

# Rural vehicles in China: appropriate policy for appropriate technology

Daniel Sperling\*, Zhenhong Lin, Peter Hamilton

*Institute of Transportation Studies, University of California, Davis, CA 95616, USA*

Received 4 February 2004; revised 4 October 2004; accepted 30 November 2004

Available online 25 January 2005

## Abstract

Over 3 million Chinese Rural Vehicles (CRVs) were produced in China in 2002, three times that of conventional passenger cars. Yet these smaller, simpler, indigenous vehicles are virtually unknown outside China. The CRV industry is unusual in that it evolved largely outside the control of government regulation and policy, using local technology and resources. CRVs now consume one fourth of the diesel fuel in China and play an important role in rural development. This paper is the first comprehensive assessment (in English or Chinese) of these vehicles and this remarkable industry. This study documents and analyzes vehicle technology, government policy, environmental impacts, market demand, and industry dynamics. We find that increasing government regulation (mostly for emissions and safety) is having profound effects on the industry, with uncertain implications for the sales and globalization of rural vehicle technology.

© 2004 Elsevier Ltd. All rights reserved.

*Keywords:* China; Motor vehicles; Energy

## 1. Introduction

With the Chinese economy expanding 8–10% per year since the late 1970s, the Chinese government has turned to the auto industry to serve growing demand for travel and spur economic growth. It designated the automotive industry as a ‘pillar’ industry of economic development in 1994, and in its *Tenth Five-Year Plan (2001–2005)* established a goal of widespread car ownership. Intense effort has been devoted to engaging the international automotive industry (National Research Council and Chinese Academy of Engineering, 2003; Gallagher, 2003). Passenger car output is increasing rapidly, from 0.6 million in 2000 to 1.09 million in 2002 (National Bureau of Statistics of China, 2003).

Virtually ignored, in striking contrast, are the even larger numbers of small 3-wheel (3-w) and 4-wheel (4-w) vehicles manufactured by domestic Chinese companies for use in small cities and rural areas. With virtually no governmental financial support, the production of these vehicles, which are referred to as Chinese rural vehicles (CRVs), exceeded 3 million vehicles per year by 1999 (China Automotive

Technology and Research Center, 2000), with the total vehicle population reaching about 22 million in 2001.<sup>1</sup> The implications are huge—in terms of safety, energy use, air pollution, noise, greenhouse gas emissions, and rural development. The available English language literature contains very little information about China’s rural vehicles (indeed, there is not even an accepted English name for this group of vehicles), and even in Chinese, information is sparse.

Much background information for this study was collected from unstructured interviews of CRV manufacturers, marketers, mechanics, users, and regulators in China

<sup>1</sup> The reported number varies from 20 to 22 million. The number 22 million is used most frequently on government web pages. See [http://sdep.cei.gov.cn/envir\\_sub/source/af2002070301.htm](http://sdep.cei.gov.cn/envir_sub/source/af2002070301.htm), accessed on July 28, 2003 (in Chinese), <http://qdnj.qingdao.gov.cn/departement/nongji.nsf/0/140B87CBC8F135D048256C3F00329C13?OpenDocument>, accessed on July 28, 2003 (in Chinese), and <http://www.drccu.gov.cn/qcyhj/qchj/200211040390.htm>, accessed on Aug 18, 2003 (in Chinese). We find the most accepted and credible number of vehicles for 1999 to be 18 million (<http://www.cfm623.com/gg/nych.htm>, accessed on Aug 19, 2003), and for 2000 to be 20.3 million (<http://www.jsast.com/fx/qg/fxqgl2.htm>, access on Aug 19, 2003). Another source suggests the population of CRVs to be as much as 25 million at the end of 2002 (<http://www.amic.agri.gov.cn/pages/infopage.asp?ino=3757>, accessed on Oct 8, 2003).

\* Corresponding author. Tel.: +1 530 752 7546; fax: +1 530 752 6572.  
E-mail address: [dsperling@ucdavis.edu](mailto:dsperling@ucdavis.edu) (D. Sperling).

by co-authors Peter Hamilton and Zhenhong Lin. These interviews were assembled into 68 sets of trip notes by Peter Hamilton, and are documented in a longer report (Sperling et al., 2004).

This paper is the first comprehensive assessment (in English or Chinese) of these vehicles and this remarkable industry. We document and analyze vehicle technology, government policy, environmental impacts, market demand, and industry dynamics. We explore the trend of increasing government regulation, and its impact on industry concentration and globalization.

## 2. Clarification: CRV, farm machinery, and automotive industry

CRVs can be defined officially and functionally. Functionally, they are vehicles mostly used for goods transport that are smaller and slower than conventional cars and trucks, with simpler technology developed in China. Officially, the Chinese government treats CRVs as part of the Chinese farm machinery industry, not the automotive industry. CRV is a specific official vehicle category with the Chinese name, Nong2yong4yun4shu1che1 or, for short, Nong2yong4che1, and technologically defined by an official government standard, *Technical requirements on safety for CRVs* (GB18320-2001). Later, we define CRVs more specifically.

CRVs are part of a spectrum of motorized vehicles produced and used in China. In rural areas, vehicle diversity is greatest. Motorized rural transportation technologies in China include CRVs, 3-w motorcycles, farm tractors, 2-w motorcycles, and mini gasoline trucks and diesel trucks, with CRVs, 3-w motorcycles, and tractors being most common.

More than 2 million tractors are sold each year in China, and they serve as an important means of rural transportation, but they are designed and used principally for farming. The annual output of 2-w motorcycles is far more than that of CRVs or tractors,<sup>2</sup> but 2-w motorcycles are mainly exported or sold in large or mid-scale cities, while CRVs are more concentrated in rural areas and small cities. 3-w motorcycles are common in some rural areas, but most seem to be illegally produced, and the number of 3-w motorcycles and their makers are difficult to discern.<sup>3</sup> We find, based on personal observation, vehicle data, and scattered literature,

<sup>2</sup> During the year 2002, nearly 13 million motorcycles were produced in China and 3.44 million were exported. China became the No.1 for motorcycle production and No. 2 for motorcycle exportation. See <http://www.china.com.cn/chinese/EC-c/408380.htm>, accessed on Oct 7, 2003 (in Chinese).

<sup>3</sup> See <http://www.newsmotor.com/mtzy2002/motor3/sczj2.htm>, in Chinese regarding lack of oversight of 3-w motorcycle production in China, which can be verified by our experience (Sperling et al., 2004, App. A, interview note #31). According to that article, most 3-w motorcycles sold to rural areas are illegally produced.

that CRVs dominate rural transportation in China, with strong advantages in price and general utility.<sup>4</sup>

The CRV industry, Chinese motorcycle industry, and Chinese automotive industry are quite distinct in terms of ownership and government regulation, though this is likely to change over time.

## 3. CRV history

The CRV industry sprang from early efforts of the Communist government to aid rural development. In the 1960s, ‘Commune and Brigade Enterprises’ (CBEs) were organized to stimulate industrial activity in the poverty-stricken rural areas of the country (Zhang, 1999). These communal enterprises evolved in the late 1970s and 1980s into Township Village Enterprises (TVEs). TVEs were not privately owned but were allowed to operate similar to profit-seeking businesses (Fisher-Vanden, 2003). Since 1984, TVE ownership has been shifting from cooperative to private ownership (Zhang, 1999). The evolution of CBEs and TVEs into large businesses provided the organizational basis for increasingly sophisticated manufacturing.

In the mid and late 1990s, growing demand for transport began attracting the interest of the large state-owned automotive and farm machinery organizations. Automotive businesses proposed serving this rural demand using existing light-duty truck technology, inserting diesel engines in place of existing gasoline engines, and the farm machinery sector proposed to serve this rural demand using small tractors with trailers. Neither proposal succeeded. Meanwhile, the local CBEs and TVEs, who better understood farmer needs, designed and produced unique CRVs without financial support from the government.

These small enterprises flourished largely independent of national and provincial governments. While they were disadvantaged in that they received little (if any) financial support from governments, they benefited from little regulation or intervention. The success of these small enterprises is attributed in part to their close connection with their customers—producing inexpensive vehicles designed for local work needs.

One senior expert of the Chinese automotive industry said: ‘Our biggest mistake in understanding the Chinese automotive market (viewing the CRV market as part of the Chinese automotive market) is that we did not expect that the CRV industry can develop into such a good condition today all by itself without one cent from the government.’<sup>5</sup>

<sup>4</sup> For example, see Y. Chen, ‘Market is more important than technology for automotive industry development’, <http://www.e-works.net.cn/ewkArticles/Category116/Article13166.htm>, accessed on Oct 7, 2003 (in Chinese).

