The True Cost of Coal

煤炭的真实成本

Mao Yushi Sheng Hong Yang Fuqiang

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Abstract

This report, The True Cost of Coal, examines the environmental and social impacts of coal from exploration, extraction, transportation and use. Methods such as the Human Capital Approach and Willingness to Pay are used in this report to comprehensively calculate the external costs of coal. When the environmental costs of coal are considered, along with the impact of price distortion caused by current regulations, the total external costs of coal reached RMB 1745 billion in 2007, equal to 7.1 per cent of China's GDP for the same year.

To address the serious impacts of coal, and taking into account the current situation of increasing prices and short supply of coal used in electricity production, the pricing system for coal in China should be reformed so that all the external costs of coal are properly reflected in the price. Any measure to internalize the external costs of coal would include expanding the reform of coal marketisation, improving the coal resources pricing system, imposing energy and environment taxes and improving liability rules.

This report suggests a roadmap to internalise the environmental costs of coal, internalise the cost of government regulations and also the true costs of any price distortion.

As coal is the primary energy source for China's economy, a general equilibrium model was used in this report. Quantified analysis was performed on the effect that coal price reform would have on the economy, consumer spending and international competitiveness, along with other key factors. The analysis found that, if the external costs of coal are internalized completely, the price would rise by 23.1 per cent. This would reduce GDP by 0.07 per cent, but the analysis also found that it would increase China's long-term international

competitiveness. Also, using 2007 data, social wealth would increase by 940 billion RMB (net).

The Government of China has the opportunity to make a real improvement to the environment by reforming the current coal pricing system. If all the external costs of coal are genuinely reflected in the coal price, this will provide a non-distorted price signal for the whole energy market.

Preface

Coal is currently the energy cornerstone of industrialization in China and plays a key role in the whole nation's economic development. China's coal resource is extensive, while reserves of petroleum and natural gas are relatively low. As a result, coal dominates China's energy infrastructure. Currently, coal accounts for more than 70 per cent of total energy consumed in China, which is far higher than the world average of 40 per cent. With its fast growing economy, China extracts and consumes more coal than any other nation, and has done for some time.

Behind China's large production and consumption of coal, however, lie expensive and worrying environmental and social costs. From extraction to combustion, every step in the process of using coal damages the environment. In particular, sulphur dioxide (SO_2), nitrogen dioxide (NO_x) and particulate matter (PM), produced in large amounts in the combustion process, are the main air pollutants in China. Carbon dioxide (CO_2) a greenhouse gas produced through coal combustion, is the main contributor to human-induced climate change.

To ensure energy security, environmental protection and the healthy development of the Chinese economy and society, it is important for China to reduce its reliance on coal. The introduction of an appropriate coal pricing mechanism is critical to achieving these aims.

Besides a lack of effective policies to reflect the true environmental and social costs of coal, there are a number of government regulations which currently distort the price of coal. Correcting the coal price is the process that internalizes part of the external costs and, in doing so, also provides incentives to reduce and/or remove them. The first challenge is to quantify the various external costs in order to provide a basis for changing the price system. As a result, in 2007, the *True Cost of Coal* investigation was initiated by Greenpeace, the Energy Foundation and WWF.

This research was carried out by a number of experts and scholars in different disciplines and institutions, including the Beijing Unirule Institute of Economics, the Energy Research Institute of National Development and Reform Commission, Renmin University of China, the Academy of Social Sciences of Shanxi, Peking University and the Chinese Center for Disease Control and Prevention. Its purpose was to integrate various domestic studies on internalizing the external costs of coal, to do quantified analysis using economics methodology and to give compelling and specific policy recommendations. We express our thanks for valuable suggestions from experts such as Wang Qingyi, Wang Jinnan, Jia Kang, Cao Yuanzheng, Ye Rongsi and Zhang Xinzu.

The *True Cost of Coal* is the first comprehensive piece of research on the external costs of coal in China. We hope it will be a valuable tool to ensure a broader debate and to ensure more policy makers and researchers are able to join in the discussion. We also hope it will ensure the future transformation of the current coal pricing system in China.

Owing to time constraints and the ambitious task we have taken on, it is possible that the report may have some shortcomings. In this case, we sincerely hope experts and readers alike will provide us with their feedback and thoughts as we move forward on this important issue.

