Crisis as a Catalyst for Quality Upgrade:

Evidence from Industrial Clusters in China

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Abstract

The quality of manufactured products made in China has improved tremendously in the past several decades. In this paper, we argue that crises beget opportunities for quality upgrade. We first develop a theoretical framework to show that a crisis, if used wisely, could present good opportunities for entrepreneurs and local governments to form collective action to improve product quality. Next, we empirically test the hypothesis using a panel data set from 1990 to 2008 at the count level in Zhejiang Province, China.

Keywords: crisis, manufacturing industry, cluster, quality upgrade

1. Introduction

The word *crisis* in Chinese contains the double meanings of danger and opportunity. Human history has been fraught with crises. Yet from a longer historical perspective, these crises often create opportunities (Toynbee 1974), as the evolution of the manufacturing sector in developed countries clearly shows. The history of the Korean carmakers' entry into the U.S. market highlights this point (Kim 1997). Hyundai, a major car company in the Korean market, entered in the U.S. market in the 1980s. But after more than one decade's struggle, its quality remained in the bottom and car sales plummeted to the lowest level by 1998. "Hyundai cars" were a synonym for shoddy products. In response to the crisis, Hyundai introduced what it called "the industry's best warranty," which offered 10-year, 100,000-mile powertrain protection to original owners (Ree 2003). The warranty served two purposes: it reduced consumers' suspicions that Hyundai cars were of inferior quality and it forced Hyundai itself to keep improving car quality. The strategy worked well. Car sales rose by more than 250% in four years.

The rapid surge in China's manufacturing sector also shows a strong link between crises and quality upgrade. During China's planned economic era (prior to 1977), the quality of its manufactured products was on a par with that of other developing countries. As the following facts demonstrate, ever since the reforms of the late 1970s, the quality of China's manufactured goods has been quickly catching up with that of developed countries (Rodrik 2006; Alvarez and Claro 2007; Scott

2008). Firstly, China's share in total world exports rose from 1.2% in 1983 to 10.7% in 2011, being the largest exporter in the world (WTO 2012).[1] Since generally exported goods have higher quality than those sold to the domestic market, such a rapid increase in export implies an improvement in product quality. Secondly, the number of registered trademarks in China has experienced dramatic growth: in 2005, applications for trademark registration in China exceeded 664,000, ranking first in the world (State Trademark Bureau 2005). Finally, since the 1990s, patent applications have also seen a phenomenal growth in China, from 41,469 in 1990 to 1,222,286 in 2010, nearly a 30-fold increase (China Statistical Yearbook, 2011). Each of these facts indicates a rapid improvement in the quality of Chinese manufactured products.

How has China upgraded its manufacturing industry in such a short time? In the economics literature, most studies attribute the quality upgrade to market competition and foreign investment (Aghion and Howitt 1992; Grossman and Helpman 1991a,b; Cozzi 2007). From a business perspective, a firm must invest in research and development to maintain competitiveness. Foreign investment can facilitate technology spillover and promote market competition, thus effectively helping to improve product quality in the host country (Xu 2000; Cheung and Lin 2004; Hatani 2009). Processing trade is also listed as a contributing factor to export sophistication (Amiti and Freund 2010). There is no doubt that China's market reform

[1] Export performance may not be a perfect measure for a country's product quality as a country can use "high-quality" versus "low-price" growth strategies (Hallak and Schott, 2011). Nonetheless, as noted by Rodrik (2006) and Hausmann, Hwang, and Rodrik (2007), the extent of China's export quality is comparable to the most developed economies in the world.

and open-door policies are important drivers behind China's fast rise up the quality ladder. Yet these two hypotheses explicitly discuss the role of crises in quality upgrade.

China's industrialization is largely cluster-based (Long and Zhang 2011). One-town / one-product has been a defining feature of China's industrialization in the past three decades. This cluster-based industrialization worked to China's advantage, especially during the incipient stage of reform, when China had high population density and lacked of financial development.

Clustering reduced transaction cost, through the easier flow of information, labor pooling and proximity to product and input markets (Marshall, 1920). In addition, clustering can help reduce the capital entry barriers by dividing an integrated production process into many incremental steps (Ruan and Zhang 2009). As a result, clusters help small and medium enterprises overcome obstacles to growth (Nadvi and Schmitz 1999; Long and Zhang 2011).

The lowered barriers to entry in the clusters mean fierce competition among producers. In the initial stage of cluster development, firms often do not have incentives to produce high-quality products because of easy imitation by others. Instead, most firms choose to produce low-quality products. However, in the face of a downward-sloping demand curve, the market for low-end products may quickly become saturated as the production volume in clusters expands. After the low-end market is exhausted, firms must compete to improve their product quality so they can target the more lucrative high-end market. They must do this in order to survive. By synthesizing the experience in the East Asian economies, Sonobe and Otuska (2006) hypothesize that cluster development often encompasses two phases: quantity expansion and quality upgrade.

However, the transition from a quantity expansion to a quality upgrade phase is not necessarily a smooth and automatic process. In reality, it is often accompanied by a crisis. Under fierce competition, most producers operate at a very thin profit margin and with little if any opportunity to raise prices. Consequently, negative shocks could pose a serious threat for the survival of many firms in the cluster. Under competitive pressure, some producers may choose to compromise their products' quality by using cheap or fake materials, which in turn could damage the reputation of the whole cluster and result in a cluster-wide quality crisis down the road. In a word, the quantity expansion stage of cluster development is bound to result from a crisis. However, the timing of the crisis is largely beyond the control of any individual entrepreneurs.

When a shock strikes, both entrepreneurs and local governments are likely to have more of an incentive to form collective action to improve product quality than in normal times because failure to do so may result in the collapse of the whole cluster, which would cut off the revenue stream for local governments and bankrupt numerous small businesses. In addition, crises reshape the way in which different stakeholders perceive the benefit and cost of proposed reform measures, making it possible to push them forward. However, it is always challenging to coordinate the interests of different parties and form collective action. Whether crises can provide an opportunity for a cluster to upgrade quality or not remains largely an empirical question.

Building upon Sonobe Otuska's insight, this paper examines the mechanism of quality upgrade in clusters and relates it to external shocks, using Zhejiang Province in China as an example. We selected Zhejiang in our empirical study for several reasons. First, the number of manufacturing enterprises in Zhejiang ranks at the top among all the provinces in China. Second, Zhejiang's industrial development is cluster-based. In 2004, there were 839 industrial clusters with total output topping more than 100 million Chinese yuan (Zhejiang Manufacturing Cluster Empirical Research Group 2007).[2] For this study we developed a conceptual model to analyze the role of crisis in quality upgrading. Then we tested our hypothesis using data collected in 85 clusters in Zhejiang. Our testing showed that crises beget quality upgrades in Chinese clusters.

Although this study is based on Chinese data, the insights apply to other developing countries. For example, a ban imposed by developed countries on the import of low-quality surgical instruments produced in Pakistan's Sialkot surgical instruments industry cluster compelled both local governments and business communities to take collective action and achieve quality upgrading (Nadvi 1999).