<sup>5</sup> L. Li, ‘Can The Auto Industry Counterattack The CRV Industry?’, <http://www.auto-society.com.cn/forum/qita/sc3.htm>, accessed on June 16, 2003 (in Chinese).

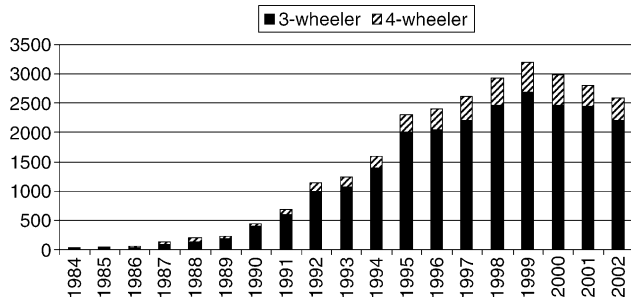


Fig. 1. CRV production (in thousands), 1984–2002. Sources: Data through 1998 are from GM (2001). Data for 1999–2000 are from *the 2000 Chinese Automotive Industry Yearbook* (2000), and for 2001–2002 from China Machinery Economic Information (2002).

The history of the CRV industry can be divided into three periods, as suggested by Fig. 1:

- Expansion of small rural collectives and enterprises in the 1980s.
- Shift to private ownership and rapid economic growth in late 1980s and 1990s.
- Industry stabilization in 2000 to present.

#### 4. Today's CRV industry

The CRV industry is maturing and consolidating. In only one year, from 2001 to 2002, the number of registered CRV manufacturers dropped from 204 to 120, although it is believed that many of those no longer registered are still in business. In any case, the market share of the ten largest is increasing. The top ten 3-w manufacturers increased their share from 59.5 to 65% from 2001 to 2002, and the top ten 4-w manufacturers increased their share from 93 to 96%. Two companies, Shifeng and Juli, accounted for 61% of the 3-w CRV market.

The government appears to favor consolidation of the CRV industry, as well as the automotive industry (Harwit, 1995), as a means of creating companies with greater resources and greater capability to develop and adopt advanced technology, including emissions control. The large number of companies in the CRV industry, ranging from small backyard shops to large industrial enterprises, is indicative of low entry barriers that have existed in this industry—in terms of capital investment and government licensing and rules. With low entry barriers, the industry has been highly competitive and focused on small and inexpensive vehicles. Price competition is severe, with strong downward pressure on prices. Until recently, there were few incentives to invest in advanced technology, especially for attributes such as reduced emissions that do not add much to consumer-perceived utility.

The new emission standards and policies being adopted by the central government will undoubtedly lead to further consolidation, with small CRV manufacturers and those with poor vehicle quality and no R&D capability disappearing. In early 2003, Yanmar Co., Ltd, a Japanese company specializing in diesel engines, and Shandong Shifeng Group Co., Ltd, established a joint venture to produce and market single-cylinder diesel engines that comply with new CRV emission regulations. The engines will be used in Shifeng vehicles, but will also be supplied to other 3-w CRV makers. It remains to be seen how this collaboration will play out in terms of the health of the industry, the creation of a supplier industry, and the industry's responsiveness to the low end of the market.

#### 4.1. Manufacturer profiles

Most of the CRV manufacturers are small backyard operations, but a few are sophisticated industrial companies. Three of the largest CRV companies—Shandong Shifeng, Shandong Juli, and Beijing Futian—are profiled in Table 1. They operate enormous manufacturing facilities, with moving assembly lines and diverse product offerings, and are building extensive R&D capabilities. Their products range from primitive 2-w walking tractors to small trucks that would look at home in a European city.

The largest and most sophisticated CRV companies are modern engineering and manufacturing firms. Shandong Shifeng Group has been the leading CRV manufacturer since 1996. It has over 28,000 employees, produces CRVs, farm tractors, and engines, and also owns wine, hotel, transportation, vehicle parts, and oil companies. It has a manufacturing capacity of 1 million 3-w CRVs, 0.2 million 4-w CRVs, 1.3 million engines, and 0.3 million farm tractors. In 2002, the group produced 0.87 million 3-w CRVs, 60,000 4-w CRVs, 1.01 million engines, and 188,000 tractors, with 6.8 billion RMB in sales (US\$823 million) and 400 million RMB (US\$48 million) profit. Its R&D division

Table 1  
Profiles of leading CRV manufacturers

	Shandong Shifeng	Shandong Juli	Beijing Beiqi Futian
Location	Liao Cheng	Weifeng	Zhucheng <sup>a</sup>
Employees	28,000	8,000	NA
Production cap.	1,000,000	600,000	200,000
Area	250 acres	Much smaller	(Not visited)
Ownership	State-owned TVE	Publicly traded	Publicly traded
Main product	3-w CRV	3-w CRV	4-w CRV, LD-truck

Source: Company literature and on-site interviews (see Sperling et al., 2004, App. A, Interview notes #35, #65 and #66).

<sup>a</sup> 4-w CRVs are produced at this site.

has 1200 technical employees, and a large computer-aided-design (CAD) capability. Shifeng has exported a small number of CRVs to more than 50 countries.<sup>6</sup>

Beiqi Futian (Beiqi Futian Automobile Co., Ltd) was founded in August 1996 by combining about 100 small enterprises. By 2003, the company expanded its capitalization from the original RMB140 million to RMB3.5 billion in 2003, and increased its number of employees from 4600 to 15,000. The company is engaged in the automotive, agricultural, construction, and finance industries. It produces a wide range of products, including motors, engines, tractors, reaping machines, chemicals, and lightweight steel construction materials, as well as CRVs. Beiqi Futian has a yearly production capacity of 160,000 4-w CRVs, 60,000 3-w CRVs, 10,000 reaping machines, and 60,000 engines. Beiqi Futian is politically well connected; it is among the 520 key national enterprises designated by the government, one of the five key pilot enterprises of Beijing, and a key supported enterprise of Beijing.<sup>7</sup> A company brochure states that the company has invested 2–3% of gross profit each year in R&D.

Shandong Juli Group Co., Ltd has a production capacity of 600,000 3-w and 40,000 4-w CRVs, and has been listed as one of China's One Hundred Best Engineering Enterprises. It has a sales team of 1280, a sales network of 900 offices, and a national vehicle service network. Juli markets CRVs throughout the country and exports to over 20 foreign countries. It has a large R&D and computer-aided-design center and applies international quality management protocol.<sup>8</sup>

Senior executives at Shifeng and Juli indicated to us that they have no plans to compete with western auto manufacturers. Instead, they focus on low-cost vehicles. Beiqi Futian, on the other hand, is focusing on the light-duty truck market, and may soon find itself competing with similar products offered by foreign firms. Both Shifeng and Juli expressed interest in interviews with us in producing gasoline-powered vehicles, as a response to tightening emission standards (Sperling et al., 2004, interview notes #65, 66).

#### 4.2. Dealership, service and warranty

Most CRV dealerships are independent, and receive a sales commission from the manufacturer for vehicles sold. In addition to sales, dealerships are expected to provide support, including after-sale service. The government requires detailed warranties for all CRV sales. Warranties

are complex and specific, covering each part of the vehicle for a specified period of time. Generally, parts and labor are covered for one year, and labor is free thereafter. Service is generally available from any licensed dealer, not just where the purchase was made. The low quality of CRVs, the high cost of this warranty requirement, and the need to provide a network of service facilities encourages industry consolidation.

#### 4.3. Globalization of the CRV industry

Integration of the Chinese CRV industry with the global economy will increase, but to what extent is highly uncertain. In 2001, the CRV industry began exporting small numbers of CRVs to other countries. Major CRV makers, such as Feicai, Heibao, Juli, Shifeng, and Wuzheng, export to many countries, mostly in Africa and Asia. In July 2001, Shandong Shifeng exported about 500 CRVs to Mexico via the United States, and in 2002 a Mexican importer announced plans to import 5000 to 10,000 CRVs annually from Shifeng.<sup>9</sup>

The industry leaders interviewed at Shifeng and Juli were optimistic about their prospects. They believe their products are price-competitive on the world market, and anticipate increased exports. While neither exported more than a few thousand vehicles in 2002, all three major manufacturers interviewed for this report believed that in the future exports would become an important part of their business. None foresaw the CRV industry directly competing with conventional vehicles manufactured by China's large international automobile manufacturers (Sperling et al., 2004, Appendix A, interview notes #65,66).

Engagement with international companies, and even large domestic automakers, is likely to expand, though. It will not be because of China's accession to the WTO, since CRVs are apparently already priced lower than rural vehicles manufactured elsewhere.<sup>10</sup> Instead, engagement will come because of government pressure to improve CRV technology. Some improvement will come via internal R&D by the largest companies, but also by acquiring technology from larger automotive companies through licenses and various financial arrangements.

#### 4.4. Future evolution of CRV industry

The CRV industry is at a crossroad. As government regulation and intervention increases, as companies gain

<sup>6</sup> See company's website, <http://www.shifeng.com.cn/info/introduce.asp?infoTypeID=10072001&infoID=100000013>, accessed on April 6, 2003 (in Chinese).

<sup>7</sup> See company's website, <http://www.futian.com.cn/ebusiness/en/index.asp>, accessed on June 23, 2003 (in Chinese).

<sup>8</sup> See company's website, <http://www.chinajuli.com>, accessed on June 23, 2003 (in Chinese).

<sup>9</sup> W. Yang, 'Shifeng's Exportation to Mexico', <http://www.amic.agri.gov.cn/njsc/pages/infopage.asp?ino=135>, accessed on June 23, 2003 (in Chinese).

<sup>10</sup> L. Hong (Chair of the National CRV Association and Chair of Anhui Feicai Group), 'How CRV Deals With WTO', <http://www.camtf.com.cn/gclt/8.htm>, accessed on July 28, 2003 (in Chinese).



access to improved technology (through internal R&D and transfer from others), and as the industry consolidates into fewer and larger companies, one would expect product quality to improve. Yanmar's penetration, as indicated earlier, into the Chinese single-cylinder diesel engine industry, the core of the 3-w CRV industry, is indicative.<sup>11</sup>

But will the industry continue to move upscale, eventually competing and merging with (or being bought out by) large domestic and international manufacturers of conventional vehicles? Or will the industry retrench and stay focused on inexpensive low-end products? The answer is related to the following factors: the nature of CRV demand in China, which is not well understood; aggressiveness of governments in enforcing safety, emissions, and quality standards and limiting usage in urban areas; the relative political influence of CRV and conventional automotive manufacturers and local farmers; and decisions by large domestic and international manufacturers of conventional vehicles to invest in CRVs and in some cases expand their product line downward. We do not provide an answer, but note the mounting tension between rural demand for inexpensive vehicles and the desire of the central government to upgrade CRV technology.

## 5. Technical attributes

CRVs are diesel-powered ground transportation vehicles with small to mid payloads, and low to medium speeds. Later in this paper, we reconcile functional definitions with the evolving government definitions. For now, note that CRVs range from simple 3-wheelers with a one-cylinder diesel engine on a motorcycle-like frame costing US\$300, to sophisticated, small, truck-like 4-wheelers exceeding US\$5000.

### 5.1. Engines

About 80% of the 22 million CRVs are powered by single-cylinder diesel engines originally designed for stationary agricultural machinery.<sup>12</sup> These one-cylinder engines are very inefficient, especially in mobile applications, and produce large amounts of pollutants.

The preference for single-cylinder diesel engines lies in technology, economics and policy. Diesel fuel is safer than gasoline, and less prone to explode and burn. Diesel engines are also easier to maintain, and can operate satisfactorily on poor quality fuels. With minimal mechanical skill, farmers

can deal with the problems of the injection pump, the principal source of diesel engine problems. In contrast, common maintenance problems with gasoline engines are related to carburetors and ignition systems, which require considerably more skill. Diesel engines are also easier to manufacture. In the 1970s and early 1980s, the only available small engines were single-cylinder diesel engines widely used for walking tractors. One expert witness said, 'Farmers themselves can even produce single-cylinder diesel engines. When CRVs became popular, many counties had their own single-cylinder diesel engine factory. One province could have tens of such factories.'<sup>13</sup> Perhaps most important has been fuel costs. Diesel engines use less fuel because they are 20–30% more energy efficient than comparable gasoline engines. Also, diesel fuel used for rural applications in China was priced 1/3 to 1/2 that of gasoline prices until the 1980s, though gasoline and diesel prices have long been similar due to policy changes in the mid-1980s.<sup>14</sup>

### 5.2. 3-w CRV

3-w CRVs are available in a variety of sizes. The least expensive (~US\$300) are small open-cabin single-seat vehicles with motorcycle handlebars, hand-crank starting, and 3-speed (plus reverse) transmissions. The most sophisticated 3-w CRVs have closed, car-like cabins with steering wheels and radio/cassette players, electric start, powered dumping capability (for the cargo bed on the back of the vehicle), and a low-range gearbox that complements the standard 3-speed transmission. Fully equipped, top-of-the-line models cost up to US\$2200. Between these extremes are vehicles with almost every conceivable combination of features. Most 3-w vehicles have the following attributes (see Fig. 2):

- One-cylinder diesel engine
- 12–15 horsepower (8.8–11.0 kW)
- Evaporative water-cooling (no water pump)
- Belt drive from engine to transmission, mounted on rear axle
- Payload capacity of 500 kg (though vehicles are often overloaded)
- Top speed of 50 km/h (specified by law)

### 5.3. 4-w CRV

4-w CRVs are generally faster and quieter, and more powerful, comfortable, and expensive, but have only slightly greater payload capacity, according to the listed product data. Prices can vary from as little as \$600 to as

<sup>11</sup> YANMAR Co., Ltd, 'Yanmar Agrees to Establish a Joint Venture with Shandong Shifeng Group, China's Largest Farm Vehicle Manufacturer', <http://www.yanmar.co.jp/english/aboutus/whats-new/news/0301/conts01.htm>, accessed on June 19, 2003.

<sup>12</sup> China Agricultural Resources Network, 'The Small Diesel Engine Industry Needs Technology Breakthrough', <http://sdnj.gov.cn/data/2002/tg/1115214.htm>, accessed on June 17, 2003 (in Chinese).

<sup>13</sup> Professor Liu, Tsinghua University.

<sup>14</sup> 'Notification about the Approval by PRC State Council on the Proposal of Abolishing Allowance Policy for Rural Diesel Consumption', <http://www.china-njx.com/zcfg/040.htm>, accessed on July 23, 2003 (in Chinese).



Fig. 2. Typical 3-w CRV.

much as \$5,400. Most 4-w CRVs share the following characteristics (see Fig. 3):

- Single or multi-cylinder indigenous diesel engines
- 20–35 horsepower (14.7–25.7 kW)
- Steering wheel
- Fully enclosed, car-like cabin
- 500 kg payload capacity (but many have considerably greater capacity)
- 70 km/h legal top speed
- Modern appearance, similar to a small light-duty truck
- One bench seat

#### 5.4. Quality

The CRV industry is highly competitive—but competition has been more on price than quality. In a 2002 survey of CRV product quality conducted by the central government (General Administration of Quality Supervision, Inspection and Quarantine), less than 70% of all CRVs achieved the minimum standard, and only 11.8% of ‘transformed tractors’ (a special category of small 4-w CRVs described later). In Henan province, none of the CRVs met the minimum quality standard. In contrast, a survey of automobiles conducted by the same governmental



Fig. 3. Sophisticated 4-w CRV.

department found that 100% qualified.<sup>15</sup> These low rates for CRVs can partly be explained by the recent tightening of product quality standards and the fact that standards are linked to often-ignored legal specifications (such as maximum speed). In any case, CRVs are widely viewed as having low reliability and quality. The predominant quality problems found in the examinations were related to safety, including malfunctioning safety signals, top speeds that exceeded legal limits (for the respective vehicle class), and fuel system integrity. Other defects related to noise and smoke.<sup>16</sup> Another indication that competition is based more on price than quality is the low number of patents. From 1996 to 2000, only 185 patents were granted to 16 CRV makers. Most of these related to design features; only 3% of this already small number of patents was for inventions.<sup>17</sup>

In interviews of users conducted by two of our co-authors during August 2002, CRV users reported a range of experiences with respect to reliability. Some had owned vehicles for many years, driven long distances, and had no problems (Sperling et al., 2004, Appendix A, interview notes #2, 10, 47). Others reported numerous problems in only two or three years of ownership (Sperling et al., 2004, Appendix A, interview notes #4, 36). Problem areas included clutches, bearings, tires and wheels, lighting, and drive belts. The drive belts appear to be the most common maintenance item for CRVs. Many people replace the belts themselves once per year as a preventative matter, at a cost of about RMB35 (US\$4) in parts. Many CRV owners reported that, apart from the drive belt, they would not routinely maintain the vehicle. Minor problems, including safety equipment such as lighting and mirrors, were mostly ignored unless they affected vehicle operation. Apparently, users define and value quality differently than the government.