September 2008

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Chapter One

The current status of coal use and coal market

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1.1 Current status of coal use

China is the largest producer and consumer of coal. Production last year grew by 8.2 per cent to 2,520 megatons and coal sales grew 7.9 per cent to 2,580 megatons. Coal accounts for 70 per cent of primary energy consumption in China, a proportion 42 per cent higher than the world average. China has 1000 billion tons of proven coal reserves. In 2006, 5.85 per cent of China's GDP was directly attributable to coal. The total added value of coal extraction and washing was RMB 358.7 billion, accounting for 1.7 per cent of GDP. The added value of electric power and heating sector accounts for 4.15 per cent of the GDP.

Just over half of the coal burned in China is used for power generation, with the steel, construction and chemical industries accounting for another 17, 16 and 5 per cent, respectively. The remainder is burnt in people's homes.

According to official figures, coal is responsible for 70 per cent of soot, 85 per cent of SO_2, 67 per cent of NO_X and 80 per cent of CO_2 emitted in the country. Under the Chinese Government's air quality criteria, over a third of Chinese cities have the air quality worse than Grade Ⅱ. And some 30 per cent of the land in China is affected by coal-related acid deposition. In addition, by 2007 China's coal industry had left behind 3.6 gigatons of gangue accounting for 40 per cent of solid waste in the country[1]. The total sink area of coal mines currently surpasses 70,000 hectares.

In 2005, there were 3,306 coal mine accidents in China resulting in 5,938 deaths. Official statistics show that the accidents and deaths mainly occurred in small and medium-sized coal mines.

1 2007–2008 China Coal Gangue Industrial Analysis and Investment Consulting Report.

Overall, the industry is responsible for more than five deaths for every megaton of coal extracted. One of the main reasons for this is that as many as 95 per cent of Chinese coal mines have relatively high gas intensities that pose a major threat to safe production. About half of major state-owned coal mines face serious gas problems.

1.2 Current status of coal market

In most cases the government agencies which approve coal trading and the transport companies that transport it by rail or sea make higher profits than the producers do.

Currently, coal is mainly bought and sold on:

I. The National Coal Trade Fair, organized by the National Development and Reform Commission, Ministry of Railways, Ministry of Transportation, National Bureau of Safe Coal Production Supervision and China National Coal Association to provide a unified trading market for coal producers, consumers and transporters.

II. Regional trading centers such as Taiyuan Coal Trading Center, South China Coal Trading Center and Qinghuangdao Coal Trading Center for Ocean Freight. These are large scale trading markets which registered national or regional players can participate in, including coal suppliers and consumers.

III. One-on-one trade between coal producers, consumers and traders, based on long-term consumers.

IV. Electronic trading platforms such as China Coal Trading Market Net, China Coal Mines and Coal Trading Net, China Coal Net and China Coal Resources Net.

Market share of coal trading platforms is shown in Figure 1.

Points III and IV can be long-term contracts and short-term spot price trading. However, prices in long-term contracts are ultimately determined

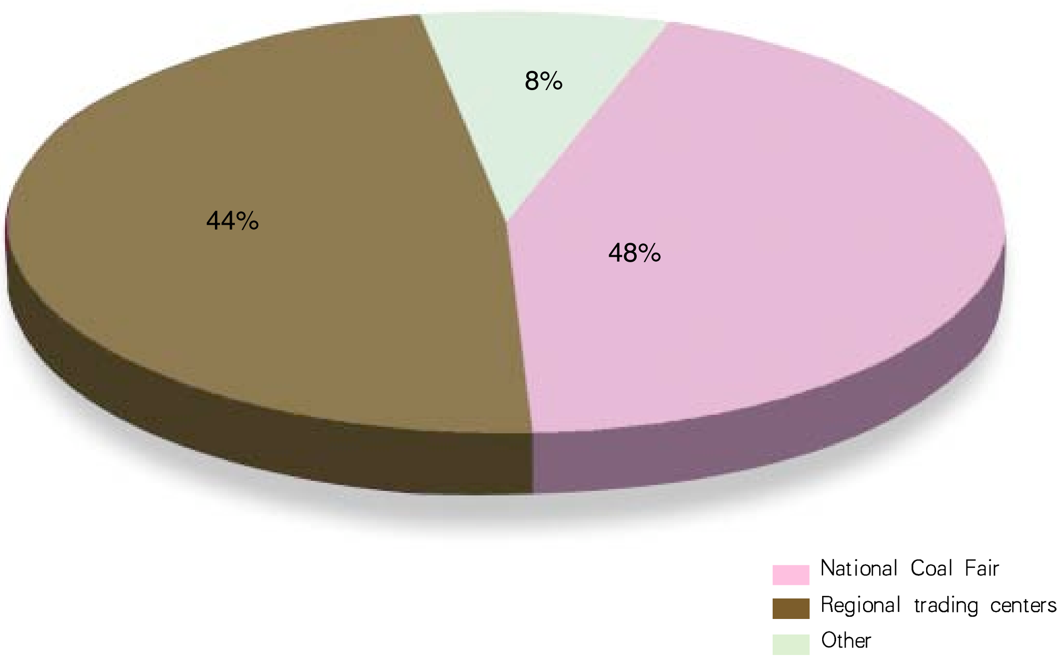

Figure 1: Market share of coal trading platforms

when trading happens, according to the market price at that time. Pithead coal prices are determined by the quality, production area and trading scale. End-use coal prices are determined by quality, selling area, distance from production site and trading scale. Coal transportation and trading is relatively transparent.

In sum, apart from the influence of alternative products and certain non-market factors in allocation and pricing, the coal price is generally determined by supply and demand in a reasonably competitive market. In the later part, we will discuss the distortion in the broader market.

Chapter Two

Environmental costs of coal

2

The environmental costs of coal are the damages resulting from coal extraction, processing, transportation and combustion. These include climate change, air pollution, water pollution as well as soil degradation. Even under complete property rights systems, free markets and efficient legal systems, these damages would not be avoided.

2.1 Environmental damage

The extraction, processing, transportation and combustion of coal produces wastewater, airborne pollution and solid residue resulting in damage to water systems as well as respiratory diseases in humans. Currently, none of these costs are fully incorporated into the pricing systems.

Environmental damages in coal extraction include water, air and noise pollution, as well as impacts on aquifer, water system and land. Wastewater from coal processing causes water pollution and damages ecosystems. The spread of coal dust, as well as other environmental problems occurs with coal transportation. Damages from coal combustion include air pollution resulted from dust, NO_X, SO_2, CO_2 and mercury. These pollutants would cause respiratory disease and seriously impact public health.

2.1.1 Air pollution

2.1.1.1 Air pollution is caused by the extraction, transportation and burning of coal

Extraction

Coal bed gas (mainly methane) is not only a major source of mine accidents but also a powerful greenhouse gas, with 21 times the effect of CO_2. According to the National Development and Reform Commission, the emissions of coal bed gas reached 15.33 billion cubic meters in 2005 in greenhouse gas terms equivalent to the emission of 220 million tons of CO_2.

Coal gangue is the solid wastes resulting from the extraction and washing of coal. The spontaneous combustion of gangue emits large amount of toxic and harmful gases such as SO_2, CO_2 and CO. According to statistics from State Coalmine Safety Supervision Bureau, there are 1500 spoil tips of coal gangue, with 389 long-term self-igniting ones[1], leading to serious pollution of the surrounding area and harm to the health of local residents, even resulting in deaths.

Storage and transportation

There are about 6000 coal storage sites in China, most without any anti-dust facilities. This not only leads to a loss of coal resources but also pollution. It is estimated that 10 million tons of coal dust are wasted each year for this reason.

When coal is transported from the mineral rich North and West to the populated South and East a great deal of dust is lost polluting the local environment along the way. In China, a loss of just 1 per cent of coal means that some 11 million tons of dust have been released into the air.

Combustion

Coal combustion is the single largest source of airborne pollution in China. The major pollutants include SO_2, CO, suspended particulates, ozone, NO_X and acid deposition. In China, coal combustion accounts for 75 per cent of total SO_2 emissions, 85 per cent of NO_2 emissions, 60 per cent of CO emissions and 70 per cent of total suspended particulate (TSP) emissions.

1 Zhang Qizi, Analysis of the Structural Change of Coal and Electric Power Industry in China, Economic News Reference, June 11, 2005.

2.1.1.2 Forms of air pollution

I. Sulphur dioxide (SO_2)

SO_2 is harmful to human health as it enters the respiratory system and causes respiratory diseases such as bronchitis. People with existing respiratory diseases, the elderly and children are particularly susceptible. SO_2 is a low intensity and long-term pollutant that also inflicts persistent damage to ecological systems.

II. Particulate matter

Particulate matter derived from coal combustion include soot, trace metals, carbon hydrogen matter and soot. Particulate matter with a diameter range equal to or smaller than 10 μm stick to the trachea inside the windpipe. Particles with a diameter less than 0.1 μm can spread freely and adhere to the mucosa of the respiratory tract. