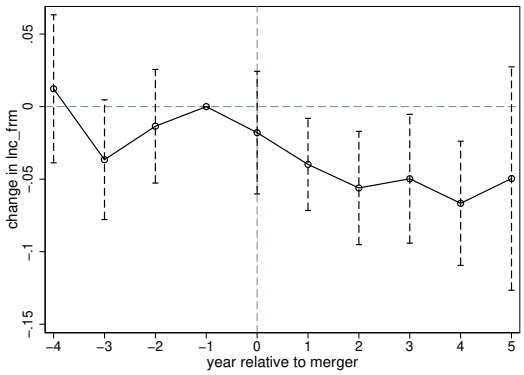
(a) effect on $profit$



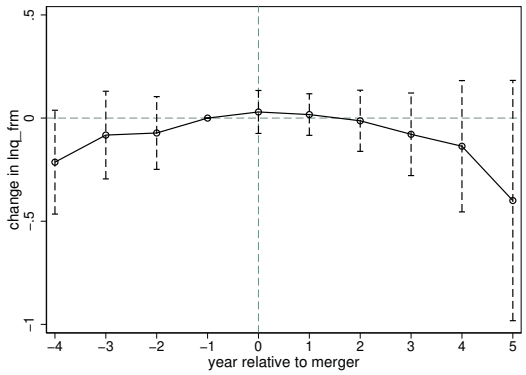
(b) effect on $mkup$



(c) effect on lnp_frm



(d) effect on lnc_frm



(e) effect on lnq_frm

Note: (a)-(e) presents effect of acquisitions on profit, markup, (log) price, (log) cost and (log) output.

Figure 2: Effects of Acquisitions at firm level

Table 4: Effects of within- and cross- province acquisitions at firm level

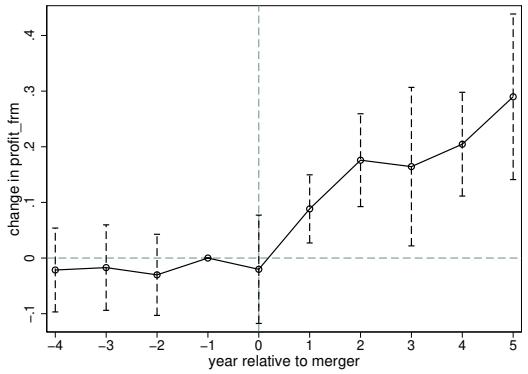
Upper panel: within-province acquisitions					
	(1)	(2)	(3)	(4)	(5)
VARIABLES	profit_frm	mkup_frm	log(p_frm)	log(c_frm)	log(q_frm)
acquired_post	0.18***	0.07***	0.01	-0.05*	0.06
	(0.03)	(0.01)	(0.03)	(0.03)	(0.16)
Observations	548	548	548	548	548
R-squared	0.62	0.58	0.88	0.85	0.88
Lower panel: cross-province acquisitions					
	(1)	(2)	(3)	(4)	(5)
VARIABLES	profit_frm	mkup_frm	log(p_frm)	log(c_frm)	log(q_frm)
acquired_post	0.02	0.00	-0.03	-0.02	-0.12
	(0.06)	(0.02)	(0.03)	(0.02)	(0.17)
Observations	566	566	566	566	566
R-squared	0.61	0.60	0.88	0.85	0.87

Note: all specifications control firm fixed affect, year fixed affect as well as firms' total asset.

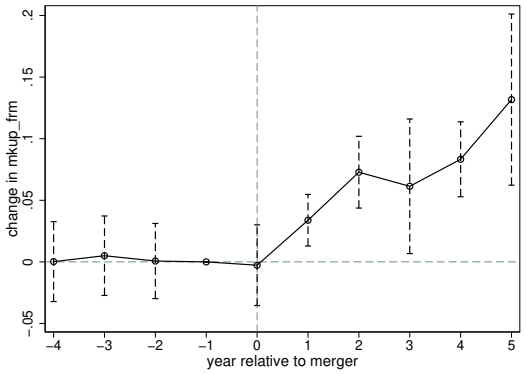
Figure 3(a)-(e) presents the dynamic effect of within-province acquisitions on profit, markup, price, cost and output quantity at firm level respectively. The dynamics of profit and markup in (a) and (b) are quite similar: before the acquisitions, the coefficients are close to zero and statistically insignificant, which suggests the acquired are very similar to non-affected firms and the absence of any pre-treatment trends. The rise in profitability becomes visible and significant one year following the acquisitions and continues throughout the sample period. Such changes in profitability are not driven by increases in price. In Figure 3(c), price dynamics remain quite similar before and after merger. The lack of change in price is corroborated by figure 3(e). Similar to price, we don't find any significant change in output either. But instead, figure 3(d) demonstrates that costs go down significantly following the acquisitions. Overall, the firm evidence suggests that lower costs and potentially efficiency gain are the main driver behind the increase in profits in a within-province acquisition.

By contrast, we don't find any significant changes following a cross-province acquisition in figure 4(a)-(e). In each figure, the coefficients of pre- and post-acquisition time are close to zero and insignificant. While the cost seems to go down slightly after the merger in figure 4(d), the magnitude is much smaller with high variance compared to a within-province merger, and as a result, cost doesn't change significantly after a cross-province merger.

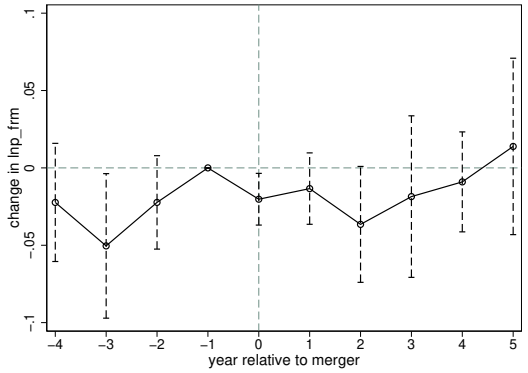
To better understand what drives the increase in profit and decrease in cost, we turn to product level outcomes. For example, one might speculate that the increase in firm profit comes from within firm resource reallocation to boost the production of profitable products and curb the production of less profitable ones. Alternatively, it is also possible that the change comes



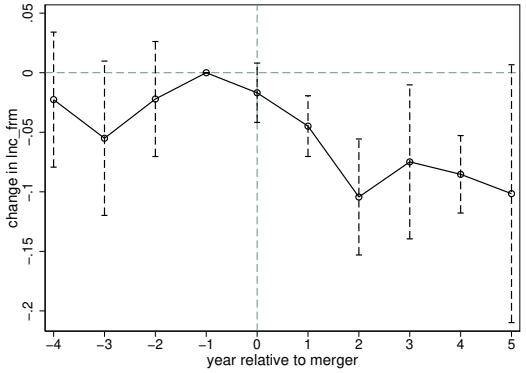
(a) effect on $profit$



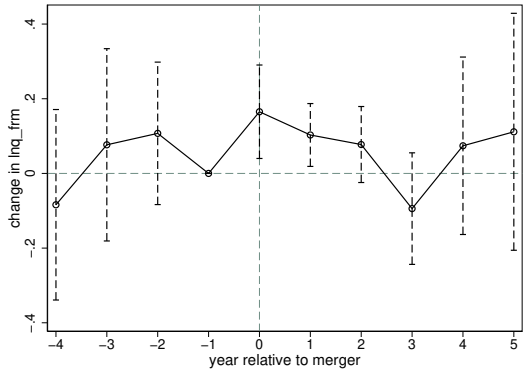
(b) effect on $mkup$



(c) effect on lnp_frm



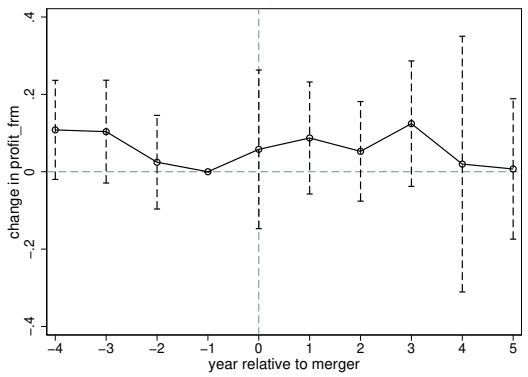
(d) effect on lnc_frm



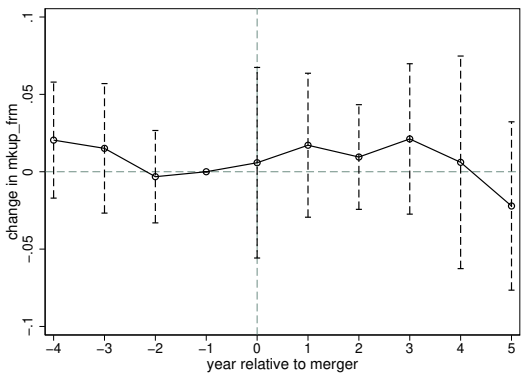
(e) effect on lnq_frm

Note: (a)-(e) presents effect of within-province acquisitions on profit, markup, (log) price, (log) cost and (log) output.

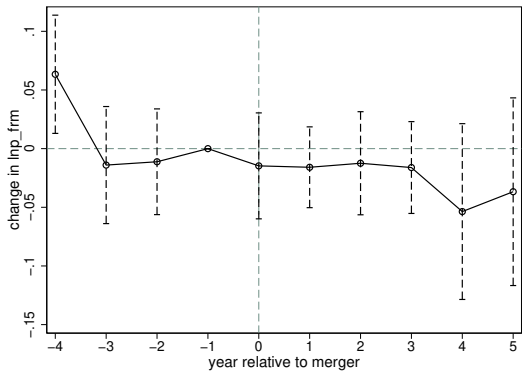
Figure 3: Effects of within-province acquisition at firm level