## 6. Vehicle safety, energy use, emissions, and noise

### 6.1. Safety

Lax enforcement of vehicle and transportation regulations and primitive vehicle designs apparently results in large numbers of traffic accidents. Many local governments ban CRVs from urban streets and intercity roads, in large part because they are perceived to be high polluters and unsafe. Traffic crash statistics, however, do not support this governmental assertion about CRV safety. Data published by the Transportation Administration Bureau of

<sup>15</sup> Eight products from eight producers were surveyed. These eight producers’ outputs shared 91% of the total output of automobiles in 2001. <http://www.people.com.cn/GB/jinji/32/178/20010618/490764.html>, accessed on July 8, 2003 (in Chinese).

<sup>16</sup> Wuhan Agricultural machinery Information Network, ‘Explanation for the Low Ratio of Qualified Number of CRVs’, <http://sdnj.gov.cn/data/2003/02/02059.htm>, accessed on June 18, 2003 (in Chinese).

<sup>17</sup> X. Hu, ‘Market Can’t Compete With Environmental Protection’, <http://www.qiche.com.cn/files/200204/02048.html>, accessed on June 26, 2003 (in Chinese).

the Ministry of Public Security indicates that CRVs were involved in only 4.9% of all traffic crashes in China (compared to 74.5% for cars, 12.9% for motorcycles, and 5.3% for tractors). Fatality data tells a similar story, with CRVs having a death rate per 10,000 vehicles of 4.36, versus 42.14 for cars, 6.26 for motorcycles, and 4.84 for tractors (Lu, 1997). The low crash and especially fatality rates for CRVs is presumably due to their low speeds and their use on lightly traveled roads. It may also be that rural crashes tend to be less reported than crashes in urban areas.

In any case, there are many opportunities to improve the safety of CRVs, especially by improving braking and steering. Given that many drivers do not have formal driving training, efforts to enhance (or require) minimal driver skills would also improve safety. Enforcement of rules in rural areas can be difficult. Many local governments impose simplistic but easy to enforce rules: they prohibit CRVs on many streets and roads, and prohibit their use for passenger transportation. These rules dampen CRV demand.

## 6.2. Energy use

Chinese petroleum consumption has increased rapidly since 1990, as indicated by Fig. 4. Much of this is due to increased motorization. Increases in gasoline consumption are indicative of rising automobile use in urban areas and motorcycle use in urban and rural areas. Increases in diesel fuel and other middle distillates are partly attributed to increasing rural diesel consumption, including consumption by CRVs. What portion of this increasing energy use is attributable to CRVs?

Unfortunately, reliable, detailed analyses of energy use by Chinese RVs do not exist. We draw upon fragmented information from the literature and our own knowledge of CRVs. Bottom-up and top-down approaches are reconciled to arrive at estimates of energy use by CRVs in China. Bottom-up data are based on vehicle estimates, while top-down are based on aggregate national estimates.

According to a study done by Yang Xunying, total Chinese diesel fuel consumption in 2000 was 69.5 million tons (see Table 2) or 21.6 billion gallons. In his study, highway transportation accounts for 24% of total diesel fuel

Table 2  
Diesel fuel consumption in China, million metric tons

User	1996	1997	1998	1999	2000
Highway transportation	8.21	8.95	10.09	13.64	16.86
Light vehicle	1.16	1.57	2.02	1.93	1.83
Medium vehicle	5.55	5.60	5.95	8.18	10.10
Heavy vehicle	1.50	1.78	2.12	3.53	4.93
CRV	9.28	10.74	13.25	13.19	14.43
Railway	4.50	4.60	4.80	5.00	5.20
Marine	3.50	3.60	3.80	4.00	4.20
Agriculture	12.00	12.40	13.70	15.00	16.00
Fishing	5.70	6.00	6.10	6.30	6.50
Electricity	4.50	5.00	4.50	4.10	3.80
Others	2.50	2.50	2.50	2.50	2.50
Total	50.19	53.79	58.74	63.731	69.49

Source: Xunying, 2001.

use, and CRV use for 21%. Total gasoline consumption in China in 2000 was 38 million tons or 13.6 billion gallons.<sup>18</sup>

Another study of the Chinese oil consumption, conducted by the China Petrochemical Consulting Corporation, arrives at similar estimates for energy use by CRVs (though assumptions and methods are not provided).<sup>19</sup> It provides estimates for 1997 and forecasts for 2000 and 2005. The forecasts are for non-military diesel consumption of 26.6 MMT in 2000, somewhat lower than the 31.29 MMT estimated above by Yang Xunying. It may be that Yang's higher 31.29 MMT estimate includes military transportation. In any case, the figures for CRV diesel consumption for 2000 are very similar for the two studies: 14.28 MMT and 14.43 MMT.

For a bottom-up estimation of CRV fuel use, this study relies on interviews with CRV users, fuel economy data provided by CRV makers (Sperling et al., 2004, Appendix A), expert opinion, previous CRV regulations, and data on number and composition of the CRV fleet. Parameters used for the bottom-up calculations for year 2000 include fuel economy of 2.8 liters per vehicle-ton per 100 km, average CRV weight (without payload) of 1.0 t, average payloads of 0.5–1 t, useful lives of 6 years for 3-w and 1-cyl 4-w CRVs and 9 years for multi-cylinder 4-w CRVs, accumulated kilometers of travel of 120,000 km for 3-w and 1-cyl 4-w CRVs and 250,000 km for multi-cylinder 4-w CRVs, and a total vehicle fleet of 19 million CRVs.

With this approach, we calculates diesel consumption by CRVs in 2000 to be 19.03 MMT if vehicles weigh 2 t (including payload), or 14.27 MMT if they were to weight 1.5 t. The latter case is very close to those of the two studies above. Based on these analyses, we presume that the two

<sup>18</sup> According to Chinese Economic Information Network.

<sup>19</sup> X. Ke, C. Shang, 'Development Trend of Domestic Civil Vehicles and Its Influences on Supply of Oil Products', China Petrochemical Consulting Corporation, [http://www.spc.com.cn/spcspc/Chinese/tep/2000\\_04/7.html](http://www.spc.com.cn/spcspc/Chinese/tep/2000_04/7.html), accessed on June 29, 2003, (in Chinese).

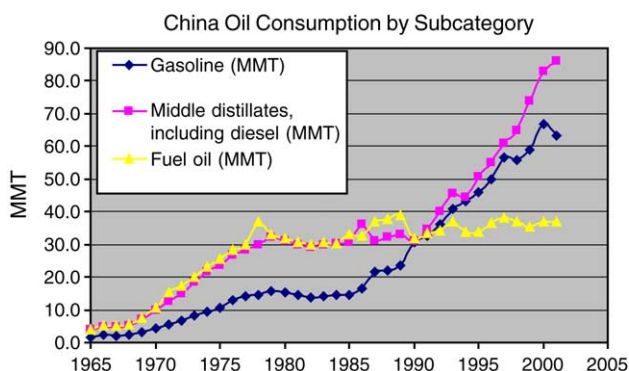


Fig. 4. Chinese oil consumption. Source: BP, 2003.



aggregate studies use company fuel economy data and the rated 0.5 t payload as part of their assumptions. But based on the high frequency of overloading, we believe that 19.03 MMT is a more reasonable estimate of total CRV diesel consumption in 2000. This amount would represent about 1/4 of total diesel consumption in 2000, equivalent to almost 1/2 of all the gasoline consumed in the country.

### 6.3. Emissions

Even less is known about CRV emissions. It is clear, though, that CRVs are high emitters of smoke and pollution. Even when new, the primitive single-cylinder diesel engines emit clouds of black smoke, particularly under heavy load and at low RPM—conditions frequently encountered due to widespread overloading and three-speed gearboxes.

For CRVs, smoke is the only emission regulated. The emissions are regulated based on a test prescribed by GB 18322-2002, *Limits And Measurement Methods For Smoke At Free Acceleration From CRVs*, whereby the pedal on a vehicle is fully depressed for four full seconds while the vehicle is idling (transmission not engaged). Vehicles tested include a prototype provided by the manufacturer; a randomly selected new production vehicle, and a vehicle that has already been in use. Different smoke emission standards are stipulated for each of these three test vehicles. Still different test procedures and standards have been adopted for multi-cylinder CRVs.<sup>20</sup>

No data exist regarding the contribution of CRVs to total pollution, but rough calculations and assumptions suggest that the total amount of pollution from CRVs may be similar to that from conventional vehicles. This conclusion is based on the following information and estimates. First, one governmental document asserts, ‘CRVs in China are powered by diesels and their emissions per unit of energy are on average twice that of trucks.’<sup>21</sup> The situation may be even worse for 3-w CRVs. Second, one source asserts that 88% of the 2.8 million CRVs produced in 2001 were single-cylinder CRVs, and that over 60% of single-cylinder 3-w CRVs and about 30% of multi-cylinder 4-w CRVs cannot meet the emissions requirements of GB 18322-2002, *Limits And Measurement Methods For Smoke At Free Acceleration From CRVs*.<sup>21</sup> With these assumptions, we crudely estimate that CRVs emit as much total air pollution in China as all other motor vehicles.