[2] The exchange rate in 2004 was about 0.13 USD/yuan.

The paper is organized as follows: Section 2 discusses the general patterns of industrial clusters and relevant crises in Zhejiang Province. Section 3 presents several case studies to illustrate the role of crisis in quality upgrading in a cluster. Section 4 develops a conceptual framework, and Section 5 tests the hypothesis. Section 6 concludes the paper.

2. Industrial Clusters and Crises in Zhejiang Province

Cluster Development in Zhejiang

Located on the eastern coast of China, Zhejiang Province has rather limited natural resources compared with many other provinces in China. During China's planned economic era before 1978, the central government strategically made less public investment Zhejiang Province than it did in any other province. The government cited of the province's proximity to the war frontier with Taiwan as the reason. As a result, the share of state-owned enterprises in Zhejiang Province was much lower than in many other provinces. When economic reforms began in 1978, per capita gross domestic product (GDP) in Zhejiang was 331 yuan (255 dollars), ranking it 13th among all provinces. Yet by 2011, Zhejiang's per capita GDP reached 49,791 yuan (7,355 dollars), placing it among the five richest provinces (National Bureau of Statistics 2012). Industrial development played a key role in Zhejiang's rapid economic growth. According to the China Economic Census, in 2004, Zhejiang had the largest number of industrial enterprises among all provinces—nearly 190,000—

among which were more than 40,000 industrial enterprises, each with an annual sales income exceeding five million yuan. The number is greater than that of any other province in the nation (National Bureau of Statistics 2006).

Zhejiang's industrial development is largely cluster-based (see Table 1). The phrases "one village, one product" and "one industry in one county" have been commonly used in the media to describe the concentration of industrial production in Zhejiang. In 2000, there were 529 industrial clusters with an annual gross output of more than 100 million yuan and 149 industrial clusters with an annual output value of more than 1 billion yuan. The average cluster among these 149 larger clusters generated a gross output value of 3.3 billion yuan, hired more than 20,000 workers and contained 1,400 enterprises. By the end of 2004, the number of clusters that produced more than 100 million yuan in industrial output increased to 839. These clusters included 156,500 enterprises, or 85.0% of the total in the province proximity to the war frontier with Taiwan as the. The total industrial output value created by the clusters was as high as 1.547 trillion yuan (187 billion dollars), accounting for 78.6% of total provincial industrial output , whereas total profit reached 79.4 billion yuan (9.6 billion dollars), amounting to 76.5% of total profit in the province's manufacturing sector. More importantly, most of the production technologies in these clusters are labor intensive, employing 7.48 million workers, or to put it another way, providing 85.7% of all manufacturing employment in Zhejiang (Zhejiang Manufacturing Cluster Empirical Research Group 2007). In 2007, the Chinese Academy of Social Sciences published a list of the top 100 industrial clusters in China, 36 of which were from Zhejiang (China Business Times 2007). In summary, in the past several decades, Zhejiang has followed a rather successful cluster-based industrialization path.

Quality Upgrade in Zhejiang

Zhejiang has witnessed not only a rapid expansion of industrial output but also an impressive improvement of quality. Table 2 shows the trend over time of patents granted and the number of enterprises with quality certifications. In 1997, Zhejiang stipulated the Zhejiang Famous Trademark Identification and Protection Regulations. In 2006, the province had 698 well-known trademarks. By the end of 2007, the number of registered trademarks in Zhejiang Province had reached 290,000, accounting for 10% of the total registered trademarks in China. Zhejiang ranks in the first place in total number of overseas trademark registrations, well-known trademarks, agricultural trademarks, and trademark infringement cases investigated. In addition to registered trademarks, the rapid growth in the number of quality certifications also reflects the overall quality improvement of manufactured goods from Zhejiang. The first quality certification occurred in Wenzhou, Zhejiang, in 1997. Since then, the number of quality-certified companies has steadily increased, reaching nearly 8,000 by 2006. As an important indicator of product quality and technological improvement, the number of patents granted in Zhejiang has jumped from 1,328 in 1990 to more than 50,000 in 2008.

Crises in Zhejiang Clusters

Zhejiang industrial cluster development has been associated with various crises. Due to a lack of comprehensive statistical data for all the clusters, we have to select large and well-known clusters with publicly available information. *Zhejiang Yearbook* (National Bureau of Statistics 2003) lists 149 clusters with gross output value of more than one billion yuan in 2000. In addition, 36 clusters were included in the top 100 national clusters by the Chinese Academy of Social Sciences Survey in 2007. Zhejiang Bureau of Small and Medium Business also published some data on industrial clusters in Zhejiang in 2007. In total, the three lists cover 158 clusters. Some less developed counties do not have large clusters, whereas some developed regions have more than three large industrial clusters. Because our analysis is at the county level, we limited the maximum number of clusters in a county in our sampling survey. In the presence of multiple clusters, we selected only the top three clusters in each county or district. We ended up surveying 85 clusters from the list of 158.

We classified crises into five categories: quality crisis, consumer boycott, export barriers, macro policy and regulations by the central government, factor price escalation (such as wage, land, energy and other raw material prices), and others (mainly accidents, such as fires and explosions). There are no official crisis-related statistical data records for industrial clusters. In the summer of 2012, we surveyed 85 clusters. By interviewing the major informants in the local government and business associations, we recorded the major milestones in the process of cluster development, such as major crises encountered and subsequent policy responses, if any.

Table 3 reports crises in the clusters by type and year. From 1990 to 2008, there were 53 crises in these clusters with quality crisis accounting for the largest share. Crises related to export barriers (10) rank the second place. All the crises happened after 2004, probably reflecting China's fast growth in exports after joining the World Trade Organization (WTO). Various other industrial sectors also occasionally run into sudden unfavorable policy changes. For instance, in 2004, China's National Development and Reform Commission announced a new regulation imposing a minimal to many entry investment thresholds for the automobile and motorcycle industries, which struck a heavy blow to small automobile part suppliers in Wenling and Yuhuan. Overall, crises have occurred more frequently since 2000. Five crises can be categorized as accidents. For example, on October 21, 2006, Zhili Children's Garment cluster suffered an accidental fire, killing eight people and injuring five. After the accident, the government imposed strong safety regulations, requiring all the workshops to install fire exit stairs and to separate production space from living areas.[3]

Figure 2 shows the number of major local government policies prior to and after a crisis. We consider 11 types of industrial policies: (1) providing infrastructure; (2) building marketplaces; (3) setting up an industrial park; (4) establishing a logistics

[3] In many workshops, workers eat, live, and work in the same place. They are often called "three-in-one" workshops.

center; (5) training workers; (6) creating an industrial association; (7) providing firms with financial incentives; (8) undertaking generic promotion; (9) hosting exhibitions; (10) establishing quality inspection centers; and (11) facilitating firms' research and development . Prior to a crisis, the first four types of policies in support of market expansion are more popular. After a crisis, policies (6)-(11), which are largely conducive to quality upgrade, were more likely to be put in place. It seems that the menu of industrial policies differs before and after a crisis.

