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# ESSAYS ON CHINA'S CIGARETTE INDUSTRY

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A Dissertation  
Presented to  
the Graduate School of  
Clemson University

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In Partial Fulfillment  
of the Requirements for the Degree  
Doctor of Philosophy  
Economics

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by  
Xi Bai  
December 2019

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Accepted by:  
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# Abstract

This dissertation comprises three chapters on the Chinese cigarettes industry. The China State Tobacco Monopoly Administration (STMA) regulates this industry, allocating quotas of production across manufacturers. Between 2006 and 2007, it mandated all cigarette firms within a province merge into a single state-owned, province-level firm. After the merger, the province-level firms allocate their quotas for the maximum number of cartons they can produce directly.

In the first chapter, I examine how the mandated change in market structure resulting from the STMA affected allocation on the quality dimension. To assess the pre-merger differences in market structure in quota allocation, I compare the changes in cigarette quality in provinces that initially had only one firm, hence whose market structure did not change, with those that initially had multiple firms. I construct a theoretical model for the monopoly market and the duopoly market. The model predicts that when there is regional competition, the proportion of high-quality cigarettes is lower than in a monopoly market. I use an event study method and a triple-differences model to identify the changes in the quality composition at the province-level before and after the merger by comparing two types of reorganization. I find that the consolidation mandated by the merger is associated with increases in product quality. I use the incentives of managers in monopoly and oligopoly markets to explain the shift in quality choices of firms in the provinces affected by the STMA mandate.

My second paper presents the analysis of the effect of the mandated merger on inventory. The Chinese cigarette industry provides an excellent opportunity to study a market with the characteristics of inflexible prices and uncertain demand. In this paper, I provide a theoretical model to take into account the demand uncer-

tainty and different market structures to predict how the mandated consolidation as an exogenous shock affects the inventory. Based on the theoretical model, if there are competitors in the region, which is a duopoly market, managers choose non-cooperative strategies by producing more high-quality cigarettes to steal their competitors' high-segment markets for higher profit margins, which leads to higher inventories. My empirical analysis confirms these effects for high-quality cigarettes and medium-quality cigarettes.

My third chapter presents the welfare analysis of the effect of horizontal mergers. Based on the theoretical model in Chapter One, after the reform, the consumers who can buy the cigarettes with desired characteristics increases. The consumer's welfare increases as a result of the consolidation. On the other hand, producer welfare increases because of the lower dollar value of the inventory.

# Dedication

To my family.

# Acknowledgments

I have many people to thank for helping me complete this dissertation. First of all, I would like to thank my advisor, Dr. Andrew Hanssen, for all the advice, encouragement, and guidance. I will always remember his assistance before my presentations and job talk, his patience, and guidance at every setback. I appreciate all the help I got from my Co-advisor, Dr. Tom Lam. He is always willing to discuss my work and concerns, provide invaluable comments, and promote my confidence over the last five years. Additionally, I am grateful for the valuable comments of other members of my dissertation committee Dr. Yichen Christy Zhou and Dr. Robert K. Fleck.

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All errors are my own.

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# Chapter 1

## Product Choice Under the Restriction of Quota: Horizontal Mergers in China's Cigarette Industry

### 1.1 Introduction

Since Coase (1937) first addressed the classic issue of “make versus buy,” economists have devoted efforts to understand what determines the boundaries of a firm. Holmstrom (1999) suggests that we should consider the internal structure of firms and the operation of markets together so that we can analyze how they interact as organizations. There are three significant types of organization in China, private, mixed, and state-owned. The Chinese cigarette industry is entirely owned by the state, as are most of the country's key manufacturing industries. As Figure 1.1 shows, the tax revenue from this industry increased from 1.165 billion RMB in 2002

to approximately six billion RMB by 2012, accounting for approximately 8% of the total government tax revenue.

In this paper, we investigate how a mandated consolidation of government-owned cigarette producers affected the mix of cigarette types on the market. The State Tobacco Monopoly Administration (STMA) determines quotas for each manufacturer, i. e., the maximum number of cigarettes it can produce. While the manufacturers can produce as much of the quotas as they are able to fill, they cannot change the allocation prices, i. e., the price of the cigarettes they sell the cigarettes back to the STMA. Within this structure, the manager decide how to allocate the quotas among the different quality levels of cigarettes.<sup>1</sup> Since the maximum quantity of cigarettes and the allocation prices are fixed, the decision on quota-allocation is the only competition strategy the managers have open to them. This study focuses on the change of quota allocation resulting from the mandated merger.

We begin by describing the reform that led to the consolidation, the nature of cigarette production in China, the incentives for the managers, and how the reform changed the structure of the industry. As a significant part of the major reform of China's state-owned enterprises begun in the late 1990s, the large tobacco firms merged into large industrial conglomerates. The reform reduced the total number of manufacturers in these enterprises from 44 in the year 2005 to 27 by the year 2009, primarily by consolidating firms within a province to a single operation, or a monopoly operator. This mandated organizational consolidation changed the market structure and competitive situation within the region.

We then introduce the incentives for the managers in the Chinese cigarette industry. Many studies have investigated how contracts provide incentives for man-

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<sup>1</sup>The STMA established classification criteria based on the allocation prices to categorize cigarettes: higher allocation prices mean better raw materials or filters and, thus, represent higher quality levels of cigarettes.

agers. For example, Besley and Ghatak (2005) explored competition and incentives in mission-oriented production, finding the payoff from the success of the principal must be high enough to offset agency costs due to the moral hazard to ensure both parties receive non-negative payoffs. Managers of state-owned enterprises are faced with managerial tasks delegated by the government or its representative bureaus (Choe and Yin, 2000). Thus, managers involved in the manufacture of cigarette need to fulfill their targets so as to use all of the quotas, minimize the inventory, and maximize the profit. As the allocation prices of the cigarettes they produce are set by the STMA, based on production costs, high-quality cigarettes have higher profit margins than low-quality cigarettes. Thus, the managers make decisions across how to allocate the quota across different quality levels of cigarettes to achieve the quota targets set by the central bureau, having no discretion on price.

We then develop a theoretical model, based on Desai (2001), which focuses on the change in the quota allocation strategies before and after the government mandated merger. The model generates two important implications regarding organizational forms of monopoly and duopoly. We contribute to the literature by focusing on the punishment for failing to fulfill the quota. Our model predicts that in a duopoly market, the punishment for not fulfilling the target causes the managers to lower the quota they allocate to high-quality goods, unlike in the monopoly scenario.

Our empirical findings are consistent with theoretical predictions. We look at how managers change their decisions regarding quota allocation in response to changes in organizations, both before and after the reorganization of the industry. To identify the effect, we used an event study model and a triple-difference approach. We found that following organization reform, the incentives for the managers changed. In the single firm market, manufacturers allocated more of the quota for higher-quality cigarettes than in the multiple firms market. The competitors in the various firm

market who are price elastic produce low-quality cigarettes to capture the customers and consequently a larger share of the market, thus making the managers in the state-owned enterprises fulfill their production target and minimize their inventory.

In this paper, given that the decision of quota allocation for different quality goods is the competition strategy, we explore two questions. First, what are the differences in the allocation decisions before and after the merger? Second, what drives the different product quality decisions in highly regulated markets under a quota restriction? This paper is the first to focus on quota allocation as a competitive strategy in a highly regulated industry. These new findings are discussed in the following sections.

The remainder of this paper is organized as follows. The next section discusses the background and regulation policy of the Chinese tobacco industry including the horizontal mergers. Section 3 presents the theoretical model. Section 4 describes the data sources, how the variables are defined and constructed, and the summary statistics. Section 5 introduces the empirical research design. Section 6 discusses the results, and Section 7 provides conclusions.

## **1.2 Industrial Background**

We begin by introducing the institutional mechanics of state-owned enterprises. We then summarize the regulation strategies of cigarettes in China, and finally, we describe the reorganization of the Chinese cigarette industry.

### **1.2.1 State-Owned Enterprises**

Based on the different types of ownership, the organization of enterprises can be categorized as private, mixed, and state-owned enterprises, with past research

focused on comparing them. For example, Holmstrom and Tirole (1989) investigated how a firm's productivity is affected by its market structure and various ownership or control rights, while Boardman and Vining (1989) compared the performance of private, mixed, and state-owned enterprises by using the property rights theory of firms, and Che and Qian (1998) suggest that state-owned enterprises play a significant role in the natural monopoly and regulated duopoly market because of the lack of secure property rights. State-owned enterprises (SOEs) under national government control are the predominant type of ownership in China, including such key industries as banking, telecommunications, energy, rail transportation, civil aviation, tobacco, and wholesale trade on agricultural inputs and outputs.

As the agent of the state-owned enterprises, the managers are the decision-makers concerning quota allocation. Thus, their incentives become an essential question: how do they choose competitive strategies when they have individual incentives for carrying out those tasks. Groves et al. (1994) found that when the responsibility for output decisions shift from the state to the firm and when firms are allowed to retain more of their profits, the incentives for managers of Chinese state-owned enterprises are strengthened. Zhang (2006) also points out that aligning the right of residual claim and the power of residual control requires established property rights and the implementation of control. Sheng and Zhao (2013) advocate for addressing the issues between the supervision and incentives of SOE managers through designing internal and external corporate governance mechanisms. In the Chinese cigarette industry, the contract set by government agencies includes the rules for profit-sharing and residual control. In addition, these contracts for the managers in a state-owned enterprise usually contain the target for profit and tax, output target, product cost target, and even fulfillment of the state plan (Zhang, 2006).

The reform of the enterprises in the state sector, which began in the late 1990s,



aimed to make the state-owned enterprises “corporatized” (Hsieh and Song, 2015). As part of the proposed reforms, which were described as “Grasp the Large, Let Go of the Small,” China’s tobacco industry introduced significant institution-building processes including the consolidation of producers. As shown in Figure 1.2, the STMA reduced the number of cigarette firms from 44 to 27, with the aim of increasing the economies of scale, and the forced reorganization by merging all manufactures in same province into one state-owned, province-level company that could allocate its production quota across all of the merging factories. Such exogenous institutional forces, coupled with the previous domestic institutional conditions, enabled a power shift from the local authorities to the central authority.

## **1.2.2 Tobacco Industry Structure**

### **1.2.2.1 The Mechanics of the Regulation**

The China tobacco industry is characterized by strict governmental regulation based on a system of vertical management and monopolized operation (Wang, 2009; Gao, Zheng and Hu, 2012). Fang, Lee and Sejjal (2017) suggests China established the State Tobacco Monopoly Administration (STMA) as the government’s representative bureau in 1984, which undertakes central planning, manages raw materials, sets regional production quotas for leaves and products.

The industrial organization of the cigarette production sector is shown in Figure 1.3. Under China’s monopoly system, the State Tobacco Monopoly Administration (STMA) determines “allocation plans” for both total production and prices of cigarettes, distributing these production quotas to each company, with the price in this process being referred to as the allocation price (Song Gao, 2012). Managers of these tobacco companies allocate the production quotas for the various prod-

ucts, which are classified into different grades. After the manufacturers produce the cigarettes, they sell them back to the STMA at the allocation price, which is set based on the production cost. The allocation prices vary based primarily on the raw materials used for specific products. This allocation price is set by the STMA as the criteria to classifying cigarettes into different categories (Gao, Zheng and Hu, 2012). I will classify the quality level of cigarettes as seen in Table 1.1, high-quality cigarettes are those with allocation prices higher than 50 Renminbi (RMB) per carton; the medium-quality cigarettes are in the price range of 30 RMB to 50 RMB per carton, while the low-quality products are those cheaper than 30 RMB per carton. Two other elements of China's cigarette price system are the suggested wholesale price and the suggested retail price set by the Chinese National Tobacco Company (CNTC). Although it and the STMA were intended to be two separate institutions, in practice, they function as one organization with two different names but under the same leadership (Liu et al., 2015). The suggested wholesale price is the price of cigarettes at which wholesalers provide cigarettes to retailers while the suggested retailer prices are what the retailers charge the consumers.

#### **1.2.2.2 The Reform Process in the Chinese Tobacco Industry**

As part of the state-owned enterprise reform, the provincial reforms aimed to dissolve the local boundaries (Wang, 2009) across the industry. The primary impact of the consolidation on the cigarette industry was the reduction the number of manufacturers. Figure 1.2 illustrates that this inter-regional consolidation of tobacco enterprises reduced the number of manufacturers in the tobacco industry from 44 in 2005 to 27 by 2009.

Figures 1.4 and Figures 1.5 show the organizational system in the tobacco industry before and after the merger orchestrated by the state. Before the restruc-

turing, the STMA directly distributed the production quotas to each manufacturer. Some of the provinces had many firms, while some were a single firm market. After the reorganization, each province has only one enterprise that decides the quota allocation. The competition structure in the province with multiple firms significantly changed after the reform, while provinces with a single firm did not change.

The managers, as the decision-makers of the cigarette manufacturers, are faced with the same contract, which includes output target and the fulfillment of the state plan. However, unlike in a duopoly scenario, in the monopoly case, the managers do not face the competition, which carries the chance they may fail to sell high-quality cigarettes.

### **1.3 Theoretical Model**

This section presents a theoretical model of the primary argument motivating the empirical model. I propose a theoretical model illustrating the change in the quota allocation strategies among tobacco firms in China that varies in the monopoly and duopoly markets characterized by both quality (vertical) and horizontal differentiation. The setup of this model is adapted from the model in Hotelling (1929), with modifications being made to determine the effect of quota constraints under different market structures. The manufacturer decides each year to allocate the quota for various quality products. I derive quota-allocation strategies in two scenarios: i) one manufacturer in the province as a regional tobacco monopoly, ii) two manufacturers in one region as a duopoly. Several new assumptions on prices are based on the real-world situation of the Chinese cigarette market. First, the allocation prices are based on the marginal costs, which are the prices at which producers sell cigarettes to the STMA, which are regulated by that body. Second, since the STMA is responsible for

protecting public health by reducing tobacco use and exposure to tobacco smoke, the quotas the STMA distributes to the manufacturers are fewer than the total demand at the given price in the market.

### 1.3.1 Model Setup

#### 1.3.1.1 Product Variants and Firms

Consider a market in which manufacturers segment their product lines on multi-products under quota restrictions. Manufacturers can offer two vertically differentiated products: a high-quality (good H) and a low-quality (good L). The high-quality cigarettes have different attributes to attract consumers; for example, they may have different flavors or a more attractive package. The marginal costs of the high-quality goods and the low-quality goods are  $c_H$  and  $c_L$ , respectively. Since the marginal costs primarily depend on the raw materials, for example, the tobacco leaves and filters, we have  $c_H > c_L$ . Under the Chinese cigarette pricing mechanism, the allocation-wholesale profit margin( $w_i$ ) set by the STMA is assumed to be exogenous to the manufacturers. I assume a high-quality products bring higher mark-up for the manufacturers, specifically,  $w_H > w_L$  (Gao, Zheng and Hu, 2012). The allocation price faced by the manufacturers is given by

$$p_i^{allocation} = c_i(1 + w_i) \tag{1.1}$$

where  $i \in \{H, L\}$ . There are two types of market structures: one manufacturer in the province representing a regional tobacco monopoly market and two manufacturers in one province representing a duopoly market.

### 1.3.1.2 Consumer Preferences

Consumers' preferences are different along both dimensions. On the one hand, each consumer has a preference for quality, either low- or high-quality cigarettes. Because consumers buy cigarettes based on a suggested retail price, also regulated by the STMA, the suggested retail price is the allocation price with an allocation-retail profit margin of  $z_i$ , which can be shown as

$$p_i^{retail} = p_i^{allocation}(1 + z_i) = c_i(1 + w_i)(1 + z_i). \quad (1.2)$$

Consumers can distinguish the quality level based on the suggested prices. Each consumer wishes to purchase one unit of the two variants of the cigarettes based on her income. In this case, low-type consumer will never purchase a high-quality cigarette because of the suggested retail price and their income. On the other hand, the high-type consumer can choose the characteristics she wishes for her cigarette. Figure 1.6 and Figure 1.6 show the consumer preferences. Assume there are a number of low-type consumers who will never buy high-quality cigarettes and three types of consumers who prefer high-quality cigarettes. Type A and Type B consumers prefer to buy cigarettes with a certain attribute, but they are indifference about the quality. For example, Type A consumer prefers cigarettes with a strawberry flavor, while Type B consumer only consumes the high-quality cigarettes with red colour package. Type C consumers in both of the figures buy high-quality cigarettes only, but they are indifferent regarding the characteristics.

### 1.3.1.3 Managers' Incentives

Since the managers of tobacco enterprises need to fulfill their contracts, I assume they use all of their quota to cover the full market.<sup>2</sup> In addition, according to Song Gao (2012), the profit margins for high-quality goods are higher than the low-quality goods, meaning the managers have the incentive to produce as many high-quality goods as possible.