Although CRVs are much more dispersed than cars, in small towns where CRVs are allowed and agricultural trade is particularly active, CRV emissions are likely having a large impact on local air quality. This pollution is not only damaging to human health, but also agricultural production.

<sup>20</sup> GB 18322-2002 in Chinese is available online at <http://www.vecc-sepa.org.cn/policys/gjbz/GB18322-2002.htm>, accessed on Oct 24, 2004.

<sup>21</sup> G. Ji, ‘The Serious CRV Pollution Issue Pushing the Government to Effort in Regulation’, <http://www.sepa.gov.cn/649096689457561600/20020702/1011810.shtml>, accessed on April 7, 2003 (in Chinese).

Table 3  
Noise limits for CRVs (dB (A))

Vehicle type	Outside, in acceleration	Driver’s seat
Multi-cylinder 4-w	≤84	≤94
3-w and One-cylinder 4-w	≤85	≤92

Source: GB 18321-2001, National standard for CRV noise, known as ‘limits for noise emitted by rural vehicles.’

Recent studies have suggested that air pollution in China in the form of ground-level ozone (Aunan et al., 2000) and atmospheric aerosols (Chameides et al., 1999) can substantially reduce crop yields. A major source of ozone is nitrogen oxides, a principal pollutant of diesel engines, and a major source of aerosols are small airborne particles, also from diesel engines, that can absorb sunlight and contribute to regional haze.

### 6.4. Noise

Public complaints about the noise and black smoke from CRVs are widely reported in China. Noise data are not available, but the following newspaper account highlights the severity of the concern.

Mr Zhao and his wife, residents in Ha’erbin, the capital of Heilongjiang Province, were reported to have bought an apartment along a road that was then under construction. Soon after the road was completed, some 3w CRVs appeared, passing by the apartment as early as 4 o’clock am, waking up the elderly couple. Mr Zhao complained humorously to a newspaper: ‘it is more efficient than an alarm.’ It was worse for the more fragile Mrs Zhao. In winter, she closed the windows and covered her head with the quilt to keep the noise out. But in the hot summer, she had to keep the windows open. Mr Zhao said they understood farmers need to make a living to transport their vegetables in the early morning, but they hoped there would be quieter 3-w CRVs.<sup>22</sup>

Noise standards have been adopted, as indicated in Table 3, but are not widely enforced.

## 7. Vehicle purchase and usage behavior

CRVs are widely available through much of China—though only since the mid 1980s. Two of our co-authors observed CRVs everywhere they traveled in the provinces of Hebei, Henan and Shandong. Their interviews and observations are summarized here (Sperling et al., 2004, Appendix A). CRVs were observed transporting all types of goods, but rarely passengers (other than assistants),

<sup>22</sup> W. Wang, Z. Yang, ‘Annoying CRVs’, <http://www.qiche.com.cn/files/200210/22039.html>, accessed on June 28, 2003. (in Chinese).



although it is well known that CRVs are also used for passenger transport. All vehicles encountered were privately owned, often purchased with savings, or with money borrowed from relatives. None reported using credit to purchase vehicles, and only a few reported having insurance. None reported renting out their CRVs, since they were not willing to let renters drive the vehicle for fear of abuse—understandable given the lack of insurance and high value of the asset relative to rural family incomes. Most owners are, or recently were, farmers.

Many owners use their vehicles for multiple purposes. Some farmers use their CRV exclusively for their own transport needs, including intra-farm and farm-to-market transport. In some cases, this results in an apparent drastic underutilization of transportation capital (Sperling et al., 2004, Appendix A, notes 8, 11). One older farmer reported an income of RMB 4000 (US\$482) per year (Sperling et al., 2004, Appendix A, note 8). He paid RMB 9000 for his vehicle, and uses it roughly once per month for a 14 km round trip. In contrast, some owners drive their vehicles to locations up to 200 km away, usually to wholesale markets, motivated by large price differentials between regional markets (Sperling et al., 2004, Appendix A, notes 2, 18, 37). Some drivers reported using their vehicles initially only to transport their own farm goods, but then found it more profitable to contract their services to others.

CRV usage is extremely varied. The principal uses may be categorized as follows, based on interviews and observations:

- *Intra-farm transport*-carrying produce and farming materials, such as fertilizer, within the confines of large farms (Sperling et al., 2004, Appendix A, notes 11, 47).
- *Farm to market*<sup>23</sup>-carrying produce from the vehicle owner's farm to wholesale and retail markets in nearby local areas, and to more remote urban and suburban wholesale markets. The distances may be as little as 2 km and as far as 200 km (Sperling et al., 2004, Appendix A, notes 1, 19).
- *Wholesale to retail*-markets-carrying perishables, such as watermelons, from wholesale markets or farms to retail markets in towns or cities (Sperling et al., 2004, Appendix A, notes 2, 37).
- *Contracted delivery of non-produce goods*-vehicle owners being contracted to carry fertilizers, construction materials, and other durable goods in local areas (Sperling et al., 2004, Appendix A, notes 6, 27).
- *Short-distance passenger transport*-carrying passengers for short trips, though this activity is illegal in many areas.

<sup>23</sup> This may be the most prevalent form of CRV usage, based on the authors' observations.

## 8. Policy and industry regulation

### 8.1. Sorting out governmental authority and responsibility

Local and provincial governments are quite powerful in China, not unlike state governments in the federal system of the United States. Policies and laws made by the central government sometimes conflict with policies and laws issued by local governments. For example, local governments play an important role in preventing the replacement of road fees with higher fuel taxes.<sup>24</sup> Local governments prefer to impose road fees, which they can retain, rather than fuel taxes controlled by the central government. In many cases, such road fees are imposed on CRVs.

To illustrate the increasing complexity and confusion regarding governmental authority and regulation, consider the following. A farmer (or any individual) can register a 4-wheel CRV today as a CRV, truck, or tractor—but not in more than one category. If registered as a truck, the vehicle can enter urban areas otherwise restricted to CRVs. But if registered as a tractor or CRV, it is taxed less. In practice, CRV buyers seem to determine how to register the vehicle, not the manufacturer. Rules about vehicle registration vary across regions. For example, CRV access to urban areas is banned in most provinces, but in Guizhou Province CRVs can legally drive inside the city and commonly do so.<sup>25</sup> We were not able to determine the extent to which buyers truly have discretion, and the extent to which local laws are being ignored or violated. What is known is that the same vehicle types are being registered in different categories.

The nature of these intergovernmental conflicts is complicated. It is uncertain how they will play out. The implications are huge for governmental policy and regulation affecting the CRV industry, and for the very existence of the industry.

### 8.2. Official CRV definition

Governmental authority over CRVs is founded on technology definitions and specifications. The current administrative definition, presented in Table 4, replaces an earlier set of specifications adopted in 1988 by the previous Ministry of Machinery Industry and the Ministry of Public Security. Revised technical specifications are expected in the near future, motivated in large part by the emergence of 'transformed tractors,' which are currently treated as

<sup>24</sup> According to Professor Zheng Liu, Road fees are based on the payload class of the vehicle (encouraging overloading). Fuel taxes relate directly to the amount of fuel consumed, and therefore encourage the purchase of fuel economic vehicles. Fuel taxes are collected by state-owned petrochemical companies or national government agencies, replacing local governments as the tax collector.

<sup>25</sup> Z. Guan, et al., 'Nice Purchase Power But Bad Soft Environment: A Comment by An Auto Dealer on the Auto Market In Guizhou Province', <http://www.gog.com.cn/jqpd/pd02008/ca319827.htm>, accessed on July 10, 2003 (in Chinese).

Table 4  
Official technical definitions of CRVs (2001)

	3-w CRV	4-w CRV
Speed (km/h)	≤50	≤70
Total mass designed (kg)	≤2000	≤4500
Length (m)	≤4.6	≤6
Width (m)	≤1.6	≤2
Height (m)	≤2	≤2.5

Source: Technical requirements on safety for CRVs (GB18320-2001).

tractors and controlled by the farm machinery departments, but in fact are similar to 4-w CRVs, and by the reality that many 4-w CRVs are essentially identical to inferior light duty trucks. Indeed, transformed tractors are now commonly treated as 4-w CRVs in statistics and news reports.