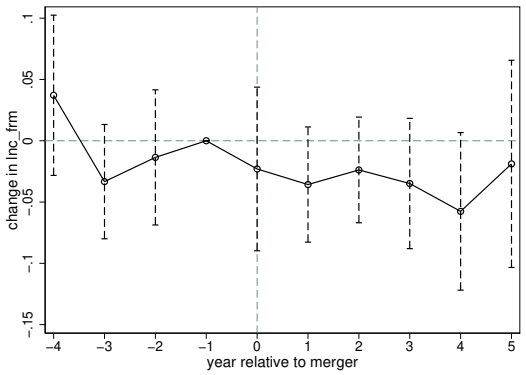
(a) effect on $profit$



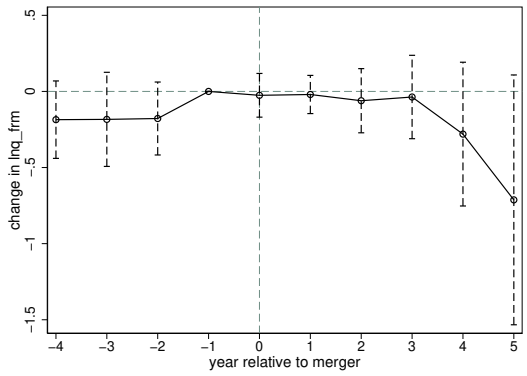
(b) effect on $mkup$



(c) effect on lnp_frm



(d) effect on lnc_frm



(e) effect on lnq_frm

Note: (a)-(e) presents effect of cross-province acquisitions on profit, markup, (log) price, (log) cost and (log) output.

Figure 4: Effects of cross-province acquisition at firm level

from better management and overarching strategies, which reduce production costs across all product lines. We investigate such possibilities by estimating the following specification:

$$y_{ijt} = \beta_0 + \beta_1 acquired_i * post_{it} + \beta_x x_{it} + \eta_{jt} + \xi_{ij} + \epsilon_{ijt} \tag{5.3}$$

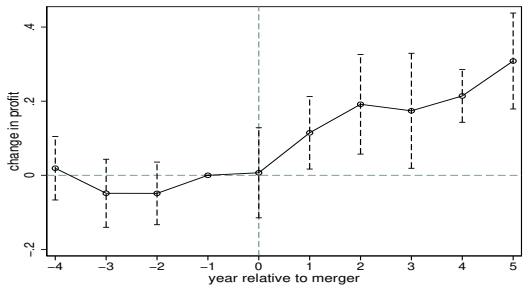
Where y_{ijt} is the outcome variable of firm i, product category j in year t. η_{jt} are product-year fixed effect to control the time specific shocks in different product categories such as demand, price of raw material etc. ξ_{ij} are firm-product fixed effect to control for firms' time invariant competitive advantage in a given product category.

Column (1) to (5) in upper panel of table 5 present the effect of within-province acquisitions on profitability, price, cost and quantity output at product level. The results look very similar to the firm level results: profitability (not matter measured in profit or markup) increases and the cost drops in all product categories. There are no significant changes in either price or quantity. On average, profit rises by 186 CNY/ton and manufacturing cost decreases by 5.3%. The magnitude of the change is very similar to the firm level results. This suggests that within-province acquisition leads to a reduction in cost and subsequently an increase in profits across all product categories. We further investigate the role of product reallocation in column (6) and (7) by looking at entry and exit at product level. We don't find the acquired firms actively enter or exit any product category following within-province acquisition. Therefore, product reallocation doesn't seem to be the driver behind improved efficiency.

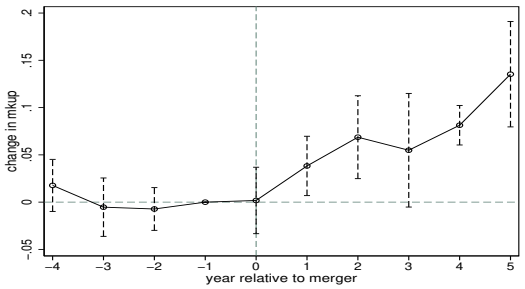
The lower panel of table 5 presents the effect of cross-province acquisitions. Similar to firm level results, we can't find any significant effect of cross-province acquisitions on profitability, price, cost or quantity in column (1) to (5). Although the results in column (6) suggest a moderate increase in entry at product level after cross-province acquisitions, however, it doesn't result in any significant change on firms' profitability.

Similar to the firm level analysis, Figure 5(a)-(g) presents the dynamic effect of within-province acquisitions on profit, markup, price, cost, output, entry and exit at product level. Consistent with results in upper panel in table 5, figure 5(a), (b) and (d) suggest significant increase in profitability and significant decrease in cost for all products one year after within-province acquisitions, while neither profit nor cost are different from non-affected firms prior to the acquisition. Figure 5(c), 5(e), 5(f) and 5(g) indicates no significant changes in price, output, entry and exit. This suggests that product reallocation doesn't drive the change of cost and profits.