3. Case Studies

In this section, we use three case studies to illustrate the evolutionary process of industrial clusters amid crises.

Burning Wenzhou Shoes at Wulin Gate in China

The city of Wenzhou is a major center of footwear production in China, renowned as "China's footwear capital." In 2004, the footwear cluster in Wenzhou produced 835 million pairs of shoes and employed 400,000 workers (Huang, Zhang, and Zhu 2008). However, the development process has not always been smooth. In particular, a consumer boycott stemming from a quality crisis in 1987 almost devastated the cluster.

Wenzhou's footwear production cluster began in the late 1970s. The clustering mode of production lowers the capital barriers to entry because many production steps are dispersed among different family workshops or firms (Huang, Zhang, and Zhu

2008). As a result, the number of enterprises soared, and total output expanded dramatically. Faced with price pressures, many enterprises adopted a low-quality and low-cost strategy. Some of them even started to use fake raw materials to reduce the cost of producing shoes. Their behavior damaged the reputation of the whole industry in Wenzhou: most producers at the time did not have their own brands, and consumers, unable to differentiate among the different producers, generalized that all the shoes made in Wenzhou were of poor quality. Wenzhou shoes were called “day shoes,” “week shoes,” and “falling-heel shoes” and were almost synonymous with counterfeiting. Consumer dissatisfaction with Wenzhou shoes climaxed on August 8, 1987, when China’s Hangzhou Industrial and Commercial Administration burned 5,000 pairs of Wenzhou-made shoes in Wulin Plaza of Hangzhou in a televised broadcast. In April 1988, consumers destroyed a shop selling Wenzhou shoes in a large shopping center in Nanjing. Subsequently, many other cities followed suit. Officials in Changsha, Harbin, and Zhuzhou also set fire to Wenzhou shoes in public. Subsequently, the Shanghai, Nanjing, Wuhan, Changchun, Shijiazhuang, and Dalian city governments imposed bans on Wenzhou shoes sales. Even as far away as Russia, signs with messages such as “No Wenzhou goods” and “Wenzhou people out of Russia” were displayed on the streets (Chen 2006).

On the positive side, the crisis triggered an opportunity for enterprises and local government to work together to improve product quality in the industry. Facing the threat of being wiped out by the crisis, local business communities and government took a series of collective actions to improve product quality to save the industry. Wenzhou District Footwear Association, the first footwear association in Wenzhou, was established by a group of footwear industry veterans in June 1988 and initially included more than 370 enterprises. It called for all members to pay attention to their product reputation and improve product quality (China Footwear Information Network 2007). It established various regulations to curb vicious competition, punish producers of poor-quality products, and restore trust among its members. For example, the association set up a new intellectual property rights committee to protect and promote the launch of new products and inhibit the spread of fake products. It blacklisted enterprises with a bad reputation, thus shaming these enterprises among the other members.

Furthermore, local governments took serious administrative actions. Led by the Lucheng district government of Wenzhou City, the Bureau of Quality and Technical Supervision, the Administration of Industry and Commerce, and several other related agencies jointly established the Lucheng Footwear Quality Management Office. Since then, all the shoes produced in Wenzhou have had to be certified by the office. The office began inspecting enterprises regularly and sampling their products. If the products meet quality standards, the office issues a certificate. However, if a firm fails the quality test, their products are banned from sale. When enterprises renew their production license with the Administration of Industry and Commerce, they must provide the quality certifications for their products (Li 2006). In 1993, the Wenzhou municipal government proposed a strategy to create a regional brand, requiring that all shoes made in Wenzhou be marked “Made in Wenzhou” in order to be permitted to be shipped out of Wenzhou. In addition, the government also began providing various incentives to encourage local enterprises to create brands. For example, if a firm earns the title of "China Famous Brand" for its products from the State Administration of Industry and Commerce, the local government will award 1 million yuan to the firm (Li 2006). Moreover, the association and local governments worked together to regulate the advertisements. Those enterprises that were blacklisted by the association for their bad reputation were banned from posting advertisements of any form in Wenzhou. Because is the major show production and market center, it is hard for the punished enterprises to gain business without any advertisements.

Quality Crisis in the Puyuan Sweater Industrial Cluster

Puyuan Township is located in northern Zhejiang Province, between Hangzhou and Shanghai. Historically, Puyuan was an important silk production center. In 1976, a collectively owned enterprise, the Puyuan Tanhua (Weaving) Production Cooperative, purchased three hand-loom weaving machines and began to produce cashmere sweaters. The cooperative's gross output value soared from 28,000 yuan to 300,000 yuan in just one year, prompting the group to devote all of its production capacity to cashmere sweaters by the end of 1977 (Chen 1996). Like the Wenzhou footwear cluster, the Puyuan sweater industrial cluster suffered quality crises between 1995 and 1996. In 1995, many merchants boycotted sweaters made in Puyuan because of their bad reputation. This greatly depressed the demand for Puyuan sweaters. In late 1995 and in 1996, the whole textile industry fell into a recession. Meanwhile, the Puyuan sweater marketplace was plagued with serious management problems. The market was established by quite a few stakeholders, but the property rights were not clearly defined. The stakeholders had disputes as to how to set rental rates, allocate revenues, and share the cost of maintenance. Owing to the disagreement, the market lacked crucial public investment and performed poorly in many necessary services. Disgruntled with the poor service, some shops closed doors, and some merchants voted with their feet by moving to another sweater market in the nearby Honghe Township.

Realizing the seriousness of the problem, the local government and entrepreneurs took a series of measures to respond to the crisis. One key initiative was to reform the management structure of the sweater market to provide better service to the merchants. Another important strategy was to improve product quality. Similar to the Footwear Quality Management Office of the Wenzhou shoe crisis, a quality control office was established to regularly inspect the sweaters' quality. In addition, the market added a new Quality Product Street, in which only well-known brands are for sale. Less well-known brands are not allowed there. Nowadays, having a brand for sale on Quality Product Street sends a strong signal that the brand is of premium quality. With these measures in place, Puyuan quickly reversed its reputation for bad quality.

The above two cases share some common features: First, each crisis damaged the reputation of the clusters and drove down demand for their products. Second, each crisis also provided an opportunity for the private and public sectors to work together to improve product quality. Together, these sectors took a series of actions such as establishing business associations, inspecting product quality, protecting brands, and punishing bad apples.

Shengzhou Necktie Cluster

Shengzhou is located in the eastern part of Zhejiang with Hangzhou to the north and Ningbao to the east. The Shengzhou necktie cluster started in 1984 when a Hong Kong businessman who originally came from Shengzhou set up a necktie plant. In less than three decades, it has become one of the largest necktie clusters in the world, developing a comprehensive supply chain. This chain involves dying, weaving, sewing and marketing. Shengzhou's necktie marketplace has the grand name "China Necktie City," which boasts that it is the largest in China. In 2010, more than 1,300 enterprises were engaged in tie production and the cluster employed more than 50,000 workers. The cluster sold over t 300 millions of ties worth 1.5 billion dollars to more than 100 countries, accounting for 90% and 40% of the market share in China and the world, respectively.