The drafting of these technical definitions is motivated by the desire to regulate, tax, and license CRVs. In fact, considerable confusion remains, primarily related to the unresolved question about whether CRVs are to be treated as motor vehicles or farm machinery. Historically, CRVs were under the purview of the farm machinery industry. As CRVs began to proliferate, Public Security departments became involved in controlling their use. The underlying issues are money (who gains the revenue from licensing the vehicles and their drivers), road safety, and air and noise pollution. The progression of CRV technology into more advanced 4-wheel vehicles and ‘transformed tractors’ that closely resemble small conventional trucks is exacerbating the confusion about how the vehicles should be treated.

### 8.3. The case of transformed tractors

An illustration of the potent effect of government rules and policies on industry creativity is demonstrated by the surge in 4-w CRV sales. About half of the expanding 4-w sales in 2002 were in a new category of CRVs called ‘transformed tractors’. Transformed tractors first emerged in Guangxi Province in 1997, characterized by single-cylinder engines and 5 t maximum payload. By August 1999, there were about 300 transformed tractor makers located in Guangxi, Sichuan, Guizhou and Hunan provinces (Li et al., 1999). These manufacturers had shifted production from farm tractors and other types of CRVs. More recent transformed tractors are sometimes equipped with 4-cylinder engines with maximum payloads up to 8 t.

There is no standard definition of a transformed tractor. They came about as a response to the increasingly stringent regulation of CRVs emissions, safety, and licensing. As can be seen from the photos in Fig. 5, so-called transformed tractors are like small trucks. They are more sophisticated than most CRVs, though they tend to have slightly lower top speeds and greater towing capability than light trucks, making them more adaptable to rough roads. They vary in price from about 12,000 to 22,000 RMB (US\$1450–2600).



Fig. 5. Shifeng 130T transformed tractor.

Transformed tractors are treated, for now, far more leniently than CRVs by government regulations and taxation. Indeed, labeling them as ‘tractors’ seems to be little more than a means of evading government rules and taxation. For instance, in Guangxi and Hunan provinces, any company can obtain permission to produce these vehicles simply by submitting a deposit to the local farm machinery agency. In addition, transformed tractors are charged a much lower annual registration fee: about RMB 800 (US\$97) compared to about RMB2000 (US\$242) for a truck, plus a lower value added tax, though taxes and rules vary greatly.

Registering the vehicle in this transformed tractor category has one principal disadvantage—it cannot be used in cities and on roads that ban other CRVs and farm equipment—but have a big advantage relative to trucks of much lower fees and taxes (as low as those for tractors).

### 8.4. Market entry regulation

While the Chinese government largely ignored the CRV industry until recently, it did play one significant role early in the industry’s history. Beginning in 1988, the Ministries of Machinery Industry and Public Security attempted to control entry to the industry by requiring companies to register annually, through the Catalogue Administration Form (CAF).

CAF was created and conducted in the environment of a directed economy. It was intended to rationalize the expansion of the CRV industry, avoiding the creation of many undercapitalized companies. Each year, a list of approved vehicle manufacturers and their product models was issued. The effectiveness of the CAF rules is unknown, since the enforcement mechanism was complicated and the government commitment apparently not very strong. Indeed, small-scale illegal CRV production seems to have been common. Gaining a catalog entry was reportedly difficult for private companies without strong political connections, but somehow large companies were able to get registered. For large CRV companies, on the other hand,

CAF seems mostly to have been an annoyance. It meant that the company had to await government approval for new products, often delaying product launches and dampening competition.

The transformation to a market economy rendered the CAF process obsolete. The industry management functions of the previous Machinery Industry Bureau were taken over by the State Economic and Trade Commission (SETC) and the State Development Planning Commission (SDPC), with the Department of Industrial Policy of SETC assuming responsibility for the CRV industry. In 2001, the SETC abolished CAF and announced that it would be replaced with a new administrative process. The intention is to impose an internationally recognized certification process, with the implication being that the CRV industry would be integrated into the Chinese automotive industry. These changes are scheduled to take effect in 2006, but so far no rules or processes are known to have been issued or carried out.<sup>26</sup>

### 8.5. Policy evolution

The CRV industry has long been treated as part of the farm machinery industry (with corresponding taxation and policy advantages relative to conventional vehicles). Initial policies and rules directed at the CRV industry were focused on manufacturing oversight. These rules and policies evolved in response to evolving CRV technology and industry expansion. Now increasing attention is being devoted to emissions, product quality, and vehicle performance.

The first explicit recognition of CRVs by government was in 1987, when the Ministry of Machinery Industry issued the *Basic Technical Requirements for CRVs (JB/NQ 160-87)* and *Test Methods for CRVs (JB/NQ 116-87)*. Then in 1993, the Ministry of Public Security issued the *Basic Safety Standards for CRVs*. These policies and laws as well as the 1988 definition enabled CRV makers to legally produce CRVs. To further regularize the industry, the government issued *Temporary Management Methods for CRV Products* in 1988 and the Ministry of Public Security issued the 46th document *Regulations for the On-road Transportation Management of CRVs* in 1993. These two policies provided detailed rules on product specification, vehicle registration, driver training, and driver licensing. Although enforcement details are unavailable, these policies reduced uncertainty for the industry, encouraging companies to invest more capital and expand their operations.

As rural road quality improved, vehicle makers increased vehicle power and speed, especially for 4-wheelers. In 1996, the performance capability of most 4-wheelers exceeded

the legal limit of 50 km/h, with some vehicles having a top speed as high as 80 km/h (Zhang and Zhu, 1997). An increasing number of manufacturers began violating JB/NQ 160-87 by illegally enlarging vehicle dimensions and employing more powerful engines, even though the official maximum speed, payload, and power remained under the legal limits. Buyers were readily informed of the actual technical specifications.

Rule violations inspired debates about how to reform the rules, but also provided opportunities and excuses for unauthorized local policies, such as the imposition of additional fees. According to some surveys (Zhang and Zhu, 1997), in 1996 there were over 20 distinct non-purchasing fees being imposed by local governments, such as fees for road use, excess payloads, bridge crossings, and vehicle registration. Some farmers reportedly purchased their CRVs in one province and registered them in a different province so as to avoid taxes and fees.

In response to technological upgrading of CRVs, new standards and rules were issued in 2001, such as *Technical Requirements on Safety for CRVs* (GB 18320-2001). For the CRV industry, this new set of rules supplemented and in some cases modified the 1997 rules. The new rules abolished the payload and engine power restrictions for CRVs, but imposed new rules for maximum size and mass. It also relaxed the maximum speed limits for CRVs.

While most rules and policies treat CRVs more leniently than conventional vehicles, there are some contrary cases. For example, the Ministry of Transportation and the SPC specified in 2000 that road fees should be charged to 4-wheelers based on the number of engine cylinders.<sup>27</sup> This means that some small 4-w CRVs are charged the same as much larger trucks with the same number of cylinders. One result of this tax policy was the rapid rise in transformed tractors, which are technologically 4-w CRVs but taxed as farm tractors.

### 8.6. Vehicle emissions

The Chinese government is beginning to pursue more aggressive policies to reduce emissions from motor vehicles. In 2002, the government announced that by 2004 diesel trucks must meet standards equivalent to EURO 2 standards<sup>28</sup> (which took effect in the European Union in 1996) and CRVs must meet the equivalent of EURO 1 standards by 2005<sup>17</sup> (effective in European Union in 1993). At the same time, the national government adopted rules and tests for CRV emissions, known as GB 18322-2002, *Limits And Measurement Methods For Smoke At Free*

<sup>26</sup> In March 2003, SETC, Ministry of Foreign Trade and Economic Cooperation (MOFTEC) and SDPC are combined into newly established Ministry of Commerce (MOFCOM). No information is available about new policy or rules regarding CRV market entry.

<sup>27</sup> 'New Trend in CRV Development', <http://sdnj.gov.cn/data/2002/zh/0814105.htm>, accessed on June 27, 2003 (in Chinese).

<sup>28</sup> China Environment News, Chinese Diesel Motor Vehicles Heading for Euro 2, <http://www.envir.gov.cn/info/2003/3/325119.htm>, accessed on 7/12/03 (in Chinese).

*Acceleration From CRVs.*<sup>29</sup> There is some uncertainty about the actual enforcement of these rules. On one large CRV maker's website, the only emission attribute specified for its 3-w and 4-w CRVs is for visible smoke.<sup>30</sup> No mention is made of other emissions, including HC, NO<sub>x</sub>, CO and invisible PM.<sup>31</sup> We conclude that only visible smoke is being regulated for CRVs.

Importantly, the national emission law, GB 18322-2002, delegates some authority to provincial governments. It states, 'Smoke limits for CRV driving in developed urban areas can be determined by provincial governments.' We are not certain as to the legal interpretation of this provision. Apparently it is the legal basis used by local governments to adopt their own policies regarding CRV use. Indeed, in many cities, diesel vehicles of all types are allowed only during the night (e.g. 9 p.m. to 6 a.m.), while in others, CRV owners may purchase special license plates that allow them to enter the city. Where CRVs are allowed in cities, the licenses and registrations are controlled and can be very expensive.

While emissions rules are more lax for the CRV industry, they are still a large challenge for CRV manufacturers. It is uncertain how this will play out. Certainly the standards create pressure for CRV companies to consolidate to support enhanced engine and emissions R&D, as well as seek investment and expertise from international car makers and parts suppliers. Indeed, that process has begun, as indicated earlier, by the joint venture formed in June 2003 between the largest CRV company (Shifeng) and an international diesel engine manufacturer (Yanmar).<sup>11</sup>

### 8.7. Industry response

Companies rarely welcome increased government intervention (an exception being large companies that believe intervention will increase market entry barriers and thereby protect them). In the case of CRV manufacturers, they seem to have ambivalent feelings. More advanced CRV makers believe they can produce low-cost trucks with their 4-w production platforms and are attracted to the prospects of competing in the automotive market. They are exploring the possibility of merging with or buying an automotive company to gain entry to the automotive market. Beiqi Futian did so, and Shifeng and other CRV makers are exploring the possibility. Others are staying focused on farmer demand for cheap vehicles and have responded by producing transformed tractors, a new type of 4-w CRVs. In fact, larger companies are simultaneously producing a variety of products. For example, Beiqi Futian is producing

light-duty trucks, conventional 4-w CRVs and also transformed tractors. All in all, CRV makers perceive a threat from governmental policies, but seem to recognize that their competitive advantage is in understanding and serving rural demand for inexpensive vehicles.

## 9. Explanations for sales decline in 2000–2002 and market rebound in early 2003

As indicated earlier, CRV sales declined in 2000–2002. One important factor seems to have been increasing government oversight and intervention. But other factors also played a role. Below, we explore the principal hypotheses of sales decline, with an eye to understanding whether the sales decline is likely to be permanent or was retrenchment leading to renewed growth and a stronger industry.

### 9.1. Explanations for sales decline in 2000–2002

One hypothesis of falling CRV demand is that falling prices of rice, wheat, and other agricultural products during this period reduced farmer income that reduced CRV purchases. But according to one study<sup>32</sup> by Institute of Agricultural Economics, Chinese Academy of Agricultural Sciences, the price change of agricultural products has little effect, especially for low income farmers, on their cash income, which is the source for purchasing durables such as CRVs. We note also that the CRV sales decrease was matched with decreased CRV prices. Thus, it is unclear whether falling farm prices were a major cause of CRV sales declines.

A more powerful explanation of falling CRV sales in 2000–02 seems to be government actions affecting CRV taxes, vehicle design, and usage. Indeed, a variety of governmental initiatives aimed directly and indirectly at modernizing the CRV industry and integrating it with the automotive industry were pursued in the late 1990s and into the new century. These strategies included:

- Significant reductions in air pollutant emissions
- Improvements in CRV quality and safety
- Simplification and consolidation of taxes and fees imposed on CRV companies and CRV users
- Encouraging the automotive industry to invest in or compete with CRVs

So far, the automotive has not made significant investments in CRVs, and the short term effect of the other initiatives was to discourage CRV sales.

<sup>29</sup> The document can be found on <http://www.sepa.gov.cn/650208304303177728/20030310/1037159.shtml>, accessed on April 7, 2003 (in Chinese).

<sup>30</sup> Juli's product introduction webpage, accessed on 7/11/03 (in Chinese).

<sup>31</sup> Smoke refers to visible PM, one of diesel vehicles emissions (in Chinese).

<sup>32</sup> W. Li, S. Wang, 'The effect of price change of agricultural products on income and expenditure of farmers in poor areas', J. of Statistics Reports, issue 2, 2002, available at <http://www.iaec.org.cn/2003zjlt.htm>, accessed on sep 14, 2003 (in Chinese).



Perceptions appear to have played an important role. Farmers and other rural business owners may not be highly knowledgeable about the details of government policies, but they readily observe indicators of shifting government priorities. For instance, in interviews with us, they reported the following changes (Sperling et al., 2004, App. A):

- More and larger CRV-related fees
- Increasing fines for CRV-related infractions
- Increasing risk of being caught by police for overloading CRVs or illegally entering urban areas
- Increasing difficulty and cost in dealing with police after being caught

We could not reliably document these perceptions, though they seemed to be widespread and critical in understanding the demand response to some policy changes discussed below.

One change, indicated earlier, was the imposition in 2000 of road fees based on the number of engine cylinders.<sup>27</sup> This means the road fee for 4-wheelers is more than that for trucks with similar technology specifications. This discouraged the sales of 4-w CRVs since they were now charged the same as much larger trucks with the same number of cylinders, and still could not enter urban areas.

Changes imposed on 3-w CRVs are even more instrumental. Not only are government rules on emissions and safety becoming more stringent (though enforcement is still uncertain), but more cities seem to be banning them from urban areas. While we do not have data on how many cities ban CRVs, the overall sense from interviews and media reports is that there is increasing concern about CRV safety and emissions.

CRVs remain economically attractive, but relatively less so. Considering fuel prices, insurance and other factors, the cost of operating CRVs is about one third to half that of cars with similar payload.<sup>19</sup> The road fee for CRVs is about \$8 per ton per month, but seems to be increasing. And the annual vehicle license fee is about \$250 less for CRVs than for conventional vehicles (roughly equal to a farmer's average income).<sup>33</sup>

In late 2001, the central government ordered local governments to strengthen enforcement of rules against overloading,<sup>27</sup> which apparently contributes to many accidents. CRV overloading was often reported on television to document 'effective' governmental work.

Increases in enforcement and use of bribes are especially difficult to document, though both activities apparently have been on the increase. Either way, poor farmers are greatly disadvantaged. Moreover, farmers, the principal market for CRVs, are strongly opposed to CRVs being treated as automobiles. They suffer higher costs and gain few benefits.

It appears that increasing government regulation and rule enforcement was the principal cause of declining sales.

## 9.2. Sales rebound in early 2003

The future of CRVs is uncertain. CRV production rebounded in early 2003. Production of 4-w CRVs increased by 123,609 and 3-wheelers by 538,336 units, representing increases of 31 and 7%, respectively, over year-earlier quarterly figures.<sup>34</sup> These production increases, presumably matched by sales increases, are all the more notable because CRV prices increased \$40 to \$60 in the first quarter of 2003 to absorb price increases for steel, rubber, and other inputs.<sup>34</sup> Chinese news analyses highlighted favorable changes in governmental attitudes towards the CRV industry as the cause of this market resurgence.

The central government made a number of changes that favored CRVs. A joint document of the Ministry of Finance and State Administration of Taxation of China, issued on June 1, 2002, states that 3-w CRVs will be treated as farm machinery. The full implications with respect to taxes, fees, and regulation are not known, but one highlighted outcome was to reduce the value-added tax (VAT) for 3-w CRVs from 17 to 13%.<sup>35</sup> It also reduced the income tax of CRV (and other farm machinery) makers.

Another short-term spur was an announcement in early 2003 by the Ministry of Public Security that CRV drivers would have to pass the same stringent tests and pay the same fees as car drivers, implying an additional cost of \$230 for a CRV driver license.<sup>36</sup> CRV sales jumped, presumably to avoid those and other more stringent and expensive rules that seemed inevitable.<sup>33</sup> But in May 2003, the Ministry of Public Security indicated at a meeting held by SETC that the driver license fees and rules would not increase after all for CRVs.<sup>37</sup>

Apparently, consideration of the financial burden and economic well being of farmers has become another factor, together with safety, environment, and energy use considerations, motivating governmental policies toward CRVs. However, as indicated above by the driver license flip-flop, the many layers of government in China are not always coordinated, especially on relatively narrow issues such as CRVs. It is clear, though, that CRVs are gaining increasing attention, and that they are increasingly

<sup>33</sup> Y. Zhang, 'A Nice 1st Quarter Start of CRV Market', <http://www.amic.agri.gov.cn/njsc/pages/infopage.asp?ino=393>, accessed on June 29, 2003 (in Chinese).