### 1.3.2 Duopoly Analysis

Since products are partial substitutes across different quality segments as Figure 1.6 shows, the Type A consumer desires only the high-quality cigarettes with a certain attribute made by Firm 1. Otherwise, she chooses to buy low-quality cigarettes instead of high-quality cigarettes from another firm. In this case, the managers only have incentives to sell their cigarettes to Type C consumers who only care about the quality level but indifference between the characteristics.<sup>3</sup> When stealing the competitors' market, the managers have the risk failing to sell high-quality goods, causing negative consequences. Therefore, in the duopoly market, the profit functions

---

<sup>2</sup>Recall, as we discussed in the Industrial Background section, the managers in state-owned enterprises have the responsibility to achieve the targets in the contracts. In the Chinese tobacco industry, the managers need to first run out of the quota to meet the criterion of the state plan. Second, managers need to maximize profit. Third, the managers will be negatively impacted by the cigarettes they fail to sell.

<sup>3</sup>According to Wang (2009), the share of low-quality cigarettes is dominated the China's cigarette market before the industry reorganization. Local governments built small-scale cigarette firms to satisfy the local need and blocked cigarettes from other regions.

for Firms 1 and 2 are

$$\begin{aligned}
\pi_1 &= (p_L - c_L)(1 - t)Q + p_H a - c_H a + \frac{tQ - a}{(tQ - a) + (t'Q - b)} 2cp_H - (tQ - a)c_H \\
&\quad - [tQ - a - \frac{tQ - a}{(tQ - a) + (t'Q - b)} 2c]I \\
&= (p_L - c_L)(1 - t)Q + p_H a - tQc_H + \frac{tQ - a}{(tQ - a) + (t'Q - b)} 2cp_H \\
&\quad - [tQ - a - \frac{tQ - a}{(tQ - a) + (t'Q - b)} 2c]I
\end{aligned} \tag{1.3}$$

and

$$\begin{aligned}
\pi_2 &= (p_L - c_L)(1 - t')Q + p_H b - c_H b + \frac{t'Q - b}{(tQ - a) + (t'Q - b)} 2cp_H - (t'Q - b)c_H \\
&\quad - [t'Q - b - \frac{t'Q - b}{(tQ - a) + (t'Q - b)} 2c]I \\
&= (p_L - c_L)(1 - t')Q + p_H b - t'Qc_H + \frac{t'Q - b}{(tQ - a) + (t'Q - b)} 2cp_H \\
&\quad - [t'Q - b - \frac{tQ - a}{(tQ - a) + (t'Q - b)} 2c]I.
\end{aligned} \tag{1.4}$$

The term  $(tQ - a)/(tQ - a + t'Q - b)$  in Equation 1.3 represents the probability for Firm 1 selling high-quality cigarettes to Type C consumers successfully, while  $(t'Q - b)/(tQ - a + t'Q - b)$  in Equation 1.4 represents the probability for Firm 2 doing so.

For Firm 1, the first order condition of  $\pi_1$  with respect to  $t$  is

$$\begin{aligned}
\frac{\partial \pi_1}{\partial t} &= -(p_L - c_L)Q - c_H Q + \frac{Q[tQ - a + t'Q - b] - Q(tQ - a)}{[(tQ - a) + (t'Q - b)]^2} 2cp_H \\
&\quad - [Q - \frac{Q[tQ - a + t'Q - b] - Q(tQ - a)}{[(tQ - a) + (t'Q - b)]^2} 2c]I \\
&= 0.
\end{aligned} \tag{1.5}$$

For Firm 2, the first order condition of  $\pi_2$  with respect to  $t'$  is

$$\begin{aligned}\frac{\partial \pi_2}{\partial t'} &= -(p_L - c_L)Q - c_H Q + \frac{Q[tQ - a + t'Q - b] - Q(t'Q - b)}{[(tQ - a) + (t'Q - b)]^2} 2cp_H \\ &\quad - [Q - \frac{Q[tQ - a + t'Q - b] - Q(t'Q - b)}{[(tQ - a) + (t'Q - b)]^2} 2c]I \\ &= 0.\end{aligned}\tag{1.6}$$

By symmetry, we assume two enterprises allocate the same proportion to high-quality goods, which is  $t = t'$ . In addition, we assume the market for the Type A consumer is the same size as the one for the Type B consumer,  $a = b$  for simplification. Thus, the first-order condition can be shown as

$$\begin{aligned}\frac{\partial \pi_1}{\partial t} &= -(p_L - c_L)Q - c_H Q + \frac{Q(tQ - a)}{[2(tQ - a)]^2} 2cp_H - [Q - \frac{Q(tQ - a)}{[2(tQ - a)]^2} 2c]I \\ &= -(p_L - c_L) - c_H + \frac{cp_H + cI}{2(tQ - a)} - I \\ &= 0.\end{aligned}\tag{1.7}$$

Equation 1.7 represents the proportion which the manager allocates to high-quality cigarettes

$$t^d = \frac{a}{Q} + \frac{cp_H + cI}{2Q(c_H + I + p_L - c_L)}.\tag{1.8}$$

### 1.3.3 Monopoly Analysis

As Figure 1.7 shows, the demand for high-quality cigarettes in each local market is all Type A, Type B, and Type C consumers. The total quota for the monopoly is  $2Q$ ; the total demand can be shown as  $2(a + b + c)$ . Then the share that manufacturers would like to allocate to high-quality cigarettes under the monopoly



case, which is

$$t^m = \frac{2(a+b+c)}{2Q}. \quad (1.9)$$

Since the two local markets are identical, we cancel out the two in both the numerator and the denominator. To simplify our model, we also assume the demand for the Type A consumer and the Type B consumer are the same. Thus, we have  $a = b$ . The final result can be shown as follows

$$t^m = \frac{a+b+c}{Q} = \frac{2a+c}{Q} \quad (1.10)$$

### 1.3.4 Conclusions and Predictions from the Theoretical Model

**Proposition 1.** When  $(2a+c)(c_H + I + p_L - c_L) > c(p_H - c_H + c_L - p_L)$ , then the percentage of the quota that manufacturers allocate to high-quality goods is higher in the monopoly market than in the duopoly market.

Proof. The difference in the proportion of the quota allocated to the high-quality cigarettes in the two different markets is

$$\begin{aligned} t^m - t^d &= \frac{2a}{Q} + \frac{c}{Q} - \frac{a}{Q} - \frac{cp_H + cI}{2Q(c_H + I + p_L - c_L)} \\ &= \frac{a}{Q} + \frac{c}{Q} - \frac{cp_H + cI}{2Q(c_H + I + p_L - c_L)} \\ &= \frac{(2a+c)(c_H + I + p_L - c_L) + c(c_H + p_L - c_L - p_H)}{2Q(c_H + I + p_L - c_L)}. \end{aligned} \quad (1.11)$$

Since  $2Q(c_H + I + p_L - c_L)$  is always greater than zero when  $(2a+c)(c_H + I + p_L - c_L) > c(p_H - c_H + c_L - p_L)$ , we have  $t^m - t^d > 0$ , which means that the share of the quota of high-quality cigarettes is lower when there is regional competition.

**Proposition 2.**  $\frac{\partial t^d}{\partial I} < 0$  for all I. When in the duopoly market, the negative consequences for not meeting the criterion cause the managers to reduce the quota

they allocate to high-quality goods from what it is in the monopoly scenario.

Proof.

$$\begin{aligned}
\frac{\partial t^d}{\partial I} &= \frac{c}{2Q} \frac{(c_H + I + p_L - c_L) - (p_H + I)}{c_H + I + p_L - c_L} \\
&= \frac{c}{2Q} \frac{(c_H + p_L - c_L - p_H)}{c_H + I + p_L - c_L} \\
&= \frac{c}{2Q} \frac{w_L - w_H}{c_H + I + p_L - c_L}.
\end{aligned} \tag{1.12}$$

Recalling the profit margin of the high-quality cigarettes is higher than the profit margin of the low-quality cigarette, we have  $w_L < w_H$ ,  $\frac{\partial t^d}{\partial I} < 0$  always exists. Proposition 2 is the key support for the main argument in this study. The property of mission-oriented contracts for managers in state-owned enterprises leads to a lower proportion of high-quality goods. As the negative consequences increase, the ratio that managers allocate to high-quality goods decreases.

## 1.4 Data

### 1.4.1 Production Data

The primary source of data for this study is from the STMA database, which is the monthly firm-brand level data on cigarette production from January 2005 to December 2011. All cigarettes are classified into five categories based on allocation prices.<sup>4</sup> The STMA adjusted the classification allocation prices in 2009. Details of cigarette classification from high to low are shown in Table 1.1, information not used here because this research focuses on quota-allocation strategies. All manufacturers faced the same standardization changes. All empirical studies in this paper are based on the three categories of cigarette allocation prices shown in the first column in Table 1.1. The luxury brands for high-quality cigarettes are those with allocation

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<sup>4</sup>I used the standard of classification from the China Tobacco Year Books between 2005–2011.

prices higher than 50 RMB per carton, and the medium-quality cigarettes are those with allocation prices between 30 RMB to 50 RMB per carton, while the low-quality cigarettes are those cheaper than 30 RMB per carton.

Figure 1.8 shows the total output of cigarettes across China from the year 2003 to the year 2012. The total number produced increases smoothly from 17,905 hundred million sticks in the year 2003 to 25,160 hundred million in the year 2012. The entire production of high-quality and medium-quality cigarettes traces the increasing trend, while the production of low-quality cigarettes decreases from the year 2009. Figure 1.9 presents the direction of the market share for the entire market from the year 2003 to the year 2012. The market share of low-quality cigarettes declines while the percentage of medium-quality cigarettes increases.

The proportion of quota for each product segment is the primary variable of interest in this study. Since different manufacturers have different quotas, which vary across provinces, to study the quota allocation strategies, this paper chooses to use proportion instead of quantity. Another advantage of using share is to address the effect of growing cigarette consumption.

### 1.4.2 Forced Mergers

Data were collected on the state-led merger movement of regional tobacco enterprises over time by the author. Table 1.2 shows the reorganization date in each province, represented as  $t_0$ .  $G_{it}$  is a dummy variable constructed based on Table 1.2. I divide my sample into two groups based on the type of reform.  $G_{it}$  equals to 1 if there exist multiple enterprises before the reform, equals to 0 if only the organizational system is reconstructed. The different types of reform are shown geographically in Figure 1.10. The dark blue areas on the map indicate the provinces with multiple

manufacturers before the reform, while the light blue areas represent the provinces with a single firm before the reorganization.  $M_{it}$  is another dummy variable in our empirical analysis,  $M_{it}$  equals 0 if it is before the reform occurring at time  $t_0$ , and  $M_{it}$  equals 1 if a province completes the horizontal merger in time  $t$ , meaning post  $t_0$ .

### 1.4.3 Summary Statistics

Table 1.3 and Table 1.4 provide the summary statistics for the variables used in this analysis. Based on the different types of reform, I decompose provinces into two categories according to the number of firms before the reform: the reorganized group with a single manufacturer before the reform and the merged group with multiple manufacturers before the reform. Table 1.3 shows the summary statistics for the proportion of the quota allocated to each quality, constructed based on three different quality levels (high, medium, and low) for the two different groups before and after the reorganization. The summary statistics reveal differences across groups, but Figure 1.11 and Figure 1.12 show interesting patterns not seen in the summary statistics. The vertical dashed lines at  $t_0$  represent the time that the merger was implemented. Different dynamic trends of quota allocation are shown in Figure 1.11 and Figure 1.12 across the two different groups. For the single firm reorganized group, the mean of the proportion of the quota for low-quality cigarettes decreases, a trend that remains constant after the reconstruction. For the merged group with several firms, the mean proportion of low-quality goods increases. After the merger, when there is only one firm in the province, there exist common trends in the two groups, meaning the quota allocation decisions are the same as the reorganized group.

Table 1.4 represents the summary statistics on the province-level control variables, which include the natural logarithm of the population, the unemployment rate,

the log of personal income per capita, the log of consumption index, and the natural logarithm of GDP.

I use these data to test whether the quota-allocation strategies are different between market structures with a regional monopoly market, and with a regional duopoly market.

## 1.5 Empirical Research Design

According to the theoretical predictions, under quota regulation, a manager should assign a larger proportion to high-quality goods when he is the only producer in the area. This section explores how different market structures influence a manager’s quota allocation strategy empirically by using an event study and a triple-difference model.

### 1.5.1 Empirical Specification: The Event Study Model

The baseline model exploits the impact of the exogenous horizontal merger in the Chinese cigarette industry. I use an event study model based on Goolsbee and Syverson (2008) to estimate the dynamic treatment effects using fixed effects regression, which includes a series of leads and lags of the merger while controlling for other influences, and two groups, “treatment” and “control”, as follows:

$$Y_{it} = \sum_{\tau=-3}^3 \beta_{M,t_0+\tau} [(Merger)_{t_0+\tau} * I(Group)] + \gamma * X_{it} + \theta_q + \epsilon_{it}, \quad (1.13)$$

where  $i$  indexes the province and  $t$  the month.  $Y_{it}$  is the outcome of interest, the percentage of production of high-quality cigarettes, medium-quality cigarettes, and low-quality cigarettes. The time  $t_0$  represents the time that the merger event occurred

in province  $i$ .<sup>5</sup>  $Merger_{to+\tau}$  is an indicator variable for whether the reconstruction was implemented in the province  $i$  at the period  $to + \tau$ .  $Merger_{to+\tau}$  are the six half-year dummies surrounding the period when the merger happens. The lead dummies are indicators for 0-6 months, 6-12 months, and 12-18 months before the merger, while the lags represent 0-6 months, 6-12 months, and 12-18 months post the merger.  $I(Group)$  denotes the type of the merged group, equalling 1 if there exist multiple manufacturers before the reform and 0 if there is only one manufacturer. The vector  $X_{it}$  contains a set of province-level control variables that include the natural logarithm of the population, the unemployment rate, the log of personal income per capita, the log of consumption index, and the natural logarithm of GDP. I also include fixed effects for the season ( $\theta_q$ ). The error term  $\epsilon_{it}$  is a province-month specific error term.

### 1.5.2 Empirical Specification: The Triple-Difference Model

Triple-difference model (DDD) estimation is one of the most widely used quasi-experimental tools for identifying the impacts of policy treatments. As specified previously, the horizontal merger in China's cigarette industry is exogenous. To exploit the effects of the mergers, I estimate a triple-difference model (DDD) on the pooled sample following Goodman-Bacon (2018) in the form:

$$\begin{aligned}
 Y_{it} = & \beta_0 + \beta_1 * dM_{it} + \beta_2 * dG_{it} + \beta_3 * dM_{it} * dG_{it} + \delta_0 * Time + \delta_1 * Time * dM_{it} \\
 & + \delta_2 * Time * dG_{it} + \delta_3 * Time * dG_{it} * dM_{it} + \gamma * X_{it} + \theta_q + \epsilon_{it},
 \end{aligned}
 \tag{1.14}$$

where  $Y_{it}$  is the outcome variable, the share of production allocated for cigarettes at three different quality levels for province  $i$  at month  $t$ .  $M_{it}$  is the treatment dummy variable.  $M_{it}$  equals 0 if before the reform, while  $M_{it}$  is defined to be 1 if post the

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<sup>5</sup>Recall: The merger times for each province are shown in Table 1.2

reform.  $G_{it}$  indicates the group dummy, defined as 0 for the reorganized group and 1 for the merged group. I also control the seasonal fixed effects, which are denoted by  $\theta_q$ . I estimate Equation 1.14 using monthly data from the year 2005 to the year 2011.

## 1.6 Results

Figure 1.13 to Figure 1.15 plot the event study coefficients  $\beta_{M,t_0+\tau}$ . The horizontal axis represents the time, where  $t_0 - 1$  represents 0-6 months before the merger event, while  $t_0 + 1$  represents 0-6 months after the reform. Each time bin includes 6 months. Figure 1.13 presents the effects of the reform treatment on high-quality cigarettes. This plot shows the deviation of the share allocated for high-quality cigarettes in the control group when we control for province characteristics and seasonal fixed effects. Similarly, Figure 1.14 shows the effects of the reform treatment for the medium-quality cigarettes, and Figure 1.15 presents the results of the reform treatment for the low-quality cigarettes. For high-quality cigarettes, the coefficients are not significant. However, the coefficients for the medium-quality cigarettes are significant, with the sign remaining negative until  $t_0 + 2$ . Figure 1.14 shows that the merger begins to affect medium-quality cigarettes a half-year after the reform. The merged manufacturers allocate more share of their quotas to medium-quality cigarettes compared to the control group. Figure 1.15 presents the effect of the merger treatment on low-quality cigarettes. The finding shows that the merger significantly decreases the proportion of the quotas the manufacturers allocate for low-quality cigarettes..

Table 1.5 presents the results of the event study model based on the estimation of Equation 1.13. The coefficients of our variables of interest capture the difference between the treatment groups and the control groups in the period around the event

point. From one and a half years before the merger until a half-year after the merger, provinces with multiple firms allocated a larger proportion of their quotas to low-quality cigarettes and less to the medium-quality cigarettes every six months than the single-firm market. Since  $t_0 + 2$ , which is six months after the merger, the merged manufacturers produce more shares of high-quality cigarettes than the reorganized manufacturers. The lag effect shown in the results is because the adjustment of the production plan takes time. Our results are all significant at the one percent level, suggesting there's a strong merger effect. There are also some interesting findings for our control variables. The manufacturers in the provinces with consumption level and GDP allocate a larger proportion of their quotas to high-quality and medium-quality cigarettes.

Table 1.6 shows the different effects of horizontal mergers for two market structures. Each column shows a regression of the quota-allocation on different levels of products on time dummies, type of merger dummies, and other province-level control variables. The results indicate that a higher proportion of the quota is allocated to low-quality cigarettes in a multiple firm market than in a single-firm market, while the single-firm market allocates a higher proportion of the quota to medium-quality cigarettes. The coefficient of the term Merge\*Type\*Time captures the difference between the quota allocated to the specific quality cigarettes between the two groups before and after the merger.

## 1.7 Conclusion

This paper investigates the effectiveness of the government forced horizontal merger on quota allocation strategies for different quality cigarettes by providing both theoretical and empirical models. State-owned enterprises play an essential role in



China, and the Chinese cigarette industry is a good example for studying managers' strategies for quota allocation under the regulations for different market structures.

This paper provides both theoretical and empirical findings for the quality choice under quota constraints and fixed pricing under the exogenous horizontal merger in China's cigarette industry. The theoretical model indicates that in the duopoly market, the managers have more incentive to lower the share of the quota to high-quality cigarettes than in the monopoly scenario, but allocate more proportion of the quota on the low-quality cigarettes. The potential explanation for these results is that the managers of the state-owned enterprises need to meet the targets in their contracts; specifically, managers in the Chinese cigarette industry need to fill their quotas as mandated by the state plan and sell their product successfully. Faced with the serious consequences for their inventory, the managers in the duopoly scenario reduce the share of their quota for high-quality cigarettes because of the competition from the manufacturer in the same province.

My empirical results confirm the theoretical predictions. When the allocation of the quotas across the different quality cigarettes is the only competitive strategy the manufacturers can use, the share of high-quality cigarettes in the oligopoly markets is lower than in the monopoly markets. This strategy results because consumers who prefer low-quality cigarettes are more price elastic, so producers allocate more quota to low-quality cigarettes to capture more market shares to fulfill the targets stipulated by the representative bureaus. The horizontal merger avoids the high cooperation fee between firms, increasing the proportion of higher quality cigarettes in the market.

Our model has several limitations. First, it analyzes only the monopoly and duopoly markets, but in reality, there were usually more than two manufacturers in the provinces before the reform. In addition, we assume the two manufacturers are symmetric. Therefore, asymmetric cases should be considered. These limitations

provide areas for future research.

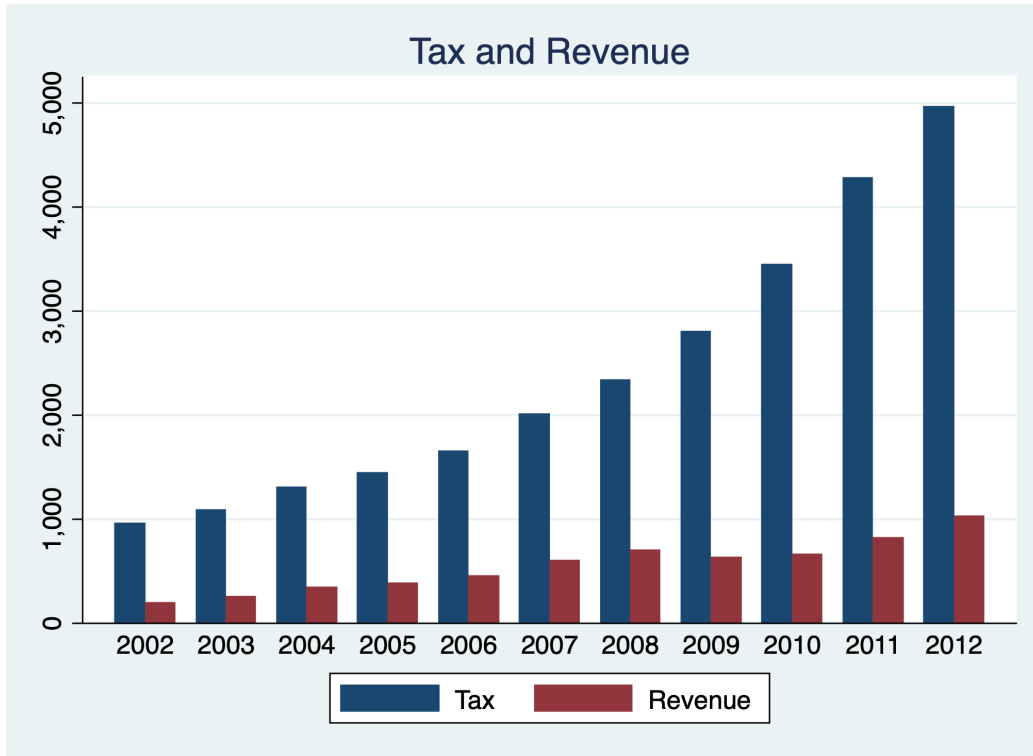


Figure 1.1: Tax and Revenue in the cigarette industry

Note: Data Sources: China Tobacco Yearbooks between 2005–2011.

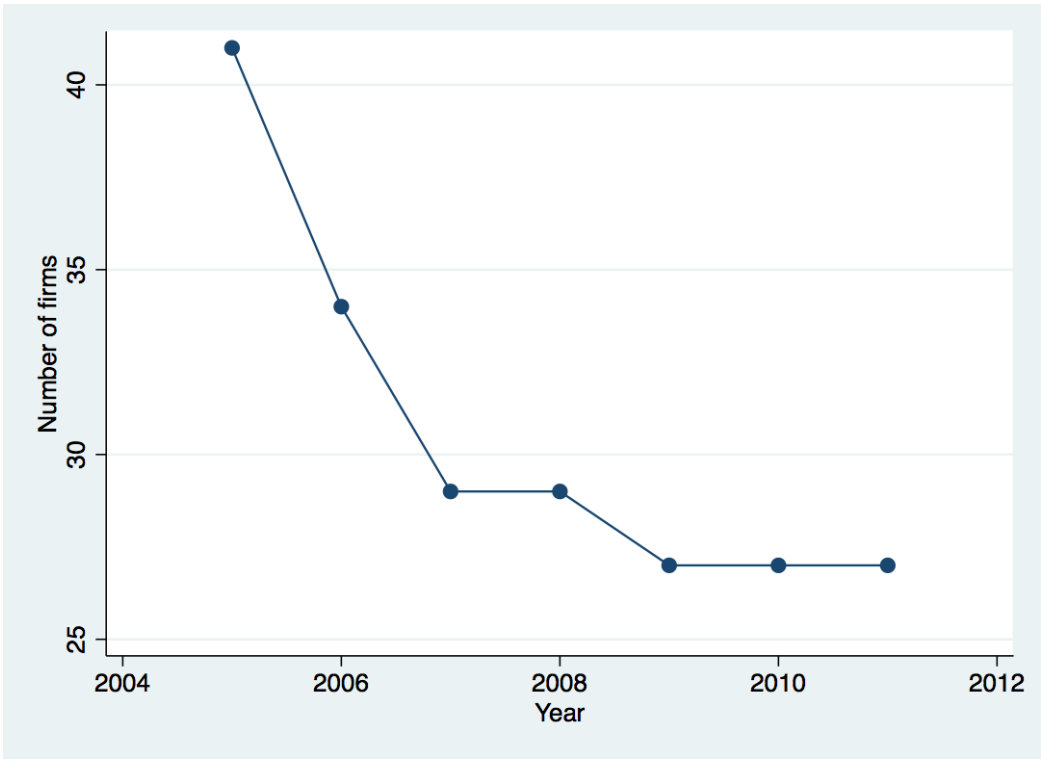


Figure 1.2: Number of Firms

Note: Data Sources: China Tobacco Yearbooks. The number of cigarette manufacturers decreases from 44 to 27 from year 2005 to 2011.



Figure 1.3: The Industrial Organization

Note: The State Tobacco Monopoly Administration (STMA) distributes the production quotas to each company, the manufacturers sell the cigarettes back to STMA by allocation prices. The allocation prices are set based on the production cost.

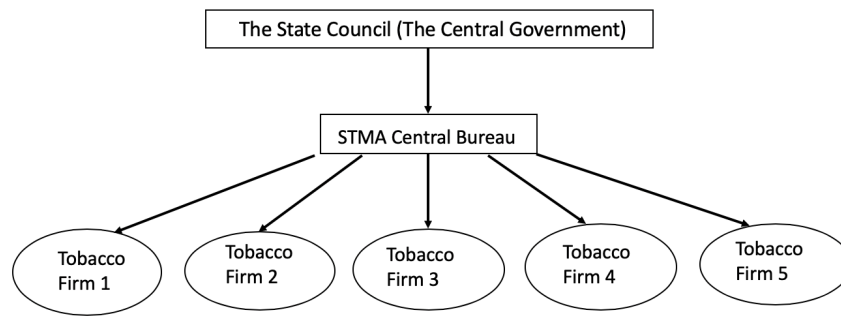


Figure 1.4: The Industrial Organization Before the Reconstruction

Note: This figure shows the organization before the reconstruction. The State Tobacco Monopoly Administration (STMA) directly distributes the production quotas to each manufacturer.

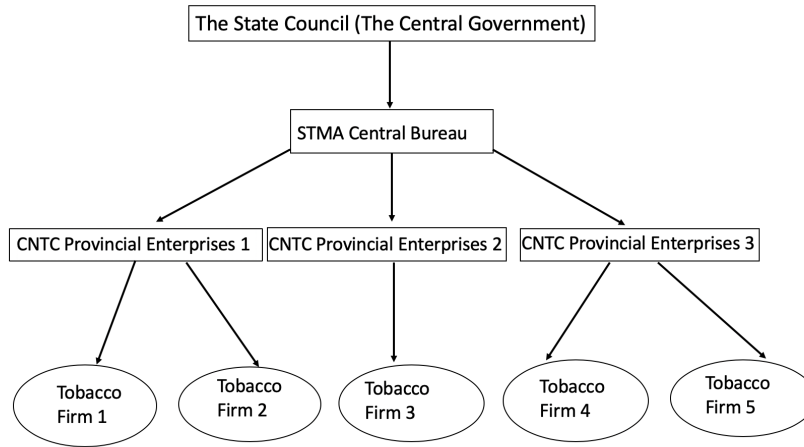


Figure 1.5: The Industrial Organization After the Reconstruction

Note: This figure shows the organization after the reform. The State Tobacco Monopoly Administration (STMA) distributes the quota to the province-level enterprises.

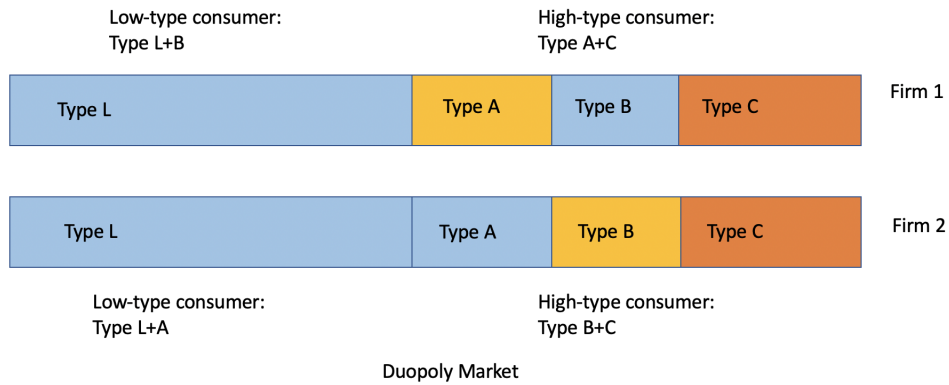


Figure 1.6: Model for Duopoly Market

Note: The figure shows the market segments in the duopoly market. Two manufacturers own their low-quality cigarette markets. In the first market, Type A consumer desire the high-quality products with particular characteristic from Firm 1, Type B consumers can not find the high-quality products with her desired feature, she will buy low-quality cigarettes instead. Type C consumers are those who always consume high-quality cigarettes. Type B consumers in the second market will buy the cigarettes produced by Firm 2 for her desired characteristics, while Type A consumers will buy low-quality cigarettes. Firm 1 and Firm 2 will compete for Type C consumers in other's market.



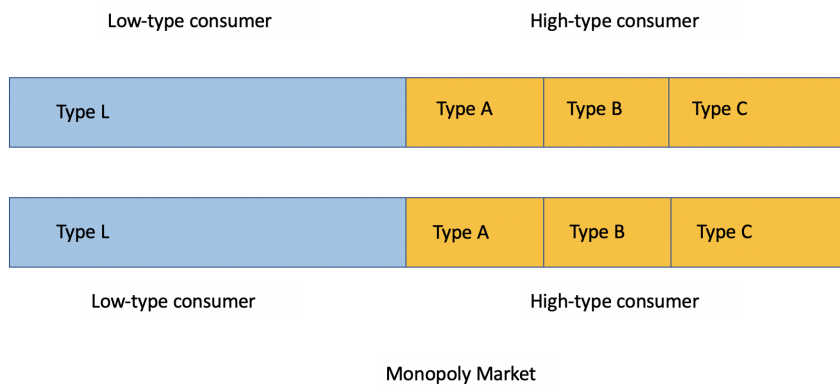


Figure 1.7: Model for Monopoly Market

Note: The figure presents the segments of the monopoly market. There are two types of consumers. Type L consumers prefer low-quality cigarettes. Type A, Type B, and Type C are consumers who desire high-quality cigarettes.

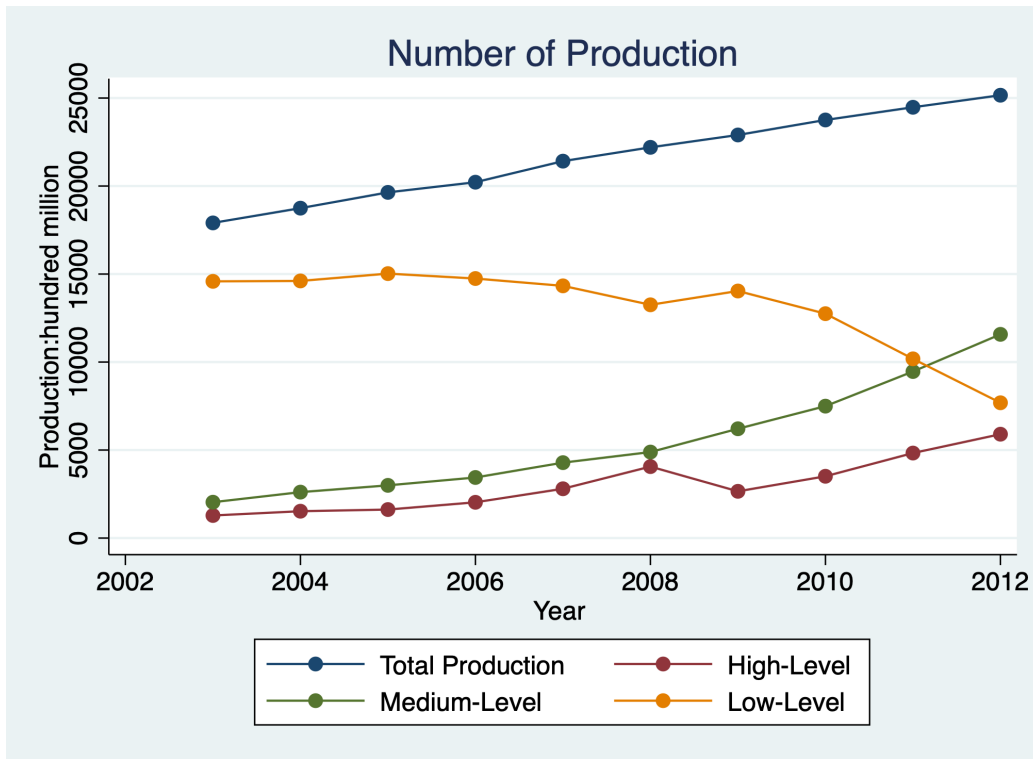


Figure 1.8: Number of Production

Note: Data Sources: China Tobacco Yearbooks between 2005-2011.

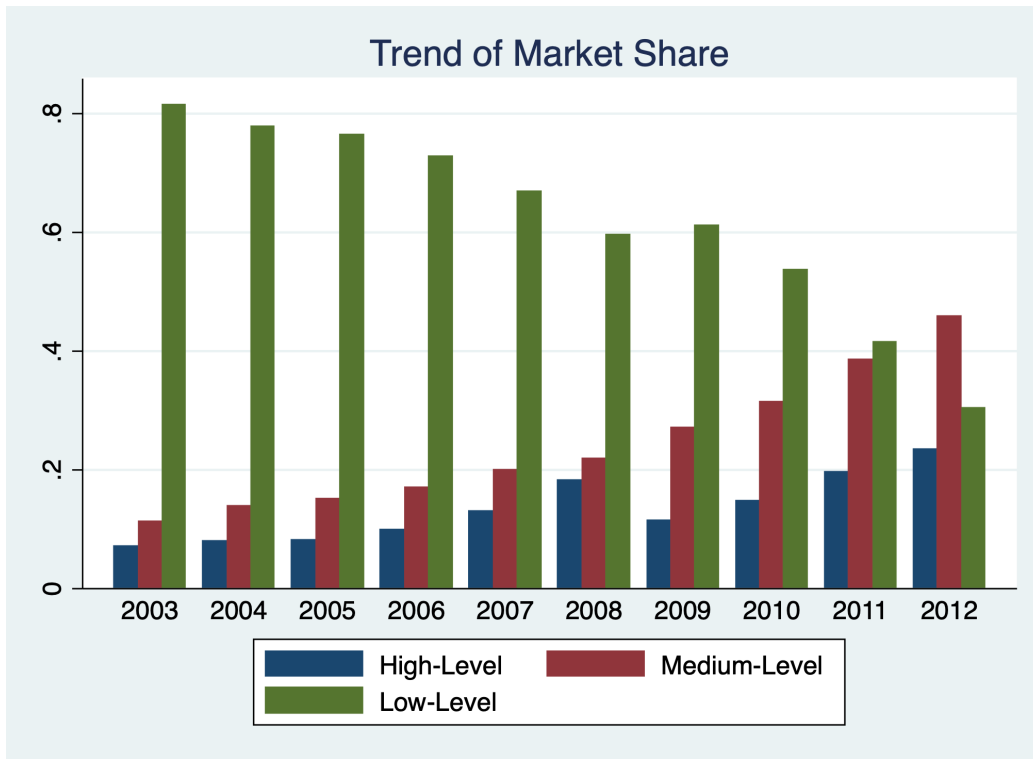


Figure 1.9: Trend of market share

Note: Data Sources: China Tobacco Yearbooks between 2005–2011.

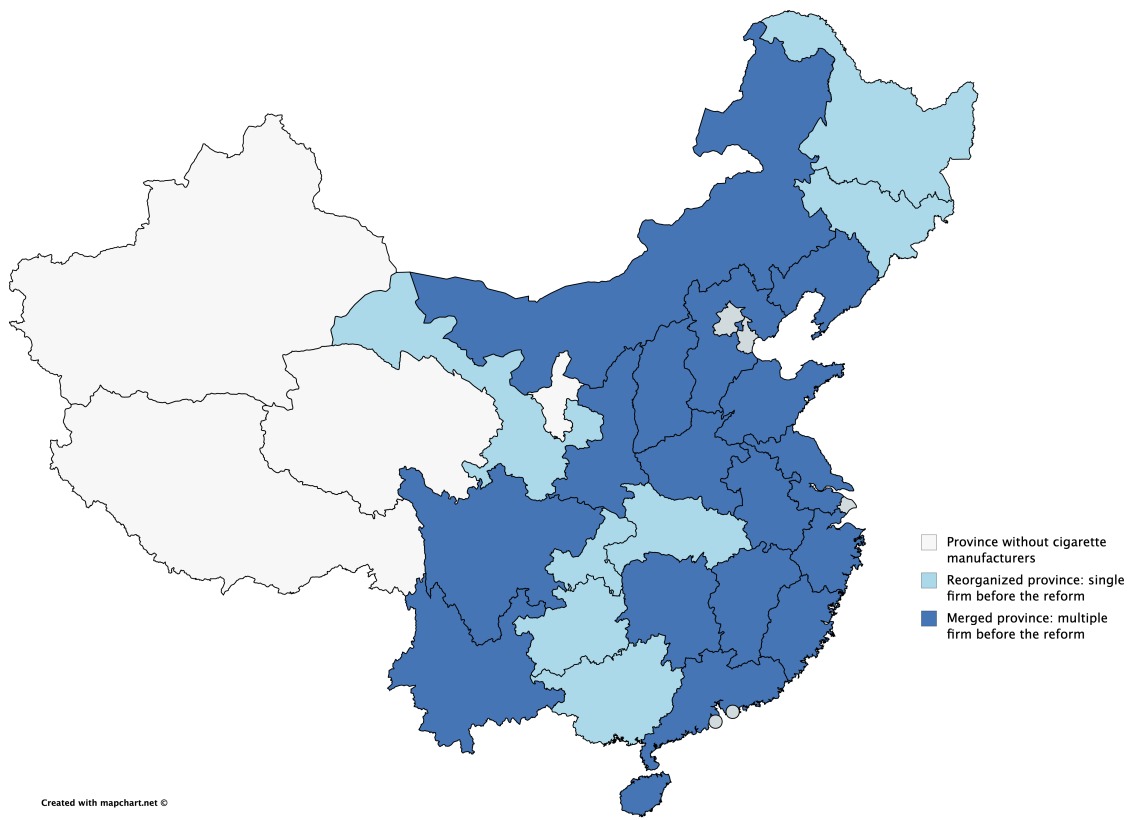
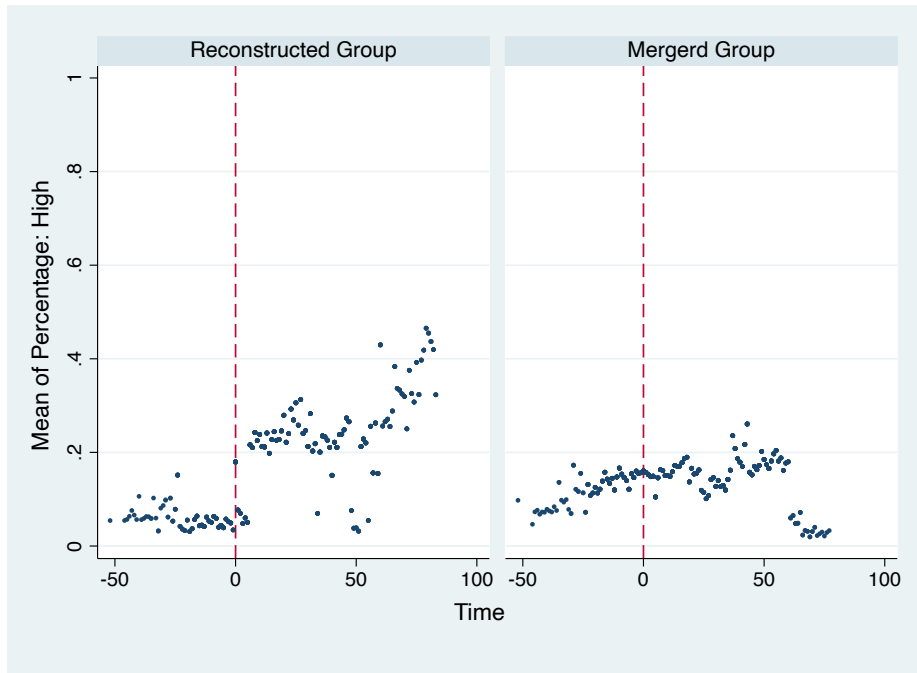
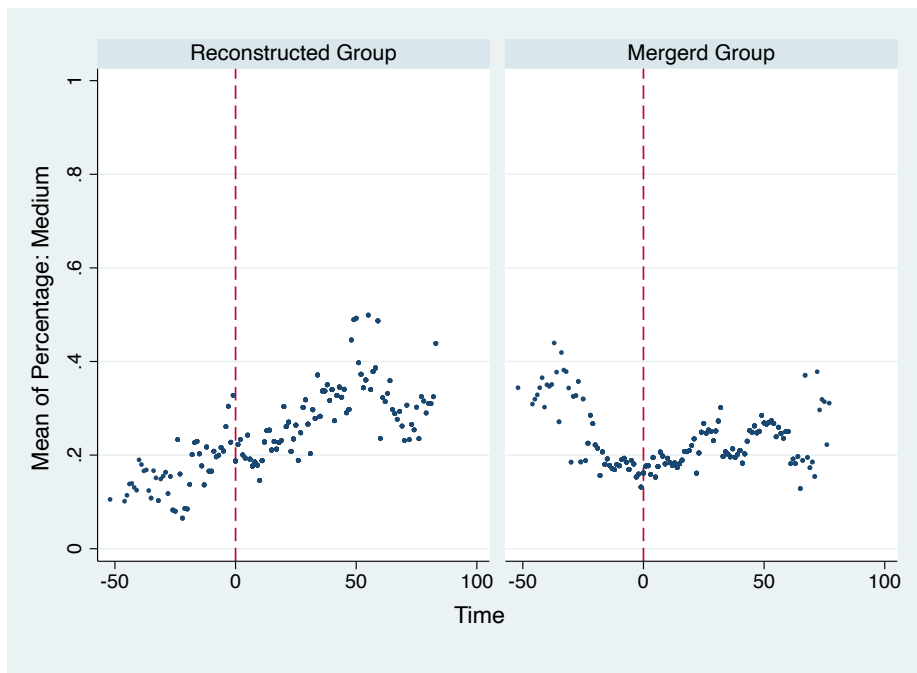


Figure 1.10: Provinces with different restructuring



(a) High-Quality Cigarettes



(b) Medium-Quality Cigarettes

Figure 1.11: The Mean of Percentage for High-Quality and Medium-Quality Cigarettes

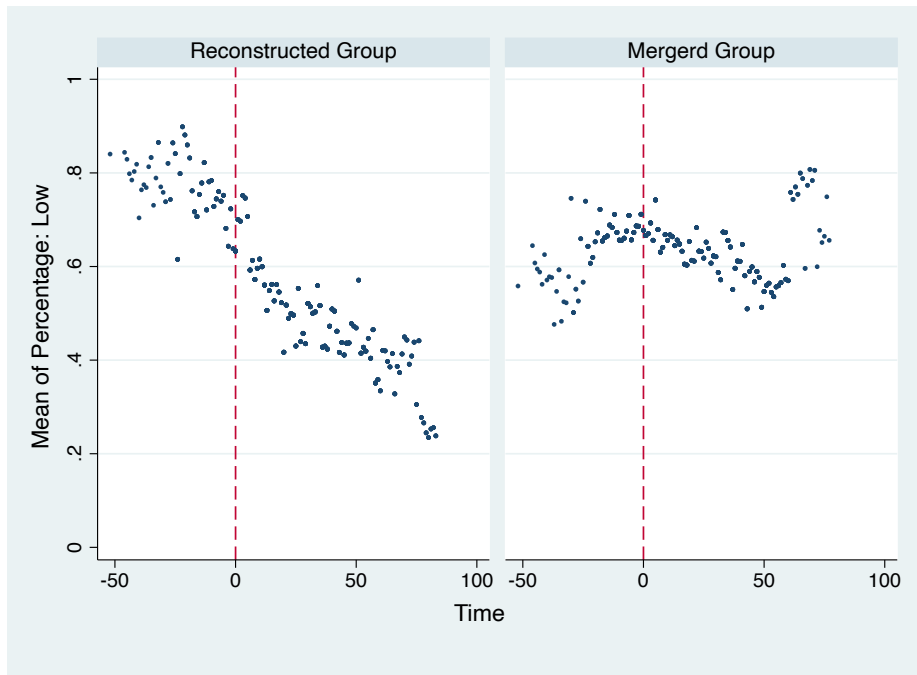


Figure 1.12: The Mean of Percentage for Low-Quality Cigarettes

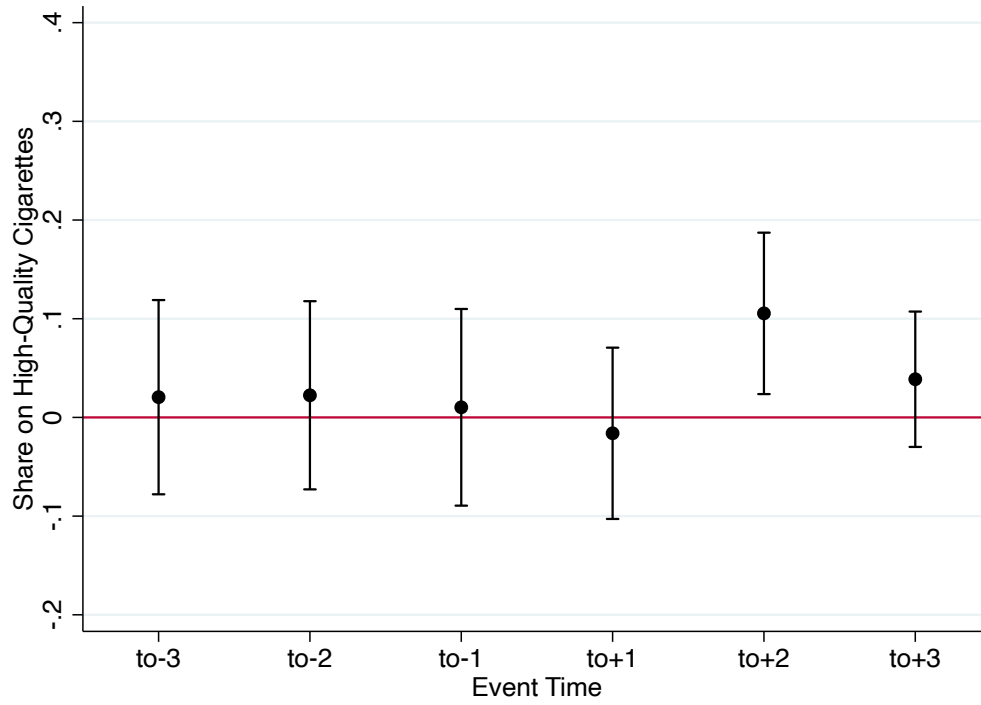


Figure 1.13: Share on High-Quality Cigarettes: Deviation From Control Group

Note: This figure is a plot of the event study coefficients  $\beta_{M,t_0+\tau}$  from regression Equation 1.13 for high-quality cigarettes. The black dots represent the regression coefficients. All regressions control for province characteristics and seasonal fixed effect. The confidence intervals are at 95% level.

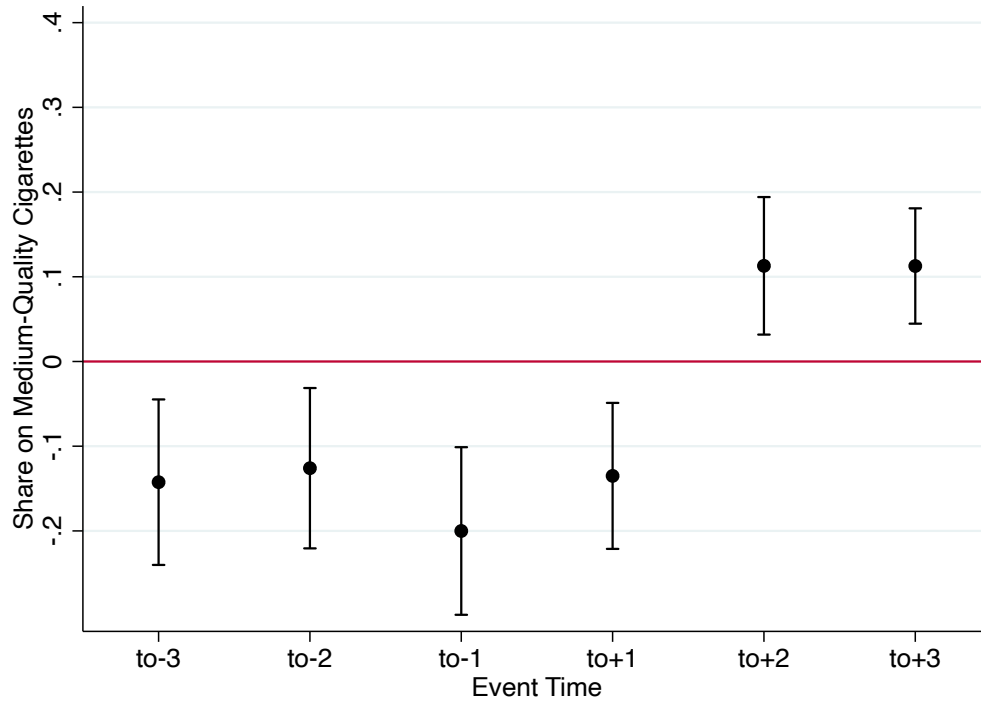


Figure 1.14: Share on Medium-Quality Cigarettes: Deviation From Control Group

Note: This figure is a plot of the event study coefficients  $\beta_{M,t_0+\tau}$  from regression Equation 1.13 for medium-quality cigarettes. The black dots represent the regression coefficients. All regressions control for province characteristics and seasonal fixed effect. The confidence intervals are at 95% level.



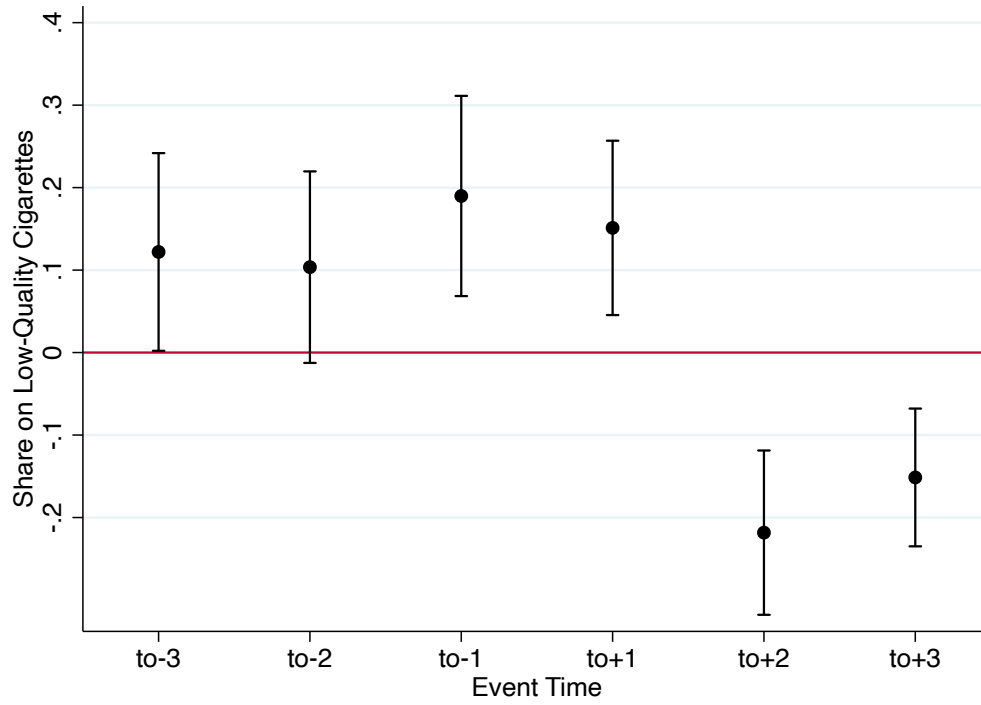


Figure 1.15: Share on Low-Quality Cigarettes: Deviation From Control Group

Note: This figure is a plot of the event study coefficients  $\beta_{M,t_0+\tau}$  from regression Equation 1.13 for low-quality cigarettes. The black dots represent the regression coefficients. All regressions control for province characteristics and seasonal fixed effect. The confidence intervals are at 95% level.

Table 1.1: Categories Based on Allocation Prices

Category	Price Range	Before 2008	After 2008
High(C1)	[50, $\infty$ ]	[50, $\infty$ ]	[100, $\infty$ )
			[50,100)
Medium(C2)	[30, 50)	[30,50)	[30,50)
Low(C3)	[0, 30)	[15,30)	[16.5,30)
		[10,15)	[0,16.5)
		[0,10)	

Note:

Data Sources: China Tobacco Yearbooks between 2005–2011.

Table 1.2: Reconstruction Time

Province	ReconstructionTime
<b>Merged Manufactures</b>	
Hongta	January, 2005
Hubei	July, 2005
Shanxi	June, 2006
Anhui	July, 2006
Shandong	December, 2006
Zhejiang	December, 2006
Sichuan	December, 2006
Hunan	March, 2007
Jiangsu	June, 2007
Henan	July, 2007
Hongyunhonghe	May, 2009
Jiangxi	July, 2009
Fujian	January, 2010
<b>Reconstructed Manufactures</b>	
Shanghai	January, 2005
Chongqing	January, 2005
Guizhou	January, 2007
Jilin	January, 2007
Guangdong	January, 2007
Guangxi	January, 2007
Heilongjiang	September, 2007
Shenzhen	September, 2007
Gansu	December, 2007
Hubei	May, 2009

Note:

The reconstruction time is the time when the manufacturers change their names .

Table 1.3: Summary Statistics for Main Variables

Variable	Mean	Std.Dev	N	Max	Min
Reconstructed: Before					
High	0.060	0.076	209	0.757	0
Medium	0.199	0.218	209	0.770	0
Low	0.741	0.252	209	1	0.023
Reconstructed: After					
High	0.240	0.308	727	1	0
Medium	0.279	0.263	727	1	0
Low	0.482	0.356	727	1	0
Merged: Before					
High	0.130	0.093	314	0.504	0.004
Medium	0.222	0.132	314	0.491	0.01
Low	0.648	0.179	314	0.948	0.283
Merged: After					
High	0.162	0.172	562	0.737	0.001
Medium	0.209	0.141	562	0.695	0
Low	0.629	0.215	562	0.959	0.029

Table 1.4: Summary Statistics for Control variables

<b>Variable</b>	<b>Mean</b>	<b>Std. Dev.</b>	<b>Min.</b>	<b>Max.</b>
GDP	11539.09	10677.81	248.8	53210.28
Population	4419.407	2782.886	280	10505
Unemployment rate	3.703	0.632	1.4	5.6
Personal income per capita	29352.19	11550.8	13688	77031

Note:

Data Sources: China Statistical Yearbooks between 2005–2011.

Table 1.5: Event Study Results

	Expensive	Medium	Low
to-3	0.0205 (0.0502)	-0.142*** (0.0498)	0.122** (0.0611)
to-2	0.0224 (0.0486)	-0.126*** (0.0483)	0.104* (0.0592)
to-1	0.0102 (0.0508)	-0.200*** (0.0505)	0.190*** (0.0619)
to+1	-0.0161 (0.0443)	-0.135*** (0.0440)	0.151*** (0.0539)
to+2	0.105** (0.0417)	0.113*** (0.0414)	-0.218*** (0.0508)
to+3	0.0387 (0.0350)	0.113*** (0.0347)	-0.151*** (0.0426)
ln(Population)	-0.377*** (0.0194)	0.0248 (0.0193)	0.352*** (0.0236)
Unemployment Rate	0.108*** (0.0896)	0.0222** (0.0089)	-0.130*** (0.0109)
ln(income)	-0.365*** (0.0288)	0.0931*** (0.0286)	0.263*** (0.0350)
ln(GDP)	0.330*** (0.0150)	0.0770*** (0.0149)	-0.407*** (0.0183)
constant	3.615*** (0.329)	-1.653*** (0.326)	-0.961** (0.400)
N	1812	1812	1812
adj. R-sq	0.298	0.159	0.363
Seasonal FE	Yes	Yes	Yes

Note:

Coefficient estimates that are significant at 1%, 5%, and 10% level are denoted with \*\*\*, \*\*, and \*, respectively.

Table 1.6: Triple-Difference Regression Results

	Expensive	Medium	Low
Time	0.00122 (0.00135)	0.00207 (0.00134)	-0.00329** (0.00164)
Merge Dummy	0.0904*** (0.0292)	-0.0183 (0.0291)	-0.0722** (0.0355)
Type Dummy	0.0600* (0.0339)	-0.128*** (0.0338)	0.0682* (0.0411)
Merge*Type Dummy	-0.0617 (0.0388)	0.0678* (0.0386)	-0.00611 (0.0471)
Merge*Time	0.00139 (0.00138)	-0.00117 (0.00137)	-0.000224 (0.00167)
Type*Time	-0.00128 (0.00181)	-0.00909*** (0.00181)	0.0104*** (0.00220)
Merge*Type*Time	-0.000789 (0.00188)	0.00753*** (0.00187)	-0.00675*** (0.00228)
ln(Population)	-0.394*** (0.0196)	0.0225 (0.0195)	0.372*** (0.0238)
Unemployment Rate	0.101*** (0.009)	0.0223** (0.009)	-0.123*** (0.011)
ln(income)	-0.433*** (0.0326)	0.0893*** (0.0325)	0.344*** (0.0396)
ln(GDP)	0.347*** (0.0153)	0.0827*** (0.0152)	-0.430*** (0.0185)
constant	4.230*** (0.362)	-1.674*** (0.361)	-1.556*** (0.440)
N	1812	1812	1812
adj. R-sq	0.311	0.167	0.377
Seasonal FE	Yes	Yes	Yes

Note:

Coefficient estimates that are significant at 1%, 5%, and 10% level are denoted with \*\*\*, \*\*, and \*, respectively.

## Chapter 2

# The Effect of Horizontal Mergers on Inventory: Evidence from China's Cigarette Industry

### 2.1 Introduction

This paper investigates how government ownership affects managers' decisions under different market structures. In highly regulated markets, firms face inflexible prices and uncertain demand (Carlton, 1978). The cigarette market in China provides an excellent opportunity for studying firm behavior in such markets. In the Chinese cigarette market, the allocation prices by which firms sell cigarettes to the State Tobacco Monopoly Administration (STMA) are fixed and, thus, do not depend on the supply or the demand. Moreover, the demand for cigarettes fluctuates over time. In this paper, we study how the inventory of cigarette firms in China responds to the change in market structure caused by the mandate consolidation of the industry.

In general, economists analyze oligopolistic competition using models based on



price (Bertrand, 1883) or quantity (Cournot, 1838) as the decision-makers' competition strategies vary. However, in Chinese cigarette market, the prices are regulated by the STMA, which is only based on the marginal cost of the product. In addition, it also mandates the total quotas each manufacturer can produce; the manufacturers cannot produce more than their quotas because they do not have the necessary permit. In such a highly regulated industry, the quota allocation for different quality cigarettes is the only competitive strategy the managers have available to them. Since the mandated consolidation occurred between the years 2006 and 2007, we have the opportunity to observe changes resulting from the different market structures. Before the reform, some of the provinces had a single firm, referred to as a regional monopoly, while others had multiple firms before the reform, referred to as a duopoly. In a duopoly market, managers face a cooperative or non-cooperative situation. A large body of literature has analyzed duopoly competition to determine the equilibrium that results from the prisoners' dilemma having to choose whether to cooperate or not (Lambertini, 1997; Levitan and Shubik, 1972). The prediction based on our theoretical model indicates that because of the prisoners' dilemma, the manufacturers in a duopoly tend to overproduce high-quality cigarettes to steal this market from their competitors even though this decision increases their inventory of high-quality goods and the managers face retribution for the failure of the tasks.

It is challenging to measure firm performance in absolute terms (Marengo, 1992). In this paper, we use the change in inventory before and after the consolidation to study how the reform in the market structure affects firm performance. We use inventory as the vehicle for studying firm behavior in a highly regulated industry with demand uncertainty, investigating how mandated consolidation as an exogenous shock to the market affects inventory. This paper provides evidence for how a cooperative and non-cooperative market situation affects a manager's decisions.

Two reasons cause a need for an inventory: uncertain demand and competition resulting from decisions made by competitors. Krane (1994) investigated the trade-off between holding costs and stockout costs, focusing on asymmetric adjustment. The study reported here examined the trade-off between earning a higher profit margin from high-quality cigarettes and the risk of negative consequences because of the inventory, the situation faced by managers in the Chinese cigarette market. When cigarette manufacturers have a monopoly in the region, this situation functions like a cooperative market; they need to consider only the demand uncertainty. However, when it is a duopoly market, the managers must not only consider the demand uncertain but also the competition.

The theoretical model developed here includes the demand uncertainty in both a monopoly and a duopoly market. Faced with demand uncertainty and competition, the managers in the latter maximize their profits after meeting their quotas. The managers face a trade-off between higher profit-margins from high-quality cigarettes and negative consequences for having an inventory. The model predicts that under different market competition situations, the monopoly always has a smaller inventory than the duopoly. Furthermore, the worse the consequences for the inventory, the smaller the inventory held by the duopoly managers.

This paper is the first to empirically investigate the causal effect of the reform of the market structure on the cigarette industry in relation to the conditions mandated by the STMA on the inventory. To address the reorganized group, which historically comprised of a single firm in the province serves as our control and the multiple firms merged group is our treatment group. In addition, since this study includes both the pre-treatment period and the post-treatment period, I use a difference-in-difference model to examine how the cooperate and non-cooperate market structure affects the inventory.

My results suggest that compared with the single firm reorganized group when multiple firms merged into a sole manufacturer, the inventory of high-quality cigarettes and medium-quality cigarettes decreased significantly while the inventory of low-quality cigarettes increased. In addition, when there was regional competition, the inventory was higher than when the manufacturer was a monopoly in the local market.

The remainder of this paper proceeds as follows. Section 2.2 describes the theoretical model. Section 2.3 presents the data and how the main variables are generated, followed by statistical descriptions of the primary variables. Section 2.4 introduces the empirical strategy applied to this study. Section 2.5 offers the main empirical results, and Section 2.6 provides conclusions and suggestions for future work.

## **2.2 Theoretical Model**

The following theoretical model is an adaptation of the Hotelling (1929) model, which predicts how a change in the market structure affects firm inventory. The setup is based on the model in Desai (2001). Several new assumptions are made in this study to investigate the highly regulated Chinese cigarette market and the effect of demand uncertainty on different market structures. An alternative specification of the model includes the demand uncertainty for both high and low quality products. In the real world, multiple firm condition would include more than two firms in the same region. For simplification, we consider on two firms in competition in our theoretical model.

## 2.2.1 Model Setup

### 2.2.1.1 Product Variants and Firms

The Chinese cigarette market includes two vertical differentiated products: a high-quality (good H) and a low-quality (good L). For each manufacturer, the marginal costs for the high-quality goods and the low-quality goods are  $c_H$  and  $c_L$ , respectively. Under the Chinese cigarette pricing mechanism, the allocation-wholesale profit margin( $w_i$ ) is set by the STMA, which is assumed to be exogenous to the manufacturers. We assume high-quality products bring a higher mark-up for the manufacturers, in particular,  $w_H > w_L$ . The allocation price faced by the manufacturers is given by

$$p_i^{allocation} = c_i(1 + w_i), \quad (2.1)$$

where  $i \in \{H, L\}$ . We consider the monopoly case where there is only one manufacturer in the province and the duopoly case where there are two manufacturers in the province.

Since there is demand uncertain, in the theoretical model, we suppose there are two states: the demand for high-quality goods in the high-state condition is  $D_H^H = D_H(1 + \Delta L)$ , and in the low-state is  $D_H^L = D_H(1 - \Delta L)$ .  $D_L^H = D_L(1 + \Delta L)$  and  $D_L^L = D_L(1 - \Delta L)$  are the demand for low-quality cigarettes in the high state and the low state, respectively. There are two probabilities that each state would occur. The demand for cigarettes is high occurs with the probability  $Prob^H$ , while the low state occurs with the probability  $Prob^L$ . We make two assumptions for analysis: based on their contracts, the managers of the state-owned enterprises use all their quotas and for low-quality goods, the production  $Q_L$  is always less than the low-state demand  $D_L^L$ , which is shown by  $Q_L < D_L^L$ .

### 2.2.1.2 Consumer Preferences

Consumer  $j$  has preference along the quality dimension, which is captured by parameters  $(x_j)$ . Each consumer has a most preferred product  $x_j$ , with  $x_j \in [0, 1]$  as in Hotelling (1929). There are two consumer segments, a high-valuation segment and a low-valuation segment, based on their different valuations for quality. High-valuation segment consumers are more willing to pay a higher price for luxury brand products. I assume that customer types differ only in their willingness to pay for product quality, the only dimension of differentiated vertical product (Mussa and Rosen, 1978). Therefore, consumer  $j$  has the following indirect utility for purchasing product  $i$ :

$$U(\theta_i, x_j) = \theta_i - k_i |x_j - x_i| - p_i^{retail}, \quad (2.2)$$

where  $i \in \{H, L\}$  represents the quality of goods they consume.  $\theta_H(\theta_L)$  represents that a consumer derives a utility from using a product of a high quality or low quality. As shown in Equation 2.4, I refer to  $x_i = 0$  as the low-quality cigarettes and  $x_i = 1$  as the high-quality cigarettes.  $K_i$  represents a transportation cost, which captures the intensity of the taste preference.  $K_H$  represents the cost the consumer who prefers to buy low-quality goods transfer to buy high-quality goods, while  $k_L$  is the transportation cost that consumers who usually buy high-quality good change to buy low-quality goods. Since it is likely that higher valuation consumers also have stronger taste preferences, I assume  $k_H < k_L$ .  $P_i^{retail}$  is the suggested retail price that consumers pay when they buy cigarettes. Suggested retail prices, the market prices the STMA suggests to the retailer, are given as

$$p_i^{retail} = p_i^{allocation}(1 + z_i) = c_i(1 + w_i)(1 + z_i), \quad (2.3)$$

where  $z_i$  is the allocation-retail profit margin. The consumer's ideal point, which is given by  $x_j$ , is uniformly distributed over the interval  $[0, 1]$ .



$$x_i = \begin{cases} 0 & \text{i=low quality} \\ 1 & \text{i=high quality} \end{cases} \quad (2.4)$$

### 2.2.2 Monopoly Analysis

The managers of tobacco enterprises need to meet the requirements of their contracts, including meeting both the output and profit targets. In addition, we also assume that  $w_H > w_L$ , meaning high-quality cigarettes bring higher profit margins than low-quality cigarettes. Thus, managers have the incentive to produce as many high-quality goods as possible. Based on the indirect utility function given in Equation 2.2, the marginal consumers who are indifferent to which quality of cigarette they purchase when  $U(\theta_H, x) = U(\theta_L, x)$ , which satisfies

$$\theta_H - k_H(1 - x) - p_H^{retail} = \theta_L - k_L x - p_L^{retail}, \quad (2.5)$$

the above equality simplifies to

$$x^* = \frac{(p_H^{retail} - p_L^{retail}) - (\theta_H - \theta_L) + k_H}{k_H + k_L}. \quad (2.6)$$

Recalling that  $p_i^{retail} = p_i^{allocation}(1 + z_i) = c_i(1 + w_i)(1 + z_i)$ , the marginal consumer satisfies

$$x^* = \frac{c_H(1 + w_H)(1 + z_H) - c_L(1 + w_L)(1 + z_L) - (\theta_H - \theta_L) + k_H}{k_H + k_L}. \quad (2.7)$$

Since in the monopoly market, the two variants consumers do not change from a given segment because the segment's self-selection constraints are satisfied, the demand for high-quality cigarette is:

$$D_H = 1 - x^* = \frac{k_L - c_H(1 + w_H)(1 + z_H) + c_L(1 + w_L)(1 + z_L) + (\theta_H - \theta_L)}{k_H + k_L} \quad (2.8)$$

We first analyze the monopolists' profits across two scenarios: i) the demand is in the high state, are both the high-quality cigarettes and the low-quality cigarettes do not have inventory, and ii) the demand is in the low state, and the monopolist can sell all the low-quality cigarettes because of the assumption that  $Q_L < D_L^L$ , but the monopolist will have inventory for the high-quality cigarettes. For the high-state market, the profit function for the monopolist is

$$\begin{aligned} \pi^H &= (p_L - c_L)Q_L + (P_H - c_H)Q_H \\ &= (p_L - c_L)(1 - t)Q + (P_H - c_H)tQ, \end{aligned} \quad (2.9)$$

where  $t$  is the share that the manager in the monopoly market decides to allocate for high-quality cigarettes.

The profit in the low-state is

$$\begin{aligned} \pi^L &= (p_L - c_L)Q_L + D_H^L P_H - c_H Q_H - (Q_H - D_H^L)I \\ &= (p_L - c_L)(1 - t)Q + D_H^L P_H - tQ c_H - (tQ - D_H^L)I, \end{aligned} \quad (2.10)$$

The expected profit is given by

$$E(\pi) = Prob^H \pi^H + Prob^L \pi^L. \quad (2.11)$$

For simplicity, we assume that the probability for the high state  $Prob^H$  and the low state  $Prob^L$  are both equal to 0.5. Then our expected profit function can be written as

$$\begin{aligned} E(\pi) &= 0.5[(p_L - c_L)(1 - t)Q + (p_H - c_H)tQ] \\ &\quad + 0.5[(p_L - c_L)(1 - t)Q + D_H^L P_H - tQc_H - (tQ - D_H^L)I]. \end{aligned} \quad (2.12)$$

The first order condition of  $E(\pi)$  with respect to  $t$  yields

$$\begin{aligned} \frac{\partial E\pi}{\partial t} &= 0.5[-(p_L - c_L)Q + (p_H - c_H)Q] + 0.5[-(p_L - c_L)Q - c_H Q - IQ] \\ &= -(p_L - c_L)Q + 0.5(p_H - c_H)Q - 0.5c_H Q - 0.5QI \\ &= [-(p_L - c_L) - c_H - 0.5I + 0.5p_H]Q. \end{aligned} \quad (2.13)$$

Since the result from the first-order condition is always less than 0, we can obtain two corner solutions. We will discuss the corner solutions based on the condition of whether the marginal benefit for producing one unit of high-quality goods is larger or smaller than the marginal cost. If the marginal benefit is more significant than the marginal cost, which is

$$p_L - c_L + c_H + 0.5I < 0.5p_H, \quad (2.14)$$

then the monopolist will choose to produce as many high-quality goods as in the high



state, and the share allocated to the high-quality products will be

$$t = \frac{D_H(1 + \Delta L)}{Q}. \quad (2.15)$$

On the other hand, if the marginal benefit is less than the marginal cost, which means

$$p_L - c_L + c_H + 0.5I > 0.5p_H, \quad (2.16)$$

the proportion of the high-quality goods will be

$$t = \frac{D_H(1 - \Delta L)}{Q}. \quad (2.17)$$

If we assume half of the enterprises face the high-state situation, then the inventory is zero, while for the half facing the low-state situation, the inventory is

$$\begin{aligned} Inventory^{Monopoly} &= \frac{D_H(1 + \Delta L) - D_H(1 - \Delta L)}{2} \\ &= \frac{2\Delta L D_H}{2} \\ &= \Delta L D_H. \end{aligned} \quad (2.18)$$

### 2.2.3 Duopoly Analysis

The demand for low-quality cigarettes is high enough, and the total quotas are lower than the market demand because of the regulation policy. In this case, the probability that the high-quality cigarettes sell on the duopoly market depends not only on the manager's strategy but also on the competitor's strategy.

the duopoly case, the profit function in the high-state for Firm One is

$$\pi_{one}^H = p_L(1-t)Q - c_L(1-t)Q + \frac{t}{t+t'}D_H^H p_H I n - tQc_H - (tQ - \frac{t}{t+t'}D_H^H)I, \quad (2.19)$$

and the profit function for Firm Two is

$$\pi_{two}^H = p_L(1-t')Q - c_L(1-t')Q + \frac{t'}{t'+t}D_H^H p_H - t'Qc_H - (t'Q - \frac{t'}{t'+t}D_H^H)I. \quad (2.20)$$

where  $t$  and  $t'$  are the proportion that the managers of Firm One and Firm Two allocate for high-quality cigarettes. Our profit function comprises three parts. The first part is the profit from selling low-quality cigarettes. The second part of the function is the profit from selling high-quality cigarettes, where the probability of selling high-quality cigarettes is expressed as  $t/(t+t')$  and  $t'/(t+t')$ . The third part of the profit function is the negative consequences for managers with an inventory.

The profit function for the duopoly in the low condition for Firm One is

$$\pi_{one}^L = p_L(1-t)Q - c_L(1-t)Q + \frac{t}{t+t'}D_H^L p_H - tQc_H - (tQ - \frac{t}{t+t'}D_H^L)I, \quad (2.21)$$

and the profit function for the duopoly in the low state for Firm Two is

$$\pi_{two}^L = p_L(1-t')Q - c_L(1-t')Q + \frac{t'}{t'+t}D_H^L p_H - t'Qc_H - (t'Q - \frac{t'}{t'+t}D_H^L)I. \quad (2.22)$$

For simplification, we assume that the probability for both states to occur is 0.5. The

expected profit for both firms yields

$$\begin{aligned}
E(\pi_{one}) &= Prob^H \pi_{one}^H + Prob^L \pi_{one}^L \\
&= 0.5(p_L - c_L)(1 - t)Q + 0.5 \frac{t}{t + t'} D_H^H P_H - 0.5tQc_H - 0.5(tQ - \frac{t}{t + t'} D_H^H)I \\
&\quad + 0.5(p_L - c_L)(1 - t)Q + 0.5 \frac{t}{t + t'} D_H^L P_H - 0.5tQc_H - 0.5(tQ - \frac{t}{t + t'} D_H^L)I,
\end{aligned} \tag{2.23}$$

and

$$\begin{aligned}
E(\pi_{two}) &= Prob^H \pi_{two}^H + Prob^L \pi_{two}^L \\
&= 0.5(p_L - c_L)(1 - t')Q + 0.5 \frac{t'}{t + t'} D_H^H P_H - 0.5t'Qc_H - 0.5(t'Q - \frac{t'}{t + t'} D_H^H)I \\
&\quad + 0.5[(p_L - c_L)(1 - t')Q + 0.5 \frac{t'}{t + t'} D_H^L P_H - 0.5t'Qc_H - 0.5(t'Q - \frac{t'}{t + t'} D_H^L)I].
\end{aligned} \tag{2.24}$$

Firms maximize expected profits. We assume that the two agents in the duopoly market are symmetric; therefore, the quota they allocate for high-quality cigarettes would be the same as  $t = t'$ . The first order condition can be written as

$$\begin{aligned}
\frac{\partial E(\pi)}{\partial t} &= -0.5(p_L - c_L)Q + 0.5 \frac{t + t' - t}{(t + t')^2} D_H^H p_H - 0.5Qc_H - 0.5(Q - \frac{t + t' - t}{(t + t')^2} D_H^H)I \\
&\quad - 0.5(p_L - c_L)Q + 0.5 \frac{t + t' - t}{(t + t')^2} D_H^L p_H - 0.5Qc_H - 0.5(Q - \frac{t + t' - t}{(t + t')^2} D_H^L)I \\
&= -(p_L - c_L)Q - c_H Q - IQ + 0.5 \frac{t'}{(t + t')^2} D_H^H p_H + 0.5 \frac{t'}{(t + t')^2} D_H^H I \\
&\quad + 0.5 \frac{t'}{(t + t')^2} D_H^L p_H + 0.5 \frac{t'}{(t + t')^2} D_H^L I. \\
&= -(p_L - c_L)Q - Qc_H - IQ + \frac{1}{8t} D_H^H p_H + \frac{1}{8t} D_H^H I + \frac{1}{8t} D_H^L p_H + \frac{1}{8t} D_H^L I \\
&= -(p_L - c_L)Q - Qc_H - IQ + \frac{1}{8t} D_H(1 + \Delta L)p_H + \frac{1}{8t} D_H(1 + \Delta L)I \\
&\quad + \frac{1}{8t} D_H(1 - \Delta L)p_H + \frac{1}{8t} D_H(1 - \Delta L)I
\end{aligned} \tag{2.25}$$

The share which the duoplist allocates for the high-quality good is represented as

$$t = \frac{p_H + I}{4(c_H + I + p_L - c_L)} \frac{D_H}{Q} \quad (2.26)$$

The inventory in duopoly case in the high condition is represented as

$$\begin{aligned} Inventory^{Duopoly^H} &= 2tQ - D_H^H \\ &= \frac{p_H + I}{2(c_H + I + p_L - c_L)} D_H - D_H(1 + \Delta L). \end{aligned} \quad (2.27)$$

Equation 2.27 needs to be positive.

The inventory for the duopoly case for the low condition is

$$\begin{aligned} Inventory^{Duopoly^L} &= 2tQ - D_H^L \\ &= \frac{p_H + I}{2(c_H + I + p_L - c_L)} D_H - D_H(1 - \Delta L) \end{aligned} \quad (2.28)$$

The average inventory in the duopoly case is

$$\begin{aligned} Inventory^{Duopoly} &= \frac{1}{2}(2tQ - D_H^H + 2tQ - D_H^L) \\ &= \frac{p_H + I}{2(c_H + I + p_L - c_L)} D_H - D_H \end{aligned} \quad (2.29)$$

## 2.2.4 Summary and Discussion

**Proposition 1.** If  $2w_{LC} - w_{HC} + c_H + I < 0$ , when the demand uncertainty is relatively small, then the inventory is larger in the duopoly market than in the monopoly market.

Proof.

$$\begin{aligned}
Inventory^{Monopoly} - Inventory^{Duopoly} &= \Delta L D_H - \frac{p_H + I}{2(c_H + I + p_L - c_L)} D_H + D_H \\
&= \Delta L D_H + \left[1 - \frac{p_H + I}{2(c_H + I + p_L - c_L)}\right] D_H \\
&= \Delta L D_H + \frac{2w_L c_L - w_H c_H + c_H + I}{2(c_H + I + p_L - c_L)} D_H.
\end{aligned} \tag{2.30}$$

Recall that since Equation 2.27 is positive, and also  $2(c_H + I + p_L - c_L) > 0$ , when  $2w_L c_L - w_H c_H + c_H + I < 0$ , we have  $\frac{2w_L c_L - w_H c_H + c_H + I}{2(c_H + I + p_L - c_L)} < 0$ , meaning that the inventory is larger when there is regional competition than in the monopoly market.

Our empirical analysis is based on this proposition.

**Proposition 2.**  $\frac{\partial Inventory^{Duopoly}}{\partial I} < 0$  for all I. When in the duopoly market, the negative consequences for not following the requirements provide an incentive for the managers to reduce their inventories.

Proof.

$$\begin{aligned}
\frac{\partial Inventory^{Duopoly}}{\partial I} &= \frac{1}{4} \frac{2(c_H + I + p_L - c_L) - 2(p_H + I)}{(c_H + I + p_L - c_L)^2} D_H \\
&= \frac{1}{4} \frac{2(c_H + p_L - c_L - p_H)}{(c_H + I + p_L - c_L)^2} D_H \\
&= \frac{1}{2} \frac{(w_L c_L - w_H c_L)}{(c_H + I + p_L - c_L)^2} D_H
\end{aligned} \tag{2.31}$$

Recall that  $w_L c_L < w_H c_H$ ,  $\frac{\partial Inventory^{Duopoly}}{\partial I} < 0$  is always true.

Proposition 2 provides the key support for the primary argument of this study. The property of mission-oriented contracts for managers in state-owned enterprises leads to a lower proportion of high-quality goods. As the negative consequences increase, the ratio that managers allocate for high-quality goods decreases. However, as we do not have the measure of these consequences, we cannot use the current data

to test this proposition.

## 2.3 Data Description

### 2.3.1 Data and Summary Statistics

The empirical tests are based on the dataset from the STMA, which includes the monthly panel inventory database from the year 2005 to the year 2011. The total number of observations is 1,787 at the province-month level.

We divided our sample into two groups for each quality of cigarette studied here: provinces with a single-firm structure before the reform (Group One) and provinces with multiple firms before the merger (Group Two). The primary variables in this study are the natural logarithm of inventories for cigarettes, and for high-quality cigarettes, medium quality cigarettes and low-quality cigarettes respectively.<sup>1</sup> Table 2.1 presents the summary statistics for the main variables of this study for reorganized provinces and merged provinces separately before and after the reform in the tobacco industry. The number of observations for Group One, which is the reorganized group, before the reform is 211 and after the reform, 700, while for Group Two, which is the merger group, before the reform the number of observations is 312 and after the merger 564. Figure 2.1 shows the mean of inventory in the calendar month. In each panel, we separate the graphs into two parts. The left side of each panel represents the mean of inventory for the reorganized group, while the right represents the mean of inventory for the merged group. Panel (a), (b), and (c) show the individual mean of inventory for high-quality cigarettes, medium-quality cigarettes, and low-quality cigarettes, respectively. As these graphs show, the market with multiple

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<sup>1</sup>We use  $\log(\text{inventory} + 1)$  to calculate log inventory

firms before the consolidation has a higher inventory than the market with a single firm. Furthermore, except for the inventory for low-quality cigarettes, both groups exhibit a horizontal trend, the high-quality and medium-quality panels all showing an increasing trend.

We take the quotas for different provinces into consideration because, under the quantity regulation market, the quotas vary across provinces exogenously; it is a significant effect of the quantity of inventory. On the other hand, as managers need to meet their production quotas mandated by the STMA, we treat the total production quantity as the quota for each province. Table 2.2 displays the comparison of the log of production and the log of inventory for each group before and after the reform. Panel (a) of Figure 2.2 shows the mean of the log of the sum of inventory, while Panel (b) presents the mean of the log of production by calendar month. There are two features seen in the total quota. First, the total inventory and the total quota show an increasing trend for both groups. Second, both the mean of inventory and the mean of quotas are double in the merged provinces, which included multiple manufacturers before the reform.

### 2.3.2 Graph Evidences

Figures 2.3 presents the stylized facts from the basic inventory regressions that motivated this research. We divided our sample into two groups for each quality cigarette: provinces with a single-firm before the reform (Group One) and provinces with multiple-firms before the merger (Group Two); the red vertical dashed line represents  $t_o$ , the time of the reorganization.

By running the regression of the equation below:

$$\ln(Y_{it}) = \beta_0 + \beta_1 * \ln(Q) + \gamma * X_{it} + \theta_m + \theta_r + \epsilon_{it}, \quad (2.32)$$

where  $i$  indexes the province and  $t$  indexes the month.  $Y_{it}$  is the dependent variable expressed by the total inventory, the high-quality cigarette inventory, the medium-quality cigarette inventory, the low-quality cigarette inventory.  $\ln(Q)$  is the natural logarithm of the quotas; and the vector  $X_{it}$  contains a set of province-level control variables that include the natural logarithm of the population, the unemployment rate, the natural logarithm of personal income per capita, and the natural logarithm of GDP.

Then we plot the residual of the log of inventory for high-quality cigarettes, medium-quality cigarettes, low-quality cigarettes, and the log of the sum of the inventory. A pattern emerges: for the reorganized group, the market structure does not change since it always has a single firm in the market. The mean of the residuals of high-quality cigarettes and medium-quality cigarettes, and the sum are constant after the reorganization, while the residuals of the log of low-quality cigarettes decrease dramatically. However, for the group where the market structure changed from multiple firms to a single firm, the log of inventory of all the quality cigarettes moves right after the merger event happened. The high-quality cigarettes, medium-quality cigarettes, and the sum of inventory exhibit decreasing trends, while the low-quality cigarettes exhibit the opposite tendency after the merger. These results suggest that the market structure affects the managers' incentives. Table 4 shows summary statistics of the residuals.

## 2.4 Empirical Model

This section presents the empirical method used in this study, which aims to examine the predictions from the theoretical model presented above. Because the periods for our data include both the pre- and the post-time frames, we have two groups,



the control group and the treatment group: Group One with a single firm before the reform as the control group and Group Two, the treatment group with multiple-firms before the merger. The difference-in-difference strategy can be used to estimate the effect of the reform on inventory outcomes. The timing of the reform in the Chinese cigarette industry, which was decided by STMA, is exogenous, and the merger mandates that multiple firms in the same province merge into one manufacturer. Because the decision to merge is exogenous, the difference-in-difference estimate of the reform is the causal treatment effect. We specify the following difference-in-difference estimator for the merger:

$$\begin{aligned} \ln(Y_{it}) = & \beta_0 + \beta_1 * dM_{it} + \beta_2 * dG_{it} + \beta_3 * dM_{it} * dG_{it} + \beta_4 * dG_{it} * dM_{it} \\ & + \gamma_1 * \ln(Q) + \gamma_2 * X_{it} + \theta_m + \theta_r + \epsilon_{it}, \end{aligned} \quad (2.33)$$

where  $\ln(Y_{it})$  is our outcome variable and  $Y_{it}$  represents the quantity of inventory for a certain quality level: the inventory of high-quality cigarettes, the inventory of medium-quality cigarettes, the inventory of low-quality cigarettes, and the sum of the inventory at month  $t$  in province  $i$ . The treatment dummy variable  $M_{it} = 1$  if province  $i$  has reorganized or merged;  $M_{it} = 0$  if it is before the reform. The group dummy  $G_{it} = 0$  if the province  $i$  is in the reorganized group which had a single firm before the reconstruction, and  $G_{it} = 1$  if province  $i$  is in the merged group which had multiple firms before the merger. The vector  $X_{it}$  contains a set of province-level control variables. Monthly fixed effects and regional fixed effects are included here, denoted by  $\theta_m$  and  $\theta_r$ , respectively. The monthly and region fixed effects explain the influences that are common in a month and for a certain area that are not captured by the province-level control variables  $X_{it}$ . We estimate Equation 2.33 using monthly data from the year 2005 to the year 2011.

## 2.5 Difference-in-Difference Results

In this section, we report the results of the differences-in-differences estimates for total inventory and the inventory for high-quality cigarettes, medium-quality cigarettes, and low-quality cigarettes based on estimates from Equation 2.33. The results for each outcome variable are presented in Table 2.4. All estimates include controls for monthly and regional fixed effects. The *Merge \* GroupDummy* is significant for all three quality levels of cigarettes, while the coefficients for high-quality cigarettes and medium-quality cigarettes are negative, and for low-quality cigarettes, it is positive. The coefficient of the total inventory is not significant. Estimates demonstrate that compared with the single firm reorganized group, when multiple firms merged into one sole manufacturer, the inventory of high-quality cigarettes and medium-quality cigarettes decreases significantly, while the inventory of low-quality cigarettes increases. These results are consistent with the prediction from our theoretical model.

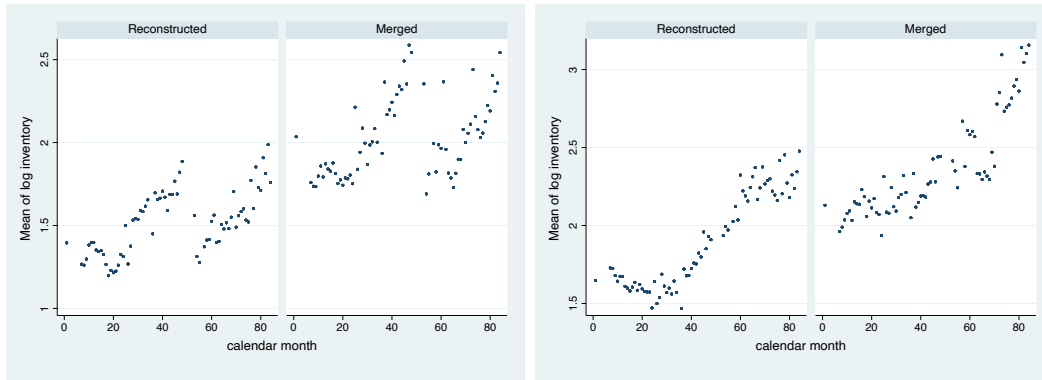
## 2.6 Conclusion

This study began with a theoretical model that includes the demand uncertainty for both the monopoly and duopoly market structures. The managers' incentive is assumed to be to maximize their expected profits from high state and low state in the face of demand uncertainty. In addition, they must reduce their inventory to avoid negative consequences. The manufacturers in a monopoly situation have a smaller inventory than those with regional competition. However, the negative consequences cause the managers in the latter situation to reduce their inventories.

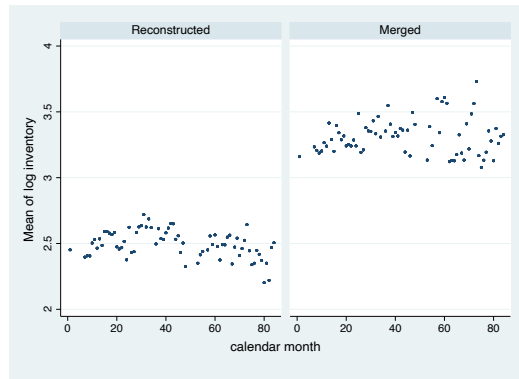
This paper uses a difference-in-difference method to examine the effects of the

mandated consolidation on inventory. The empirical results are consistent with our theoretical predictions. The evidence suggests, when in a monopoly market and the manager faces only demand uncertainty, the inventory for high-quality cigarettes and medium-quality cigarettes decreased, while the inventory for low-quality cigarettes increased. The empirical results for high-quality cigarettes and medium-quality cigarettes are consistent with the predictions from the theoretical model.

There are several opportunities for further development of our theoretical model. First, we assume that managers are all risk neutral. However, in the real world, managers have different risk preferences; we could use a non-linear utility function instead of profit function to capture the managers' risk preferences. Second, as before the consolidation provinces included more than two manufacturers in the region, we could extend the model to include more than two managers in the future.

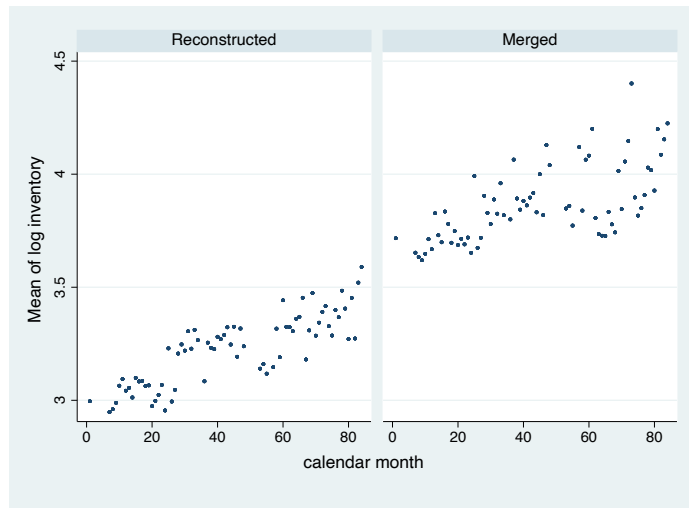


(a) mean inventory for high-quality cigarettes (b) mean inventory for medium-quality cigarettes

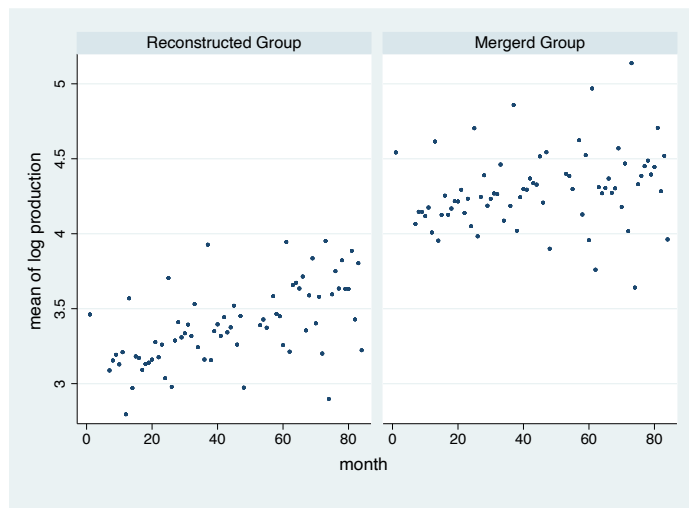


(c) mean inventory for low-quality cigarettes

Figure 2.1: Mean of Inventory by Calendar Month

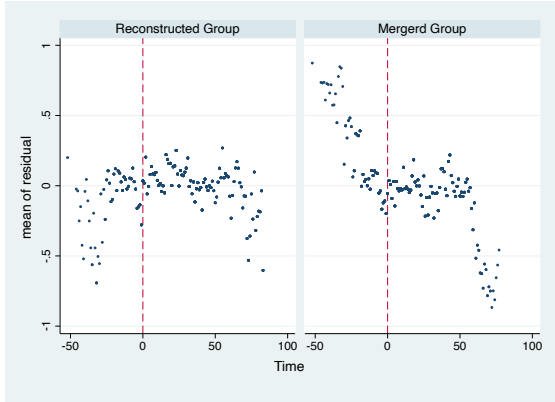


(a) mean inventory

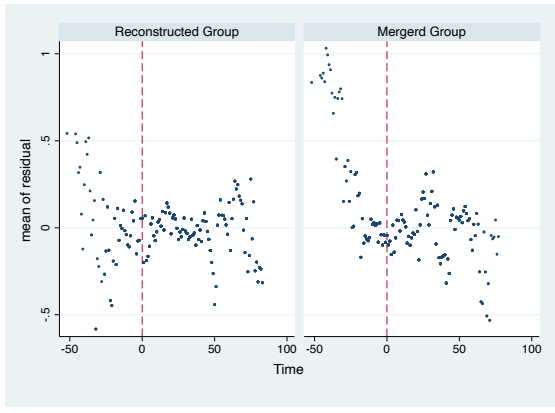


(b) mean production

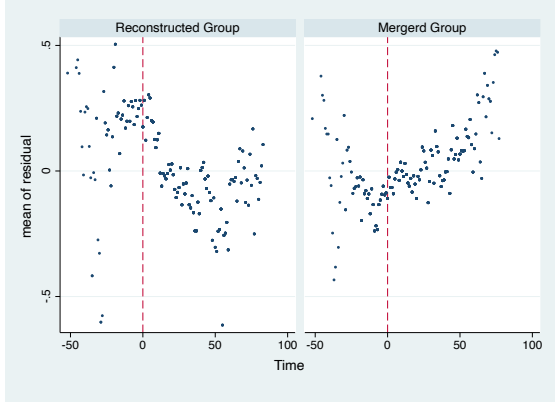
Figure 2.2: Mean of  $\ln(\text{Inventory})$  and  $\ln(\text{Production})$  by Calendar Month



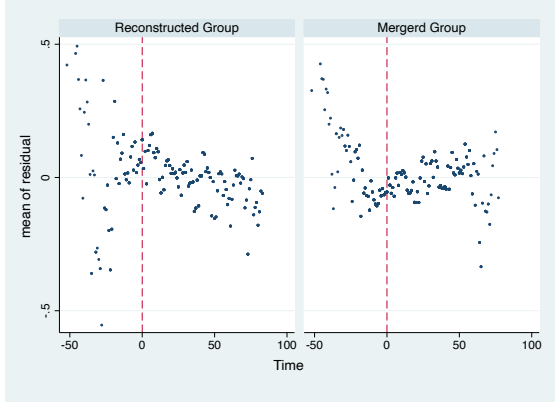
(a) residual for high-quality good inventory



(b) residual for medium-quality good inventory



(c) residual for low-quality good inventory



(d) residual for inventory

Figure 2.3: inventory residual mean

Table 2.1: Summary Statistics for Inventory

ln(Inventory)	Mean	Std.Dev	N	Max	Min
Before: Single Firm					
High	1.042	0.913	211	3.083	0
Medium	1.419	0.926	211	3.394	0
Low	2.640	0.874	211	4.220	0.513
All	3.030	0.842	211	4.680	0.688
After: Single Firm					
High	1.655	1.138	700	4.603	0
Medium	2.030	1.376	700	5.469	0
Low	2.455	1.445	700	4.585	0
All	3.274	1.347	700	5.878	0.010
Before: Multiple Firms					
High	2.019	0.869	312	4.446	0.501
Medium	2.335	0.824	312	4.473	0.967
Low	3.275	0.638	312	4.696	1.411
All	3.812	0.651	312	5.459	2.640
After: Single Firm					
High	2.041	0.894	564	4.055	0.166
Medium	2.391	0.849	564	4.883	0.166
Low	3.334	0.598	564	4.874	1.585
All	3.902	0.572	564	5.618	2.721

Note:

For the  $\ln(\text{Inventory})$ , I sum the inventory for high-quality cigarettes, medium-quality cigarettes, and low-quality cigarettes up first, then take the natural logarithm of the sum of inventory .

Table 2.2: Summary Statistics for Log of Quotas

ln(Quotas)	Mean	Std.Dev	N	Max	Min
Before: Single Firm					
3.263	0.899		211	5.393	1.297
After: Single Firm					
3.417	1.418		700	6.049	0.01
Before: Multiple Firms					
4.253	0.631		312	5.924	3.036
After: Single Firm					
4.314	0.569		564	6.007	2.595



Table 2.3: Summary Statistics for Main Variables Residual

ln(Inventory)	Mean	Std.Dev	N	Max	Min
Reconstructed: Before					
High	-0.064	0.477	211	1.529	-1.210
Medium	-0.061	0.570	211	1.538	-1.403
Low	0.198	0.440	211	1.281	-0.999
All	0.029	0.386	211	1.309	-1.698
Reconstructed: After					
High	0.027	0.666	700	1.526	-2.077
Medium	0.004	0.628	700	1.711	-2.716
Low	-0.051	0.505	700	1.421	-1.785
All	0.001	0.254	700	0.926	-0.837
Merged: Before					
High	0.097	0.548	312	1.342	-1.224
Medium	0.108	0.588	312	1.518	-0.824
Low	-0.066	0.298	312	0.507	-1.125
All	0.006	0.219	312	0.436	-0.818
Merged:After					
High	-0.063	0.572	564	1.289	-1.684
Medium	-0.042	0.556	564	1.314	-1.085
Low	0.026	0.294	564	0.861	-1.135
All	-0.015	0.214	564	0.639	-0.883

Table 2.4: Difference-in-Difference Regression Results

	ln(inventory)			
	High	Medium	Low	Total
ln(Q)	0.486*** (0.0225)	0.866*** (0.0226)	0.600*** (0.0154)	0.792*** (0.00968)
Merger Dummy	0.0130 (0.0630)	-0.0241 (0.0632)	-0.283*** (0.0432)	-0.0259 (0.0271)
Group Dummy	0.123 (0.0751)	0.150** (0.0753)	-0.324*** (0.0515)	-0.0801** (0.0323)
Merger*Group Dummy	-0.269*** (0.0731)	-0.113* (0.0733)	0.387*** (0.0501)	0.0360 (0.0314)
ln(population)	0.122 (0.113)	-1.169*** (0.113)	1.221*** (0.0774)	0.477*** (0.0485)
unemployment rate	0.169*** (0.0457)	0.165*** (0.0459)	0.228*** (0.0313)	0.149*** (0.0197)
ln(income)	2.008*** (0.179)	-0.813*** (0.180)	0.742*** (0.123)	0.813*** (0.0770)
ln(GDP)	-0.0332 (0.0849)	0.992*** (0.0851)	-0.962*** (0.0582)	-0.371*** (0.0365)
constant	-21.53*** (1.181)	6.826*** (1.823)	-9.189*** (1.246)	-9.190*** (0.781)
N	1787	1787	1787	1787
adj. R-sq	0.658	0.707	0.861	0.936
Month FE	Yes	Yes	Yes	Yes
Region FE	Yes	Yes	Yes	Yes

Note:

Coefficient estimates that are significant at 1%, 5%, and 10% level are denoted with \*\*\*, \*\*, and \*, respectively.

# Chapter 3

## The Welfare Analysis of the Effect of Horizontal Mergers

### 3.1 Consumers Welfare Analysis

Recall the theoretical model in Chapter One, which models the two effects of the reorganization. First, Type A and Type B consumers have more choices as they can buy high-quality cigarettes with their desired attributes after the merger. In a duopoly market, Type B consumers in Firm One's market and Type A consumers in Firm Two's market will buy the low-quality cigarettes instead of the high-quality cigarettes because of their strong preferences for a particular attribute. After the mandated consolidation by the State Tobacco Monopoly Administration (STMA), the openness of the markets makes the consumers can buy the cigarettes with their desired attribute; thus, the welfare of these types of consumers improves because of the reform. Second, because of the change in the market structure, consumers who can buy cigarettes with their preferred quality level increases; thus, the total consumption of cigarettes increases. Since the mandated reorganization does not change the price

mechanism and profit margins, the prices charged to the consumers do not change, meaning the welfare of Type C consumers remains the same. Based on this analysis, the welfare of all consumers increases as a result of the consolidation.

## 3.2 Producers Welfare Analysis

Based on the results from the theoretical model and the empirical model in Chapter Two, the inventory for high-quality cigarettes and medium-quality cigarettes decreases, while the inventory for low-quality cigarettes increases. As cigarettes are products with a fairly short expiration date, much of their inventory may have to be discarded. We measure the inventory in terms of dollars to analyze the welfare of the producers.

In my data, the mean of the allocation prices for low-quality cigarettes is 15 RMB and for medium-quality cigarettes, 40 RMB, while the mean for high-quality cigarettes is 65 RMB.<sup>1</sup> To estimate the dollar value of the inventory change compared with the counterfactual group without the change in market, we use the equation below

$$Y_{it} = \beta_0 + \beta_1 * dM_{it} + \beta_2 * dG_{it} + \beta_3 * dM_{it} * dG_{it} + \beta_4 * dG_{it} * dM_{it} + \gamma_1 * \ln(Q) + \gamma_2 * X_{it} + \theta_m + \theta_r + \epsilon_{it}, \quad (3.1)$$

where  $Y_{it}$  represents the sum of the inventory at month t in province i in dollars.

<sup>2</sup> The treatment dummy variable  $M_{it}$  captures whether the reorganization occurred or not.  $G_{it}$  is the dummy variable for the types of reorganization:  $G_{it} = 0$  for our

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<sup>1</sup>Recall: In Table 1.1 in Chapter One, I report the cigarette classification from high to low based on the allocation prices of the STMA standardization.

<sup>2</sup>To calculate the dollar amount of the total inventory, we use  $Y_{it} = 65 * Inventory_{it}^{High} + 40 * Inventory_{it}^{Medium} + 15 * Inventory_{it}^{Low}$ . The summary statistics for the inventory in dollar is shown in Appendix Table 1.

control group, while  $G_{it} = 1$  for the treatment group. Province-level control variables, monthly fixed effects and regional fixed effects are included in Equation 3.1. The results for the inventory in dollars are shown in Table 3.1. The negative coefficient of the term  $Merger * GroupDummy$  indicates that compared with the control group without the change in market structure, the dollar value of the inventory decreases after the mandated consolidation occurred. The welfare of the producers increases because of the lower dollar value of the inventory after the change in the market structure.

### 3.3 Grasp the Large

The reform in the state-owned sector in the late 1990s was meant to grasp the large state-owned enterprises. After the reform, the reorganized large industrial conglomerates are still under the control of the central government. The centralization reform led by the state occurred not only in the cigarette industry but also in other key sectors, such as the steel, automotive, and coal industry. However, the regulation of both price and quantity quotas makes the cigarette industry unique, where the managers can choose only quota-allocation for different quality cigarettes as their competition strategy, meaning their welfare depends only on the quantity of cigarettes as regulated by the quota. Therefore, it is easier to identify the welfare change due to the reform using the cigarette industry. In a non-regulated market, moving from a duopoly to a monopoly will cause a deadweight loss and decrease consumer welfare. However, as China's cigarette market is highly regulated, the welfare increases because of the reduction in market players.

There is a contrasting type of reform in the state-owned sector as we discussed above, i.e., the telecommunication industry exhibits as the decentralization process.

The state reorganized the industry into three large enterprises. Both types of reform are under state controlled regulation strategies; it would be interesting to discover the difference in the welfare change between these two types of reform in the future.

Table 3.1: Difference-in-Difference Regression Results

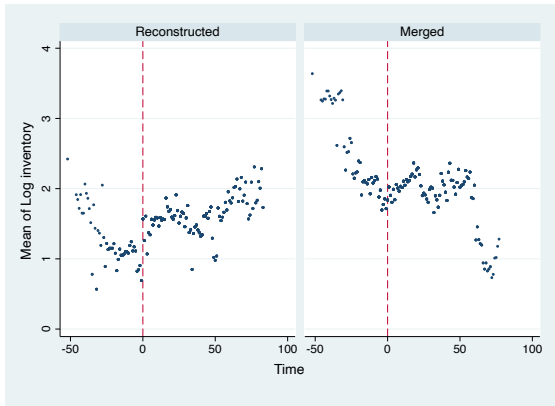
	Dollar Value of Inventory
ln(Q)	1044.2*** (38.87)
Merger Dummy	-263.4** (108.7)
Group Dummy	224.1* (129.6)
Merger*Group Dummy	-545.9*** (126.1)
ln(population)	-481.4** (194.9)
Unemployment Rate	526.4*** (78.90)
ln(income)	914.5*** (309.3)
ln(GDP)	380.9*** (146.5)
constant	-13029.8*** (3137.0)
N	1787
adj. R-sq	0.603
Month FE	Yes
Region FE	Yes

Note:

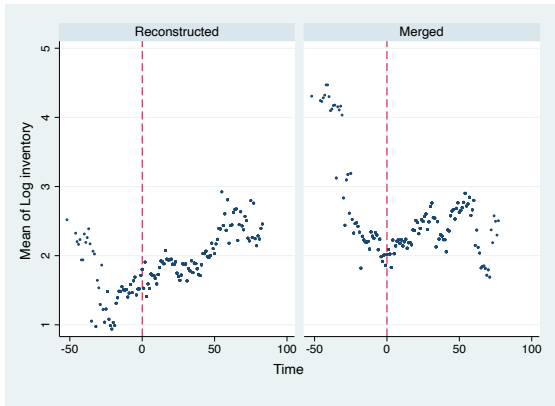
Coefficient estimates that are significant at 1%, 5%, and 10% level are denoted with \*\*\*, \*\*, and \*, respectively.

# Appendices

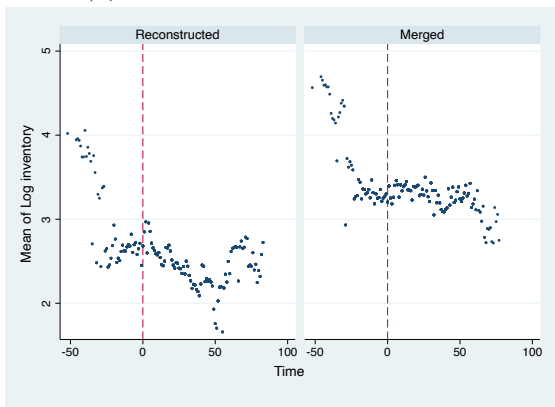




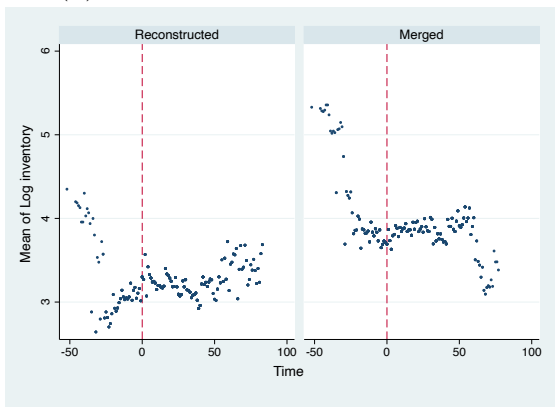
(a) high-quality good inventory



(b) medium-quality good inventory

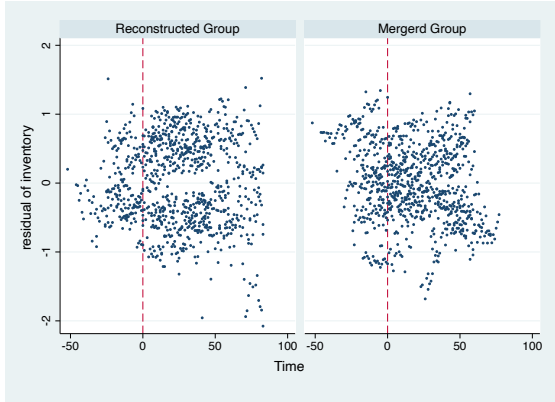


(c) low-quality good inventory

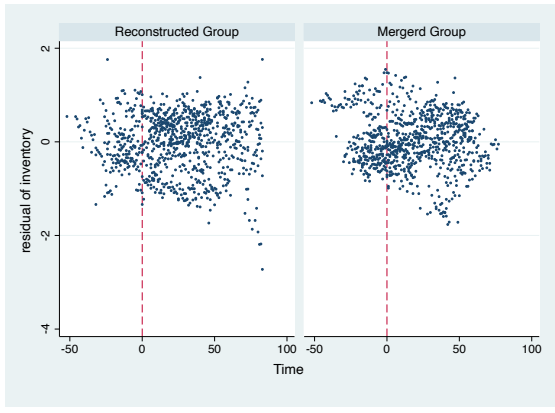


(d) inventory

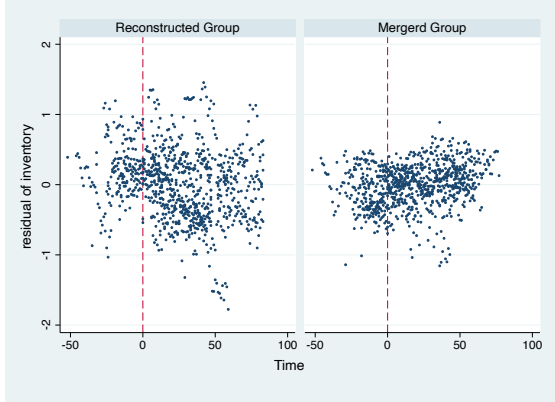
Figure 1: Mean of Inventory



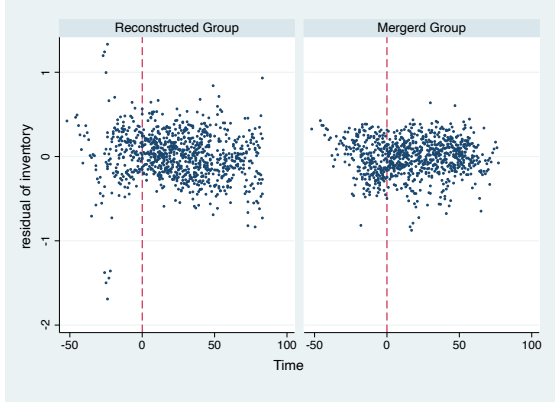
(a) residual for high-quality good inventory



(b) residual for medium-quality good inventory

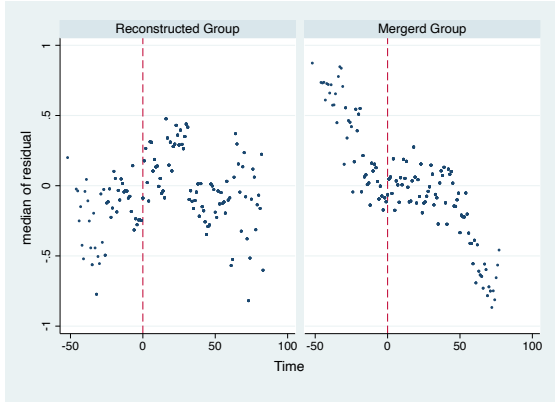


(c) residual for low-quality good inventory

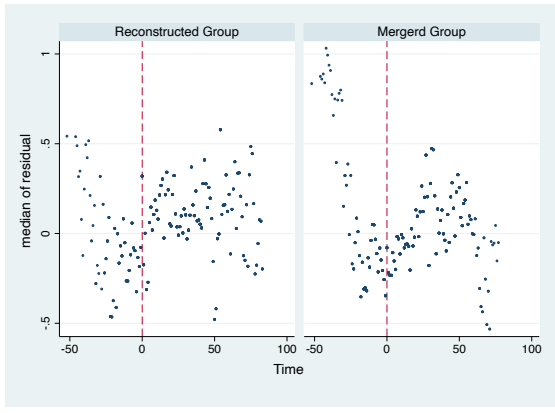


(d) residual for inventory

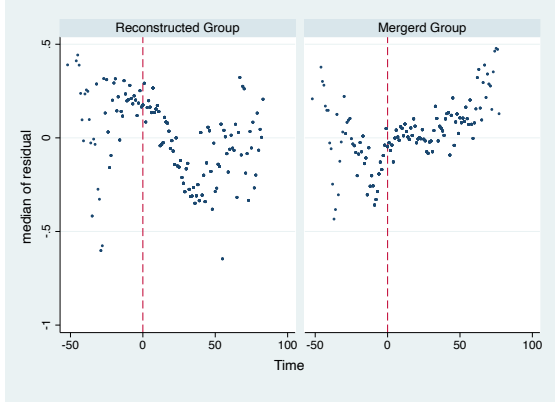
Figure 2: inventory residual



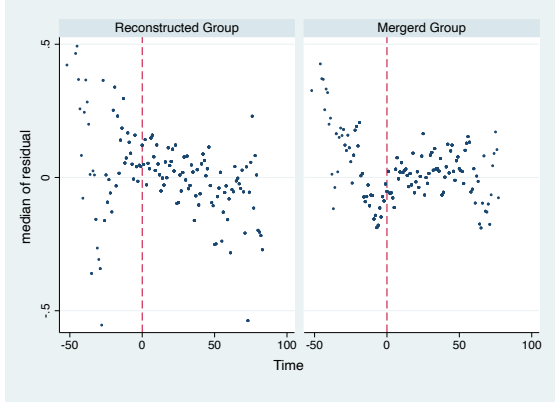
(a) residual for high-quality good inventory



(b) residual for medium-quality good inventory



(c) residual for low-quality good inventory



(d) residual for inventory

Figure 3: inventory residual median

Table 1: Summary Statistics for Dollar Values of Inventory

Inventory (Dollar)	Mean	Std.Dev	N	Max	Min
Reconstructed: Before					
High	217.8763	279.656	211	1353.3	0
Medium	208.436	232.952	211	1150.8	0
Low	279.6782	232.3037	211	1005.3	10.05
All	705.9905	625.3967	211	3181.4	22.85
Reconstructed: After					
High	585.0604	785.0695	700	6240.7	0
Medium	710.6686	1149.626	700	9444.4	0
Low	351.5919	373.0515	700	1454.55	0
All	1647.321	1926.839	700	14721.4	0.65
Merged: Before					
High	674.5042	817.0331	312	5480.15	42.24
Medium	611.2846	830.561	312	3466.4	65.2
Low	474.4072	340.3968	312	1628.1	46.5
All	1760.196	1836.963	312	9782.2	301.8
Merged:After					
High	664.988	639.4327	564	3683.55	11.7
Medium	608.9709	730.088	564	5241.6	7.2
Low	487.2125	310.6858	564	1947.45	58.2
All	1761.171	1378.33	564	8935.8	341.55

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