Apart from the rapid expansion in the quantity of neckties produced by the cluster, there has been swift improvement in quality.. In order to better control quality in the cluster, the Shengzhou government set up a "China Necktie Quality Inspection Center," the most authoritative of such centers in China. Five brands in Shengzhou earned the title of "China's famous trademarks" and eleven brands enjoyed the status of export exemption (no need for inspection). In addition, the government named "Shengzhou Necktie" a regional brand.

These developments did not come about as part of a totally smooth process. The industry has only come to this glamorous stage by threading through numerous challenges. The most salient one was price escalation for raw materials in 2005. Silk is the major material for necktie production. The cluster consumed 7,000 tons of silk, 95% of which came from elsewhere. In the beginning of 2005, the wholesale price started at 170,000 yuan/ton, soared to 260,000 yuan/ton by the end of the year, and ended up at 344,000 yuan/ton by February of 2006. An increase of 10,000 yuan/ton in the price of silk of 1 adds 0.4 yuan to the production cost of each necktie. This means that the rise in silk price over14 months made each necktie 7 yuan (about US$1) more costly. The industry runs on a thin margin. As the silk price escalated, profit was milked out and the whole industry fell into the red during 2005—2006.

In response to rising silk prices, the local government and firms came up with a series of collective actions. First, the industrial association persuaded 33 members of larger firms to collectively raise necktie prices by 10%. In order to ensure the pledge was kept, the association collected a security deposit based on a firm's number of sewing machines. A firm's deposit would be forfeited if it independently lowered the price of its products.

The second strategy was to lower the transaction cost of buying silk and expand the silkworm cocoon production base. The local government earmarked 2 million yuan a year to support a logistics company that purchased raw materials on behalf of local necktie companies. Thanks to its greater bargaining power, the logistics company could obtain lower prices for the firms than if a firm had acted alone. Meanwhile, under the support of the Shengzhou government, some big firms signed agreements with the producers of silkworm cocoons in the western region to secure a stable supply.

Third, the local government and the industrial association of necktie firms helped a few big firms to establish a digital necktie design library, which was open to all the firms in the cluster. The availability of a large variety of historical designs provided firms with a fertile ground to pollinate innovative designs.

Fourth, the local government encouraged firms to establish their own brands. It earmarked a fund to subsidize firms that exported neckties under their own brands, purchased international brands, or registered their brands overseas. The policy quickly paid off. A local firm purchased an Italian necktie company well known for its design. Another company set up a design studio in Milan, Italy.

Thanks to these efforts, and despite rising silk prices, the Shengzhou tie cluster has thrived and steadily moved up the quality ladder.

4. Conceptual Framework

Drawing on insights from these case studies, we present a simple conceptual model in this section to discuss the relationship between crises and quality upgrade in industrial clusters. We assume each cluster makes one product of low or high quality. Enterprises in a cluster choose whether to produce low- or high-quality products. Compared with that of low-quality goods, production of high-quality goods requires higher fixed and variable costs (Berry and Waldfogel 2010). The costs include but are not limited to those of registering trademarks, investing in research and development, buying high-end equipment, training skilled workers, and buying better raw material. The difference between the two types of firms is reflected in the average and marginal cost curves shown in Figure 1. If consumers can distinguish the high-quality and low-quality products and the market is competitive, the price of a high-quality product should be higher than that of a low-quality one.

For a given product, a firm maximizes its output at the point where the marginal cost equals price. The corresponding profit amounts to the product of the difference between price and average cost and the quantity of sales. In Figure 1, if a firm chooses low-quality production, its profit equals area A, whereas area B reflects the profit in the case of a firm that specializes in high-quality products. Suppose that, at the beginning, all businesses engage in low-quality production. An enterprise always evaluates the option of switching to the high-quality product by comparing areas A and B. However, the decision also depends upon the overall quality reputation of the cluster. Due to information asymmetry, consumers may have a problem distinguishing a cluster's high-quality products from its low-quality products. If, on average, the cluster leaves a bad quality image with consumers, many enterprises may want to stick to the low-quality production because it would be very difficult for an individual producer to change the quality image of the whole cluster. If consumers pay the same price for high-quality and low-quality products, it would be impossible for an enterprise's investment in quality upgrade to pay off. Therefore, if an enterprise wants to switch to a high-quality product, it must find ways to signal the quality premium of its product. For example, it can set up specialty stores, purchase advertisements in the media, and hire lawyers to fight counterfeiters. All these will drive up average cost and diminish profit margins (a smaller area B in Figure 1). In theory, it pays to make a reputational investment in the long run (Klein and Leffler 1981; Shapiro 1983), but facing uncertainty and credit constraints, most enterprises prefer to continue making low-quality products. In other words, the whole cluster may be stuck in a low-quality equilibrium.

Now let's examine how a crisis affects quality upgrade decisions. There are many types of crises, such as the imposition of export barriers or of a consumer boycott. Major accidents can also create crises. Despite the different natures of the crises, their impact on a cluster is similar: many enterprises that produce low-quality products will be weeded out by the harsher environment, and those remaining in business may face a lower profit margin. This is reflected by the shrinking area A in

Figure 1. Some crises may reduce consumer demand and depress prices, whereas other crises, brought about by the rising price of raw materials, may escalate production costs.

Next we introduce the role of local governments into the model. Some scholars have argued that China's rapid economic growth stems largely from the inter-county competition associated with a decentralized fiscal and centralized political system (Cheung 2008; Zhang 2006). In China, local officials' job promotions largely hinge upon how well they promote local economic development. Therefore, in areas with industrial clusters, local officials have a strong incentive to foster cluster development. The two most commonly observed ways of promoting cluster development are to establish markets and undertake generic promotion of the clusters. When markets are nearby, enterprises can significantly cut marketing and purchasing costs. The generic promotion of the cluster attracts more merchants, benefiting all the producers. These interventions can either lift up the price curve (P_{HQ}) or lower the average cost curve (AC_{HQ}) of individual firms. However, all these initiatives cost money. Thus the local governments have to calculate the benefit-cost ratio of their interventions. Their tax revenues are directly determined by the enterprises' profit.

If all firms are in a low-quality equilibrium, the total local government revenue is $r\sum_{i=1}^{n} A_i$, where *r* is tax rate. If instead all the enterprises produce high-quality goods, the revenues collected by local governments amount to $r\sum_{i=1}^{m} B_i$. A cost is required for the industry to upgrade its product quality. Before a crisis, firms may not have an incentive to voluntarily upgrade their product quality as discussed above. Local governments are not certain about promoting quality upgrade as it is unclear whether there is a net gain in revenue or not ($r\sum_{i=1}^{m} B_i - r\sum_{i=1}^{n} A_i$ positive or negative). Given the sunk cost of public interventions and the uncertainty of whether any revenue flows will result, the local governments are less likely to aggressively advocate cluster quality upgrade in normal times.

However, a crisis may reshape how entrepreneurs and government officials perceive benefits and costs of proposed reforms. Normally, crises drive down the profits of most firms in a cluster. Consequently, the local governments observe a drop in total revenue ($r\sum_{i=1}^{n} A_i$). This will change how governments' calculate the costs and benefits of their interventions to upgrade cluster quality. Inaction may lead to the loss of revenue streams and the collapse of the cluster. Therefore, in the event of a crisis, governments are more likely to take bold actions. Similarly, amid crises, enterprises must find a way to survive. When the option of continuing low-quality production is eliminated by a crisis, the pressure to climb the quality ladder builds. On the one hand, enterprises are more likely to allocate a larger share of their limited capital resources to improve product quality. On the other hand, they may be more willing to accommodate governmental interventions. These include product quality inspection, brand protection, and banning of counterfeits, even though these measures may increase average production cost. In other words, in a cluster, crises may foster collective action (Schmitz 1997).

5. Empirical Analyses

In this section, having presented the case studies and conceptual framework, we describe how we empirically tested the impact of crises on quality upgrade in clusters. To do this, we used county-level data in Zhejiang Province for the period of 1990–2008 following the specification below:

$$Q_{it} = \alpha * Crisis_{it} + \beta X_{it} + \epsilon_{it}, \quad (1)$$

where Q_{ij} stand for quality measures in county *i* at year *t*. It would have been ideal to use the quality measures at the cluster level. However, such data were not systematically available. Instead we based our analysis at the county level. We considered three outcome variables: patents per capita, quality certifications per capita, and share of professional and technical personnel in a total population. These three variables are in logarithm. The patent data since 2000 come from the Zhejiang Intellectual Property Office, while the data prior to 2000 are obtained from the website of the China Intellectual Property Office. The number of firms with quality certification is from Zhejiang Bureau of Quality and Technical Supervision.

$Crisis_{it}$ is defined as the total number of crises that county *i* has encountered by time *t*. In regressions, we also used lagged crisis variables as a robustness check.

Among the 85 clusters in our sample, most were at the county level in Zhejiang, but some were at the township level (one level below the county). However, because the cluster-level data was not systematically available, we used the county-level data to measure variables related to clusters in our analysis. If a county had more than one cluster, we defined the crisis variable as the total number of crises that had occurred at time *t* in all the clusters sampled in a county. As a result, the value of crisis can be larger than 1.

X_{jt} is a set of control variables at the county level in year *t*, such as per capita GDP, population density, per capita foreign direct investment, the share of industrial GDP, and share of state-owned enterprises (SOEs). All the data are gathered from various issues of *Zhejiang Statistical Yearbook* (National Bureau of Statistics 1991–2009). Some data were missing from the provincial yearbooks. As much as possible, we tried to replace the missing values with figures we found in local statistical yearbooks or government documents. However, we still had to interpolate a few variables. From 1990 to 1992, the provincial yearbook did not report the GDP for the industrial sector. We used the ratio of gross industrial output value in total gross output value to total GDP to estimate the missing GDP in the industrial sector. In 1992, the gross industrial output values in a few counties were missing. We interpolated them with the average values in 1991 and 1993. We used the share of the number of State Owned Enterprises (SOEs) in 1991 to replace the missing value in 1990. In 1999 the provincial yearbooks stopped reporting the number of SOEs at the county level, as most of the restructuring of SOEs had finished; therefore, we set the share of the number of SOEs at zero since 1999. In addition, we included time trend, county fixed effects, or year fixed effects in the regressions as alternative specifications.

Regressions Analyses

We first regressed the number of patents per capita in logarithm on the crisis variable and other control variables according to equation (1). The first four regressions (R1-R4) in Table 4 report the estimation results using the crisis variable in the current year. The first regression (R1) does not include time trend, year and county fixed effects; in R2 we included county fixed effects; in R3 we added another time trend variable on top of R2; and in R4 we included both county and year fixed effects. The models fit well. In particular, regression R4 has the highest adjusted R^2 and the lowest AIC value, suggesting it is the best specification. All four regressions clearly show that the coefficient for the patent variable is statistically significant and positive. The coefficients for other variables across the four specifications are less robust than for the crisis variable. Because it takes time for a crisis to take effect, we also ran a set of regressions (R5-R8) by lagging the crisis variable for one year. All the main results remained robust. The lagged crisis has a positive impact on the number of patents per capita across the four specifications.

Table 5 presents the regression results on the number of quality certifications. Since quality certification did not take place until 1997, we restricted our sample to

1997–2006 in regressions on this variable. In the same vain as in Table 4, we ran two sets of regressions, one with a current and one with a lagged crisis variable. As with the previous table, we considered four specifications for each crisis variable. In regression R1–R4, we used the current crisis variable, and in R5–R8, we included the lagged crisis variable. Regardless of whether we used current or lagged crisis variables in the regressions, the coefficients for the crisis variables are statistically significant at the 1% level in all the regressions.[4] A comparison of the AIC values reveals that the specification with both county and year fixed effects performs the best. Per capita GDP is positively related to the number of quality certifications. Interestingly, the share of industrial GDP in total GDP is highly negative, probably due to its high collinearity with the per capita GDP variable. The coefficient for FDI is insignificant in any of the regressions on the number of quality certifications.

Table 6 repeats Table 5 but replaces the dependent variable with the share of professional and technical personnel in the total population. Because the provincial yearbook did not report this variable until 1995, the regressions are for the period 1995–2008 in this table. The findings for the crisis variable still hold up. Crisis is positively correlated to the number of technical staff. This suggests that crises may induce firms to hire more highly skilled laborers to upgrade their product quality. Coefficients for GDP and share of industrial GDP have the same signs as in Table 5. The coefficient for SOEs is positive and highly significant in all the regressions.

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[4] Here we mainly examined the correlations between crises and quality upgrade. One should be cautious in drawing any strong inferences on causality.

Tables 4–6 examine the impact of shocks on quality upgrade without distinguishing their types. In principle, it is possible that different types of shocks may have different effects on the outcome of quality upgrade. To address this concern, Table 7 presents the estimates of the five types of shocks listed in Table 3 on three measures of quality upgrade. For the crisis variable, we used the current value in the regressions. The regressions based on lagged value are similar and are not reported here. The five types of shocks have a consistent positive impact on the three outcome variables. In the first panel on the number of patents (R1–R4), the coefficient for the crisis variables is statistically significant in 24 out of 25 regressions. In the regressions on the number of quality certification (R5-R8), only three out of 25 regressions report insignificant coefficients for the crisis variable. As shown in R8, the most favorable specification, four out of five types of crisis, correlate positively with the number of quality certifications. We observed the same pattern in the regressions on the number of professional and technical staff as shown in R9–R12.

6. Conclusion

The quality of products manufactured in China has improved significantly in the past several decades. For this study we aimed to understand the mechanism of the quality upgrade process. Crises reshape both entrepreneurs' and local governments' perceptions of the payoffs and costs involved with proposed reform measures. When facing a harsh external environment, the public and private sectors are more likely to take collective action to improve product quality. Using data from 85 industrial clusters in Zhejiang Province, we empirically examined the impact of crises on the quality upgrade process. We found that the number of patents, the number of enterprises with quality certification, and the share of professional and technical staffs in the clusters all show a significant increase post-crisis. Therefore, we find that crises do imply an opportunity for upgrading product quality in clusters.

However, the positive correlation between crises and quality upgrade does not mean one can expect crises to automatically solve all quality problems. Only if crises can be successfully addressed can they become the catalyst for an institutional change (Edgar 2006).

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Table 1. The Distribution of Industrial Clusters in Zhejiang Province

Sector	Number of Clusters	Gross Industrial Output Value (in Hundred Millions, Chinese yuan)	Ratio of Gross Industrial Output Value of all Manufacturing Clusters (%)		Sector	Number of Clusters	Gross Industrial Output Value (in Hundred Millions Chinese yuan)	Ratio of Gross Industrial Output Value of all Manufacturing Clusters (%)
Processing of Food from Agricultural Products	25	281.8	1.8		Manufacture of Textile Wearing Apparel, Footwear, and Caps	44	760.1	4.9
Manufacture of Foods	6	50.5	0.3		Manufacture of Leather, Fur, Feather, and Related Products	20	680.8	4.4
Manufacture of Beverages	10	59.2	0.4		Processing of Timber; Manufacture of Wood, Bamboo, Rattan, Palm, and Straw Products	18	165.6	1.1
Manufacture of Textiles	56	2669.6	17.3		Printing, Reproduction of Recording Media	32	184.1	1.2
Manufacture of Furniture	11	90.7	0.6		Manufacture of Articles for Culture, Education, and Sports Activities	18	182.8	1.2
Manufacture of Paper and Paper Products	45	396.6	2.6		Manufacture of Raw Chemical Materials and Chemical Products	51	988.6	6.4
Manufacture of Medicines	1	40.9	0.3		Smelting and Pressing of Ferrous Metals	6	93.5	0.6
Manufacture of Chemical Fibers	4	306.8	2		Smelting and Pressing of Nonferrous Metals	15	293.6	1.9
Manufacture of Rubber	13	80	0.5		Manufacture of Electrical Machinery and Equipment	51	1595	10.3
Manufacture of Plastics	58	854.2	5.5		Manufacture of Communication Equipment, Computers, and Other Electronic Equipment	22	672	4.3
Manufacture of Nonmetallic Mineral Products	58	624.4	4		Manufacture of Measuring Instruments and Machinery for Cultural Activity and Office Work	18	181.4	1.2
Manufacture of Metal Products	57	748.9	4.8		Manufacture of Artwork and Other Manufacturing	36	323.8	2.1
Manufacture of General Purpose Machinery	68	1660.2	10.7		Recycling and Disposal of Waste	3	28.9	0.2
Manufacture of Special Purpose Machinery	47	474.4	3.1		Manufacture of Transport Equipment	46	986.3	6.4

Source: Zhejiang Manufacturing Cluster Empirical Research Group (2007).

Table 2. Number of Approved Patents and Enterprises with Quality Certifications in Zhejiang Province

Year	Number of Approved Patents	Growth Rate (%)	Number of Enterprises with Quality Certifications	Growth Rate (%)
1990	1,328	—	0	—
1991	1,928	45.18	0	—
1992	2,513	30.34	0	—
1993	1,868	–25.67	0	—
1994	2,368	26.77	0	—
1995	2,276	–3.89	0	—
1996	2,632	15.64	0	—
1997	3,393	28.91	1	—
1998	4,341	27.94	5	400.00
1999	7,172	65.22	5	0.00
2000	7,495	4.50	31	520.00
2001	8,355	11.47	89	187.10
2002	10,478	25.41	106	19.10
2003	14,402	37.45	330	211.32
2004	15,250	5.89	2,181	560.91
2005	19,056	24.96	4,255	95.09
2006	30,968	62.51	7,994	87.87
2007	44,712	44.38	—	—
2008	52,924	18.37	—	—

Source: The numbers of approved patents after 2000 come from Zhejiang Intellectual Property Office (http://www.zjpat.gov.cn). The numbers of approved patents before 1999 come from National Intellectual Property Office (http://search.sipo.gov.cn/). The numbers of enterprises with quality certifications come from Zhejiang Quality and Technology Supervision Office.

Table 3. Major Crises in Zhejiang Clusters

year	Shock Types					Total
	Quality Crisis	Export Barriers	Macro Policy	Factor Price	Accidents and others	
1990	2	0	0	0	0	2
1992	0	0	1	0	0	1
1995	3	0	0	0	0	3
1996	1	0	0	0	0	1
1997	1	0	0	0	0	1
1998	1	0	0	1	0	2
1999	1	0	0	0	0	1
2001	2	0	0	0	0	2
2002	0	0	1	1	0	2
2003	0	0	0	1	1	2
2004	1	0	4	2	2	9
2005	3	6	3	3	0	15
2006	0	1	0	2	1	4
2007	0	1	1	1	1	4
2008	1	2	1	0	0	4
Total	16	10	11	11	5	53

Note: The table reports the number of crises by type and year. The financial crisis in 2008 was not included as it literally affected all the clusters.

Table 4. Crises and Number of Patents

	Patents Per Capita in Logarithm							
	R1	R2	R3	R4	R5	R6	R7	R8
Current crisis	0.333***	0.686***	0.540***	0.409***				
	(2.933)	(6.212)	(5.066)	(3.690)				
Crisis lagged by one year					0.361***	0.714***	0.559***	0.384***
					(2.850)	(6.020)	(5.040)	(3.386)
Per capita GDP (log)	0.900***	0.719***	-0.071	0.208	0.912***	0.735***	-0.12	0.174
	(8.016)	(7.530)	(-0.802)	(1.019)	(7.788)	(7.182)	(-1.292)	(0.911)
Population density	-0.105	-4.268*	-9.771***	-8.450***	-0.071	-4.830*	-10.887***	-9.421***
	(-0.047)	(-1.672)	(-3.715)	(-3.331)	(-0.032)	(-1.993)	(-4.315)	(-3.777)
Per capita foreign direct investment (log)	0.008	0.051	0.006	0.039*	0.009	0.058*	0.002	0.040*
	(0.219)	(1.601)	(0.291)	(1.788)	(0.235)	(1.691)	(0.094)	(1.679)
% of industrial GDP	1.050***	1.021**	0.521**	-0.041	1.110***	1.090**	0.495**	-0.073
	(2.695)	(2.626)	(2.490)	(-0.171)	(2.688)	(2.424)	(2.248)	(-0.291)
% of state owned enterprises	-0.855	-1.994***	0.599	2.361**	-0.998	-2.015***	0.621	2.424**
	(-1.075)	(-3.012)	(1.165)	(2.541)	(-1.273)	(-3.032)	(1.224)	(2.573)
Time trend			0.175***				0.185***	
			(9.312)				(9.471)	
County fixed	no	yes	yes	yes	no	yes	Yes	yes
Year fixed	no	no	no	yes	no	no	No	yes
Adj-R^2	0.593	0.777	0.81	0.838	0.582	0.768	0.806	0.835
AIC	3639.467	2728.455	2507.001	2298.164	3431.042	2581.29	2347.388	2151.821
Number of observations	1387	1387	1387	1387	1314	1314	1314	1314

Note: AIC stands for Akaike information criterion. The t-statistics clustered at the county level are in parentheses. The symbols *, **, and *** represent significance levels at 10%, 5%, and 1%, respectively.

Table 5. Crises and Number of Quality Certifications

	Number of Enterprises with Quality Certifications in Logarithm							
	R1	R2	R3	R4	R5	R6	R7	R8
Current crisis	0.651***	0.603***	0.604***	0.413***				
	(3.862)	(4.058)	(4.157)	(3.966)				
Crisis lagged by one year					0.588***	0.479***	0.481***	0.335***
					(3.444)	(3.308)	(3.335)	(3.135)
Per capita GDP	1.898***	3.932***	3.569***	1.845***	1.953***	4.054***	3.680***	1.876***
	(6.623)	(21.336)	(8.255)	(5.037)	(6.746)	(22.532)	(8.477)	(4.881)
Population density	-8.349***	34.361***	32.899***	27.449***	-8.379***	33.805***	32.303***	26.931***
	(-3.285)	(3.260)	(3.098)	(2.829)	(-3.308)	(3.244)	(3.081)	(2.805)
Per capita foreign direct investment (log)	0.029	-0.001	-0.006	-0.036	0.026	-0.004	-0.009	-0.039
	(0.531)	(-0.057)	(-0.243)	(-1.234)	(0.463)	(-0.154)	(-0.348)	(-1.301)
% of industrial GDP	-3.389***	-8.082***	-7.676***	-6.445***	-3.237***	-8.375***	-7.956***	-6.555***
	(-2.971)	(-5.650)	(-5.156)	(-4.506)	(-2.791)	(-5.731)	(-5.186)	(-4.483)
% of state owned enterprises	-1.278**	3.000***	3.322***	0.951	-1.275**	3.086***	3.417***	0.995
	(-2.293)	(5.973)	(6.087)	(1.483)	(-2.218)	(6.175)	(6.150)	(1.559)
Time trend			0.049				0.051	
			(0.907)				(0.916)	
County fixed	no	yes	yes	yes	No	yes	Yes	yes
Year fixed	no	no	no	yes	No	no	No	yes
Adj-R^2	0.506	0.82	0.82	0.885	0.494	0.813	0.814	0.882
AIC	2317.308	1501.381	1501.641	1181.292	2334.457	1527.929	1528.153	1199.982
Number of observations	730	730	730	730	730	730	730	730

Note: AIC stands for Akaike information criterion. The *t*-statistics clustered at the county level are in parentheses. The symbols *, **, and *** represent significance levels at 10%, 5%, and 1%, respectively.

Table 6. Crises and Share of Professional and Technical Personnel in Total Population

	Share of Professional and Technical Personnel in Total Population (Logarithm)							
	R1	R2	R3	R4	R5	R6	R7	R8
Current crisis	0.102	0.230***	0.231***	0.224***				
	(1.658)	(2.843)	(2.873)	(2.713)				
Crisis lagged by one year					0.112*	0.228***	0.228***	0.232***
					(1.783)	(3.056)	(3.090)	(2.962)
Per capita GDP (log)	0.710***	0.708***	0.636***	0.632***	0.709***	0.720***	0.645***	0.640***
	(10.166)	(10.004)	(3.367)	(2.751)	(10.302)	(10.542)	(3.403)	(2.775)
Population density	-3.192***	-4.569***	-4.820***	-4.774***	-3.189***	-4.677***	-4.940***	-4.892***
	(-3.574)	(-3.064)	(-3.363)	(-3.242)	(-3.588)	(-3.069)	(-3.397)	(-3.295)
Per capita foreign direct investment (log)	0.044***	0.015	0.014	0.01	0.044***	0.016	0.015	0.009
	(3.641)	(1.204)	(1.120)	(0.736)	(3.673)	(1.250)	(1.165)	(0.666)
% of industrial GDP	-1.341***	-2.447***	-2.378***	-2.343***	-1.336***	-2.481***	-2.409***	-2.348***
	(-3.880)	(-3.915)	(-3.839)	(-3.674)	(-3.860)	(-4.003)	(-3.905)	(-3.707)
% of state owned enterprises	0.817***	0.458**	0.543*	0.742*	0.816***	0.476**	0.565*	0.758*
	(3.216)	(2.219)	(1.794)	(1.742)	(3.232)	(2.334)	(1.902)	(1.809)
Time trend			0.01				0.01	
			(0.369)				(0.387)	
County fixed	no	yes	yes	yes	No	yes	Yes	Yes
Year fixed	no	no	no	yes	No	no	No	Yes
Adj-R^2	0.612	0.727	0.727	0.729	0.612	0.725	0.725	0.728
AIC	1062.407	627.199	628.682	631.257	1061.773	633.421	634.86	633.26
Number of observations	1021	1021	1021	1021	1021	1021	1021	1021

Note: AIC stands for Akaike information criterion. The *t*-statistics clustered at the county level are in parentheses. The symbols *, **, and *** represent significance levels at 10%, 5%, and 1%, respectively.

Table 7. Impact of different types of shock on quality upgrade

	Number of Patents				Number of Quality Certification				Number of Professional and Technical Staff			
Types of shock	R1	R2	R3	R4	R5	R6	R7	R8	R9	R10	R11	R12
Quality Crisis	0.252	0.562***	0.471**	0.341*	0.566**	0.018	0.029	0.130	0.059	-0.016	-0.015	-0.021
	(1.302)	(2.869)	(2.193)	(1.715)	(2.568)	(0.093)	(0.135)	(0.898)	(0.926)	(-0.188)	(-0.167)	(-0.229)
Export Barriers	0.555***	0.859***	0.657***	0.440***	1.723***	1.078***	1.084***	0.748***	0.157	0.275**	0.277**	0.274**
	(3.982)	(5.158)	(4.181)	(2.952)	(5.117)	(5.554)	(5.773)	(4.496)	(1.499)	(2.338)	(2.364)	(2.264)
Macro Policy	0.444**	0.821***	0.618***	0.459***	0.942**	0.691***	0.686***	0.348**	0.180*	0.279**	0.278**	0.282**
	(2.243)	(5.541)	(4.035)	(2.698)	(2.474)	(3.130)	(3.212)	(2.396)	(1.704)	(2.239)	(2.239)	(2.194)
Factor price	0.461**	0.751***	0.550***	0.351***	0.750***	0.591***	0.599***	0.444***	0.124	0.295**	0.296**	0.293**
	(2.638)	(4.646)	(4.053)	(2.834)	(3.022)	(4.499)	(4.751)	(4.728)	(1.091)	(2.318)	(2.374)	(2.264)
Others	0.655***	0.864***	0.601**	0.417	1.196	1.032**	1.019**	0.600*	0.217	0.476**	0.475**	0.474**
	(2.731)	(3.043)	(2.331)	(1.479)	(1.374)	(2.506)	(2.506)	(1.774)	(1.236)	(2.222)	(2.194)	(2.186)
Time trend	no	no	yes	no	no	No	yes	no	no	no	yes	no
County Fixed	no	yes	yes	yes	no	Yes	yes	yes	no	yes	yes	yes
Year Fixed	no	no	no	yes	no	No	no	yes	no	no	no	yes

Note: We use Current crisis. The *t*-statistics clustered at the county level are in parentheses. The symbols *, **, and *** represent significance levels at 10%, 5%, and 1%, respectively.

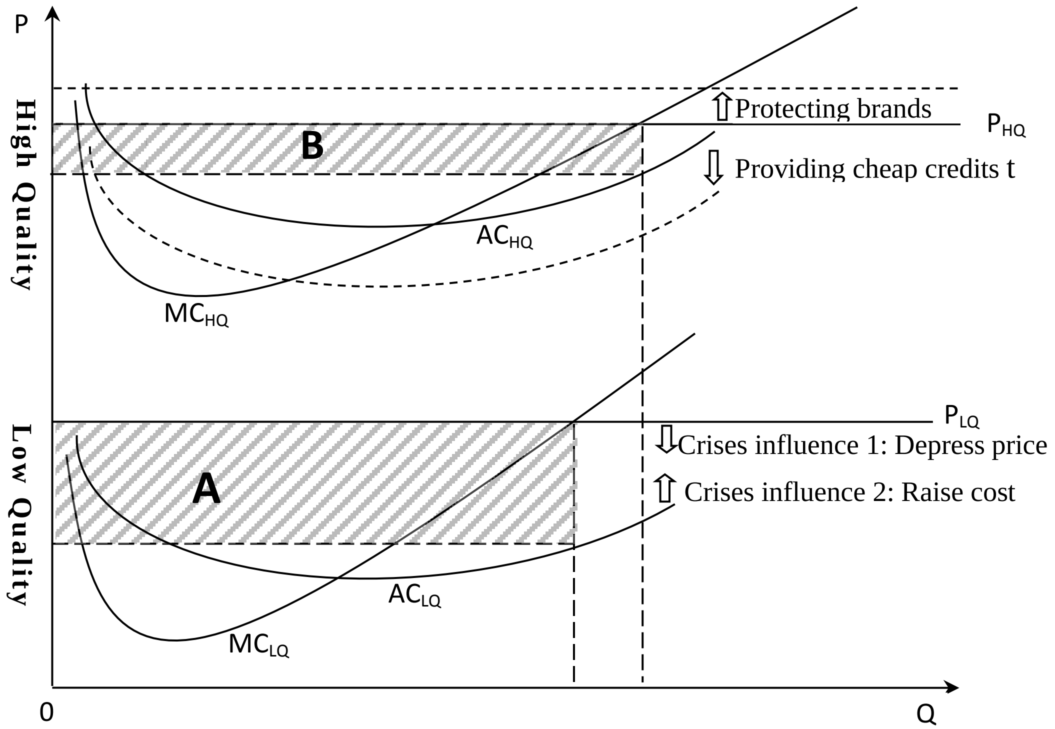

Figure 1. Crises and quality upgrade

Source: drawn by authors.

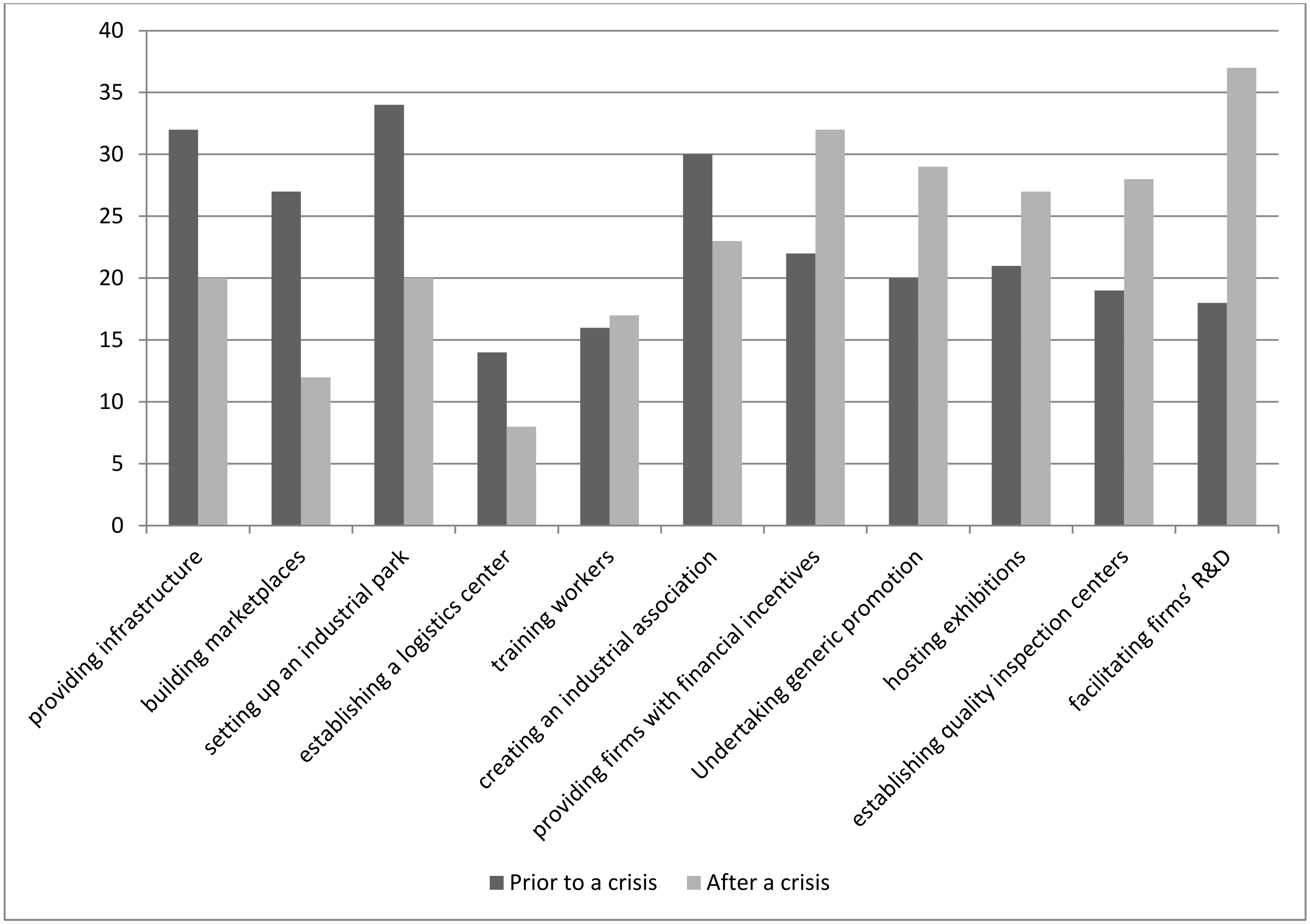

Figure 2 Major Local Industrial Polices Prior to and After a Crisis

Sources: Authors' surveys.