<sup>34</sup> Agricultural Equipment Network, 'Hot CRV Market in This First Quarter', <http://www.nongji-info.com/houtai/details.asp?code=0301andid=396>, accessed on June 29, 2003 (in Chinese).

<sup>35</sup> State Economic and Trade Commission, ordered another favorable policy—lowering the 13% by 40% ('3-w CRVs Regain the 13%', <http://www.aweb.com.cn/2002/7/12/2002712102525.htm>, accessed on June 29, 2003, (in Chinese)).

<sup>36</sup> 'New bill from the Ministry of Public Security', [http://auto.jsinfo.net/asp/fagui\\_more.asp?cjl=3826](http://auto.jsinfo.net/asp/fagui_more.asp?cjl=3826), accessed on June 29, 2003 (in Chinese)).

<sup>37</sup> 'Driver License Administration for CRVs Will Remain Unchanged', China Farm Machinery Safety News, <http://www.sdnj.gov.cn/data/2003/05/05046.htm>, accessed on June 29, 2003 (in Chinese).

appreciated for the important role they play in rural development. With China's huge rural population and its lagging rural development, it is likely that CRVs won't be ignored in the future.

## 10. Conclusions

Few developing countries have the capabilities to design and mass produce a functional vehicle at low cost without significant foreign assistance and public subsidy, yet this is precisely what happened in China. China's relative isolation from the 'modern' world may have provided indigenous industry with a crucial gestation period. But has it been enough? Will China's ascension into the WTO shatter China's CRV industry? Or, will the CRV industry soon become a strong exporter? What would it need to do to become a major CRV exporter?

What can be stated with certainty is that China's 900 million farmers are a huge untapped market. Farm income is low, about US\$285 in 2001, which is about 1/6 the per capita income of urban Chinese residents. In the rural areas, where 80% of the Chinese population lives, there are approximately 70 million non-motorized vehicles used for rural goods transport.<sup>38</sup> Their owners are the future buyers of CRVs. As farm income rises, some wealthy farmers will be able to afford light-duty trucks, but the potential market for CRVs is likely much larger.

For now, much uncertainty hovers over the CRV industry. Much of the uncertainty is rooted in government policy and strategy. Sales are being dampened by concerns over aggressive government restrictions and taxes on CRV use, and the prospects of increasingly stringent safety, emissions, and energy rules, all imposing higher costs. There is anxiety that perhaps the Chinese government wants to focus on advanced technologies to the detriment of CRVs.

On the positive side for CRVs are the huge potential domestic market and the prospect for exports. Domestic growth will be aimed at goods transport, but there are also untapped prospects for passenger transport. Particularly intriguing is the export market. There are many large developing countries with strong demand for low-cost rural vehicles, including Pakistan, Bangladesh, India, Malaysia, Brazil, and Mexico. As far as we know, only India produces vehicles in significant numbers for these rural markets.

For the CRV industry, increasing government intervention is a mixed blessing. On the one hand, more strict requirements for safety, emissions and quality will enhance those attributes. It will also accelerate the weeding out of under-capitalized companies with weak technical

capabilities. These companies will be better able to compete in the world market. On the down side, questions remain whether the industry will serve the low-cost rural markets as well, and whether competing governmental interests will create an even more uncertain and risky financial and market environment for CRV makers.

In any case, the future of the CRV industry plays an important role, not only in China but potentially worldwide. CRVs play a central role in Chinese rural development, and could play an equally positive role in other developing countries. But CRVs, as built today, are inefficient users of petroleum and large emitters of pollution and greenhouse gas emissions.

Until now, the automotive industry has largely ignored China's rural vehicles. Domestic and international automotive companies are rethinking that approach. Some are beginning to think that an automotive golden age could emerge in China if the government were to aggressively stimulate rural economic growth and encourage a consolidation of the CRV and auto industry. The result would be huge demand for simple, high-quality, and low cost vehicles that are somewhat upgraded versions of today's CRVs-analogous to the role played by Ford's Model T. Given the huge and somewhat dispersed rural population, this vision is not implausible. The demand for small inexpensive vehicles for goods and passenger transport is likely to skyrocket as incomes rise (Gan, 2003).

The future of the industry is largely in the hands of the Chinese government. Will the government clamp down on the negative attributes of CRVs with more stringent rules and more aggressive enforcement? Or will it create incentives for their proliferation? It is a question of how to balance rural development benefits with negative safety, energy, and environmental attributes, how to develop effective industrial policy, and what policies to adopt that mitigate the bad and enhance the good? The debate would be greatly helped by more research on costs and benefits, and the effectiveness of a variety of industrial policy strategies and policy instruments.

## Acknowledgements

We thank Hanming Huang, an analyst at Chinese Economic Information Network, and emeritus Professor Zheng Liu of Tsinghua University, for assistance in procuring data and information. Haifeng Yu translated for some interviews in China, Professor Scott Rozelle of UC Davis provided valuable early assistance, and Feng An, Dennis Scheutzle, and Michael Quanlu Wang provided helpful suggestions. Seed funding was provided by General Motors, Toyota, DaimlerChrysler, and the Energy Foundation.

<sup>38</sup> 'The Hope of the Chinese Auto Market', Jilin Scientific Information Network [http://218.27.89.158/kjck18.htm#\\_Toc522952518](http://218.27.89.158/kjck18.htm#_Toc522952518), accessed on June 19, 2003 (in Chinese).

## References

- Aunan, K., Berntsen, T.K., Seip, H.M., 2000. Surface ozone in China and its possible impact on agricultural crop yields. *Ambio* 29 (6).
- British Petroleum (BP), 2003. BP statistical review of world energy 2003-workbook. Available online at: <http://www.bp.com/centres/energy> (accessed on Oct 25, 2004).
- Chameides, W.L., Yu, H., Liu, S.C., Bergin, M., Zhou, X., Mearns, L., Wang, G., Kiang, C.S., Saylor, R.D., Luo, C., Huang, Y., Steiner, A., Giorgi, F., 1999. Case study of the effects of atmospheric aerosols and regional haze on agriculture: an opportunity to enhance crop yields in China through emission controls?. *PNAS* 96 (24).
- China Automotive Technology and Research Center, 2000. The 2000 Chinese Automotive Industry Yearbook. China Machine Press (in Chinese).
- Fisher-Vanden, K., 2003. Management structure and technology diffusion in Chinese state-owned enterprises. *Energy Policy*, 31.
- Gallagher, K.S., 2003. Foreign technology in China's automobile industry: implications for energy, economic development, and environment, China Environment Series. The Woodrow Wilson Center, Washington, DC. Issue 6.
- Gan, L., 2003. Globalization of the automobile industry in China: dynamics and barriers in greening of the road transportation. *Energy Policy* 31, 537–551.
- Harwit, E., 1995. China's Automobile Industry: Policies, Problems, and Prospects. M.E. Sharpe, Armonk, NY.
- Li, J., Lang, Z., Wu, Q., 1999. Current situation of the CRV industry and analysis of transformed tractors. *J. Tractors Rural Vehicles*. Issue 6 (in Chinese).
- Lu, Z., 1997. Development and prospect of rural vehicles. *J. Factory Construction Design*. Issue 2 (in Chinese).
- National Research Council and Chinese Academy of Engineering, 2003. Personal Cars and China. National Academies Press, Washington, DC (also available in Chinese from China Academy of Sciences).
- National Bureau of Statistics of China, 2003. China Statistical Yearbook. China Statistics Press, Beijing.
- Sperling, D., Lin, Z., Hamilton, P., 2004. Rural vehicles in China: an exploratory analysis of technology, economics, industrial organization, energy use, emissions, and policy. Institute of Transportation Studies, University of California, Davis, UCD-ITS-RR-04-1. <http://www.its.ucdavis.edu/publications/2004/UCD-ITS-RR-04-01.pdf>.
- Xunying, Y., 2001. Analysis and forecast of China's gasoline, kerosene and diesel fuel market. *Pet Petrochemical Today* 9 (11), 13–18 (in Chinese).
- Zhang, L., Zhu, K., 1997. An exploration in the development of rural vehicles. *J. Motor Vehicle Res. Dev.* 1997; Issue 2 (in Chinese).
- Zhang, Z., 1999. Rural Industrialization in China: From Backyard Furnaces to Township and Village Enterprises. *East Asia*, Autumn.