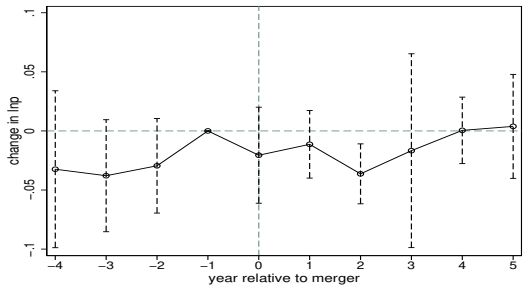
Figure 6(a)- (g) presents the dynamic effect of cross-province acquisitions on profit, markup, price, cost, output, entry and exit at product level. The effect of a cross-province merger is insignificant on almost all outcomes. There exists a significant increase in product entry four years after the acquisition in figure 6(f). Nevertheless, it doesn't lead to any significant change in profits and cost.



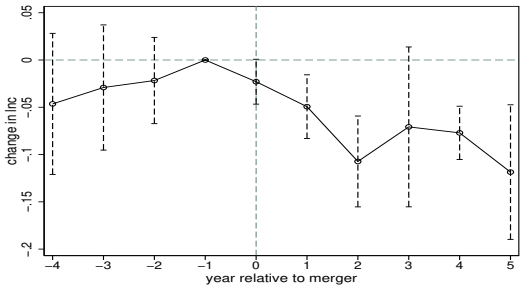
(a) effect on $profit$



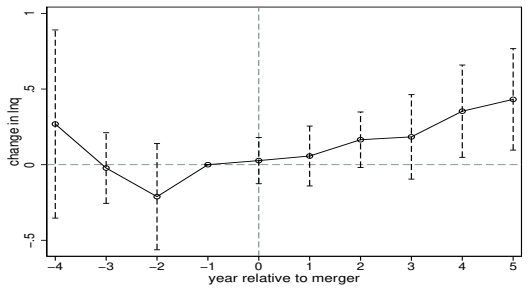
(b) effect on $mkup$



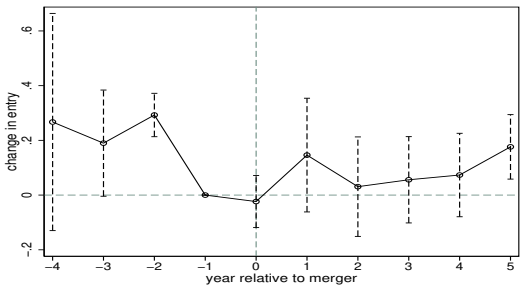
(c) effect on lnp_frm



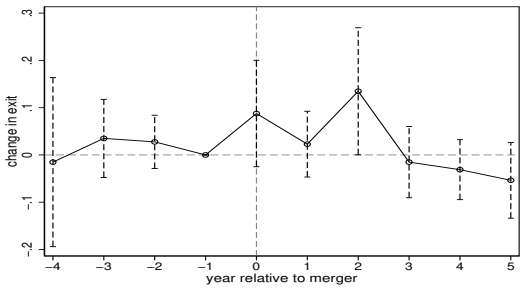
(d) effect on lnc_frm



(e) effect on lnq_frm



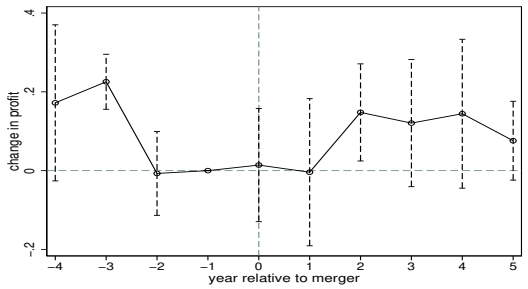
(f) effect on $entry$



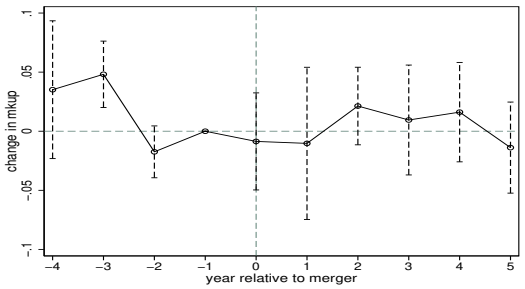
(g) effect on $exit$

Note: (a)-(e) presents effect of within-province acquisitions on profit, markup, (log) price, (log) cost, (log) output, entry and exit.

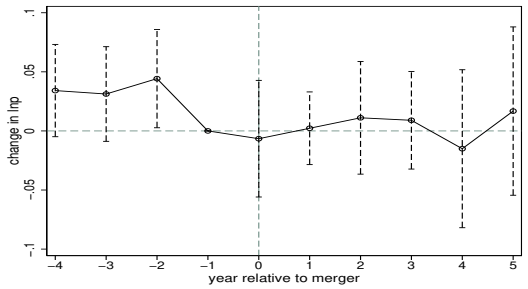
Figure 5: Effects of within-province acquisition at product level.



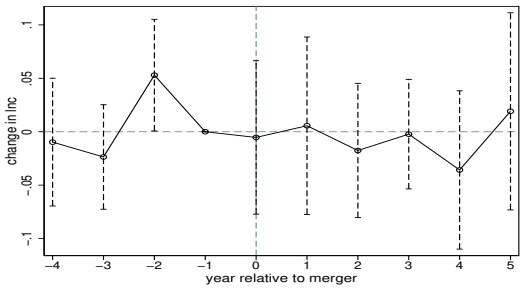
(a) effect on $profit$



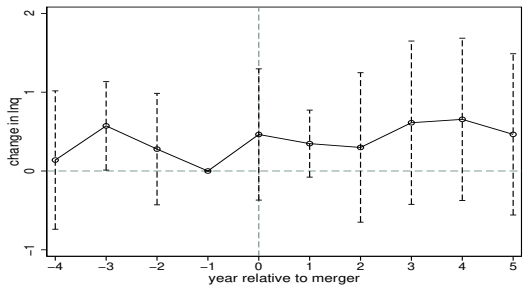
(b) effect on $mkup$



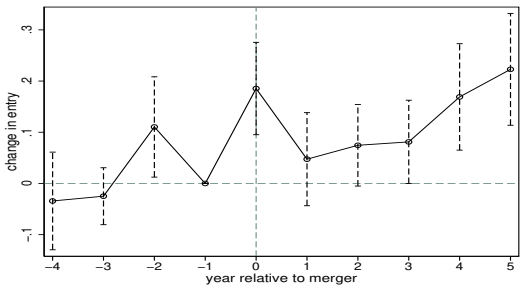
(c) effect on lnp_frm



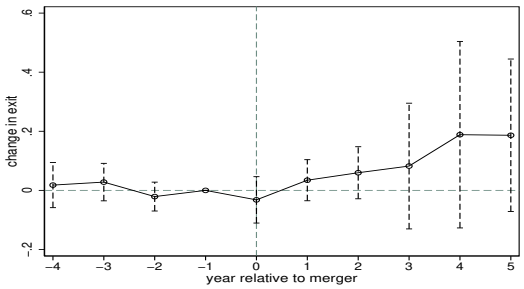
(d) effect on lnc_frm



(e) effect on lnq_frm



(f) effect on $entry$



(g) effect on $exit$

Note: (a)-(e) presents effect of within-province acquisitions on profit, markup, (log) price, (log) cost, (log) output, entry and exit.

Figure 6: Effects of cross-province acquisition at product level.

Table 5: Effects of within- and cross- province acquisitions at product level

	Upper panel: within-province acquisitions						
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
VARIABLES	profit	mkup	ln(price)	ln(cost)	ln(quantity)	entry	exit
acquired_post	0.186***	0.0635***	0.00848	-0.0538***	0.197	-0.115	0.0279
	(0.0653)	(0.0185)	(0.0193)	(0.0200)	(0.119)	(0.128)	(0.0373)
Observations	1,830	1,830	1,830	1,830	1,830	1,719	1,695
R-squared	0.643	0.629	0.909	0.882	0.854	0.340	0.420
	Lower panel: cross-province acquisitions						
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
VARIABLES	profit	mkup	ln(price)	ln(cost)	ln(quantity)	entry	exit
acquired_post	0.0252	-0.00617	-0.0141	-0.0108	0.261	0.0859*	0.0823
	(0.0479)	(0.0151)	(0.0237)	(0.0326)	(0.351)	(0.0470)	(0.0517)
Observations	2,039	2,039	2,039	2,039	2,039	1,898	1,904
R-squared	0.628	0.619	0.910	0.878	0.822	0.333	0.402

Note: all specifications control product-year fixed affect, firm-product fixed affect as well as firms' total asset.

Overall, our results suggest the growth in profitability and decrease in cost of targets after within-province acquisitions across all product categories. Product reallocation is not the main driver behind the change. However, we don't find significant effect on targets after cross-province acquisitions. Before we discuss the underlying mechanisms, we conduct some robustness check on the findings.

5.3 Robustness Check

In this section, we investigate robustness of our main results under alternate estimators. We give the result of the estimator in Appendix:

(i) **Staggered DID robust estimator**. Although DID estimator with TWFE is widely used, recent literature (De Chaisemartin and D'Haultfœuille, 2024) points out the results of TWFE DID estimator could be hard to interpret under heterogenous treatment effects. To solve these problems, we use several staggered DID robust estimators (De Chaisemartin and D'Haultfœuille, 2024; Sun and Abraham, 2020; Borusyak et al., 2021) to rerun the regressions and find similar results.

(ii) **PSM estimator**. The descriptive evidence shows the acquired firms are on average less profitable than the non-affected firms. We conduct a propensity score matching estimation to compare the acquired firms with the non-affected firms similar to the acquired. We conduct a one to five matching and match on total asset, employment, revenue, as well as revenue share of the steel product. The results are similar to our main results.

5.4 Mechanism

We test three mechanisms that could result in cost reduction after within-province acquisitions: (i) Reduction in labor input or improvement in labor productivity; (ii) Improvement in technical efficiency; (iii) Improvement in management of inventory. To test these mechanisms, we follows the TWFE DID specification 5.1, and looks into change in employment, output per worker, SO2 emissions per unit of output, as well inventory after acquisitions. The upper panel in table 6 gives the results.

Column (1) and column (2) of the upper panel looks into change in employment and output per worker after within-province acquisitions. The coefficient is insignificant and the magnitude is quite close to zero, which indicates that there is no obvious effect on employment or labor productivity on the acquired firms after within-province acquisitions. Column (3) looks into change in SO2 emissions per ton of output after within-province acquisitions. SO2 emission per ton of output is closely related to energy consumption rate during the production. We use it to measure technical efficiency since information on energy input is unavailable. The results show 68% decrease in SO2 emission per ton of output after within-province acquisitions. One may concern that the reduction in SO2 emission can come from increase in emission control after the acquisitions. To rule out this possibility, column (4) tests change in expenses on emission treatment after within-province acquisitions. The insignificant coefficient indicates the substantial reduction in SO2 emission mainly comes from increase in technical efficiency rather than from more effort on emission control.

Column (5) looks into change in inventory after within-province acquisitions. The coefficient is significant and the inventory decreases by 37% after within-province acquisitions. The results demonstrate substantial improvement in management of inventory after the acquisitions. Overall, the results indicate obvious spillover to the acquired in both technical efficiency and management capacity after within-province acquisitions.

The lower panel of table 6 looks into change in labor input, labor productivity, SO2 emissions per ton of output and inventory after cross-province acquisitions. We only find significant decrease in labor input after cross-province acquisitions in column (1). However, our previous results indicates that this decrease in labor input doesn't result in any reduction in production cost. Besides, we don't find any significant change in labor productivity, SO2 emissions per ton of output or inventory after cross-province acquisitions.

The improvement in technical efficiency and management in inventory after within-province acquisition is further demonstrated by the results of event study in figure 7. In figure (c), the coefficients are statistically insignificant on most year before the acquisitions, which indicates the absence of pre-treatment trends. After the acquisitions, the SO2 emission per ton of output decreases. The coefficient is only close to significant on the first year, and becomes significant on the second and third year after the acquisitions. In figure (d), the coefficients on change in inventory are close to zero and insignificant before the acquisitions. The inventory decreases

Table 6: Mechanism of Cost Reduction

Upper panel: within-province acquisitions					
	(1)	(2)	(3)	(4)	(5)
VARIABLES	ln(labor)	ln(lab_prod)	ln(so2perton)	ln(emi_exp)	ln(inventory)
acquired_post	0.02	-0.00	-0.68**	-0.10	-0.37***
	(0.13)	(0.23)	(0.28)	(0.85)	(0.12)
Observations	625	548	341	306	492
R-squared	0.96	0.81	0.71	0.42	0.90
Lower panel: cross-province acquisitions					
	(1)	(2)	(3)	(4)	(5)
VARIABLES	ln(labor)	ln(lab_prod)	ln(so2perton)	ln(emi_exp)	ln(inventory)
acquired_post	-0.14**	0.02	0.23	0.35	-0.20
	(0.07)	(0.15)	(0.24)	(0.61)	(0.19)
Observations	637	566	359	319	505
R-squared	0.96	0.82	0.69	0.47	0.90

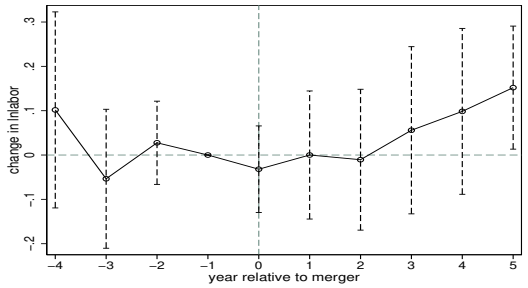
Note: all specifications control firm fixed affect, year fixed affect as well as firms' total asset.

significantly since the year of acquisition. figure (a), (b) and (d) indicate no significant change in labor input, labor productivity and expense on emission control after within-province acquisitions.

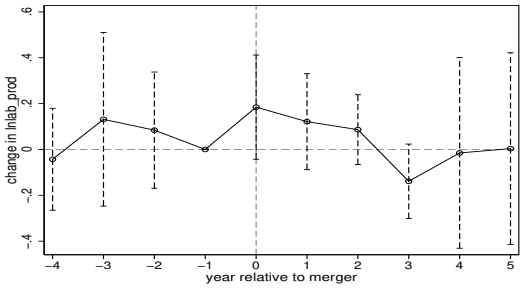
Consistent with results in lower panel in table 6, the results of event study in figure 8 indicates only significant decrease in labor input after cross-province acquisitions: there is no pre-treatment trends before the acquisitions, and the employment decrease after the acquisition and the coefficient become significant since three year after cross-province acquisitions. At the meanwhile, there is no significant change in labor productivity, SO2 emission per ton of output, expense on emission control as well as inventory after cross-province acquisitions.

5.5 Discussion

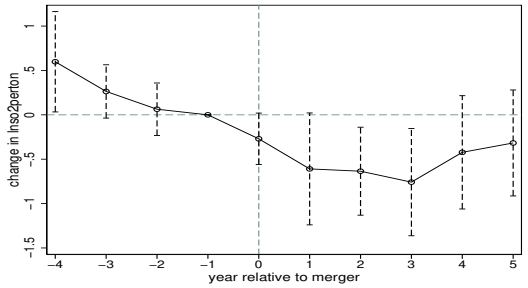
Why the acquired firms can't benefit from cross-province acquisitions? It can be explained from the difficulties in coordination between the acquirers and targets. After a cross-province acquisition, the central enterprise (the acquirer) need to negotiate and coordinate with the local government (which own the target) on personnel, production and management of the target. Because the central enterprise and local government have conflicts on interest, the negotiation and coordination can be difficult and take a long time. By contrast, a within-province acquisition can be easily coordinated by the local government. This may explain a better performance of the acquired firm after a within-province acquisition.



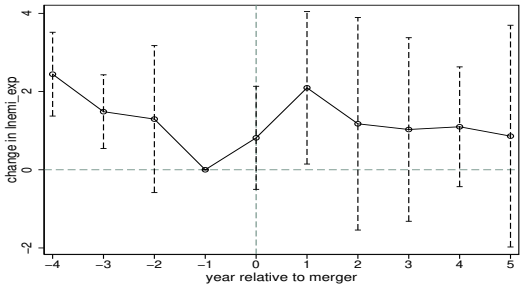
(a) effect on *lnlabor*



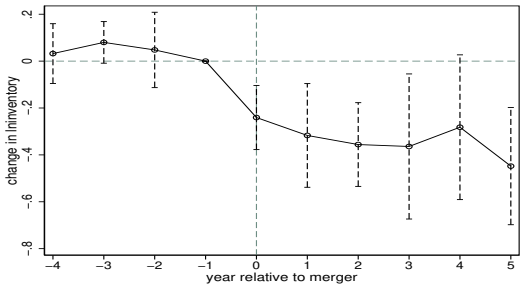
(b) effect on *lnlab_prod*



(c) effect on *lnso2perton*



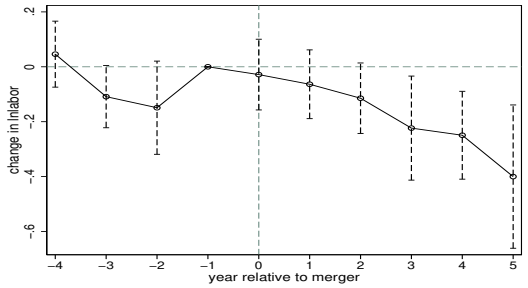
(d) effect on *lnemi_exp*



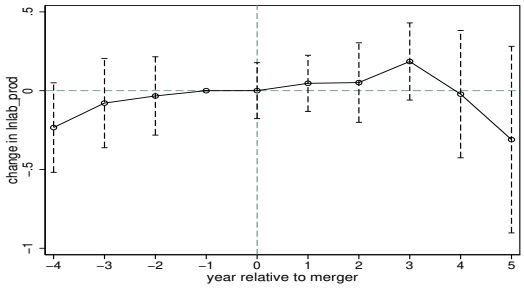
(e) effect on *lninventory*

Note: (a)-(e) presents effect of within-province acquisitions on (log) employment, (log) labor productivity, (log) so2 emissions per unit of output, (log) expense on emission treatment and (log) inventory.

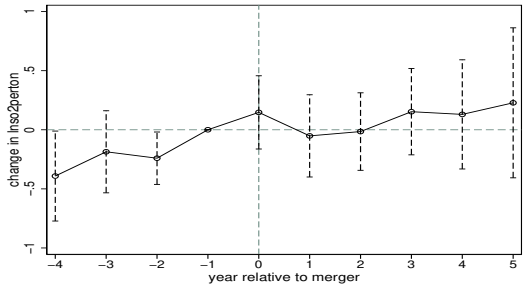
Figure 7: Mechanism of Cost Reduction in Within-province Acquisitions



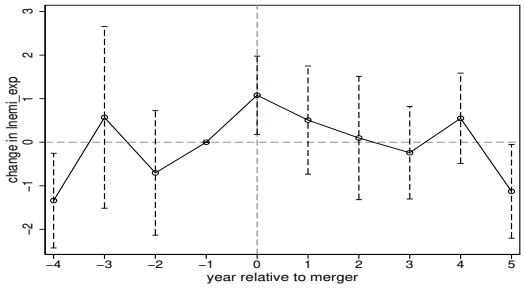
(a) effect on *lnlabor*



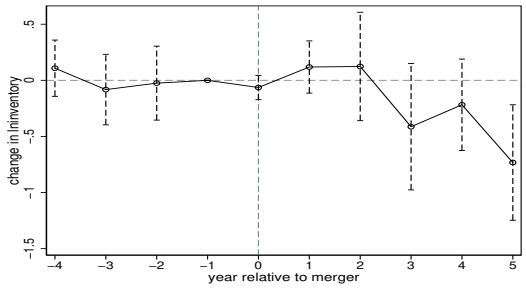
(b) effect on *lnlab_prod*



(c) effect on *lnso2perton*



(d) effect on *lnemi_exp*



(e) effect on *lninventory*

Note: (a)-(e) presents effect of cross-province acquisitions on (log) labor input, (log) labor productivity, (log) so2 emissions per unit of output, (log) expense on emission treatment and (log) inventory.

Figure 8: Mechanism of Cost Reduction in Cross-province Acquisitions

6 Conclusion

In some industries, government may encourage M&A to achieve economy of scales and improvement of efficiency. In China, M&A are encouraged by industrial policy in several key industries, such as automobile, steel and airline industry. This paper evaluates effects of acquisitions led by the government in Chinese steel industry. We find evidence of decrease in cost and increase in profitability in acquired firm after acquisitions. However, the reduction in cost and increase in profit only happen among within-province acquisitions. The product-level evidence demonstrates the cost reduction happens across all product categories rather than from the product reallocation. Investigation on the mechanism of cost reduction points to spillover on technical efficiency and management capacity to the acquired firms after within-province acquisitions. By contrast, we don't find any evidence of efficiency gain or change in price after cross-province acquisitions. Overall, our findings demonstrate that acquisitions led by the government can result in efficiency gains. But the effects differ by the geographic scope of the acquisitions.

References

[1] Angrist, J.D., Graddy, K., and Imbens, G.W., 2000. "The interpretation of instrumental variables estimators in simultaneous equations models with an application to the demand for fish." *The Review of Economic Studies*, 67, 499-527.

[2] Borusyak, K., Jaravel, X. and Spiess, Jann., 2021. "Revisiting Event Study Designs: Robust and Efficient Estimation," Papers 2108.12419, arXiv.org.

[3] Braguinsky, S., Ohyama, Atsushi., Okazaki, Tetsuji., and Syverson, C., 2015. "Acquisitions, Productivity, and Profitability: Evidence from the Japanese Cotton Spinning Industry." *American Economic Review*, 105, 2086–2119.

[4] Carlton, Dennis, Mark Israel, Ian MacSwain, and Eugene Orlov, 2019. "Are Legacy Airline Mergers Pro- or Anti-Competitive? Evidence from Recent US Airline Mergers." *International Journal of Industry Organization*, 62, 58-95.

[5] Clark, Robert, and Mario Samano, 2022. "Incentivized Mergers and Cost Efficiency: Evidence from the Electricity Distribution Industry." *Journal of Industrial Economics*, 70(4): 791–837.

[6] De Chaisemartin, Clément, and D'Haultfœuille, Xavier, 2014. "Difference-in-Differences Estimators of Intertemporal Treatment Effects." The Review of Economics and Statistics, 1–45.

[7] Gaynor, Martin, Mauro Laudicella, and Carol Propper, 2012. "Can Governments Do It Better? Merger Mania and Hospital Outcomes in the English NHS." *Journal of Health Economics*, 31(3): 528–43.

[8] Hosken, Daniel, Louissken Silvia, and Christopher Taylor, 2011. "Does Concentration Matter? Measurement of Petroleum Merger Price Effects." *American Economic Review*, 101(3), 45-50.

[9] Huang et al.,2018. "Report on the Competition Structure in the Iron and Steel Industry."

[10] Kwoka, John, and Evgenia Shumilkina, 2010. "The Price Effect of Eliminating Potential Competition: Evidence from an Airline Merger." *Journal of Industrial Economics*, 58(4): 767–793.

[11] Lewis, Matthew S., and Kevin E. Pflum, 2017. "Hospital Systems and Bargaining Power: Evidence from out-of-Market Acquisitions." *The RAND Journal of Economics*, 48(3): 579–610.

[12] Ma, Wenliang, Qiang Wang, Hangjun Yang, and Yahua Zhang, 2020. "Evaluating the Price Effects of Two Airline Mergers in China." *Transportation Research Part E: Logistics and Transportation Review*, 141: 1020-1030.

[13] Mark Anderson, D., Benjamin Hansen, and Daniel I. Rees, 2013. "Medical Marijuana Laws, Traffic Fatalities, and Alcohol Consumption." *The Journal of Law and Economics*, 56(2): 333–369.

[14] Sun, Liyang, and Sarah Abraham, 2021. "Estimating Dynamic Treatment Effects in Event Studies with Heterogeneous Treatment Effects." *Journal of Econometrics*, Themed Issue: Treatment Effect 1, 225(2): 175–99.

[15] Yan, Jia, Xiaowen Fu, Tae Hoon Oum, and Kun Wang, 2019. "Airline Horizontal Mergers and Productivity: Empirical Evidence from a Quasi-Natural Experiment in China." *International Journal of Industrial Organization*, 62: 358–376.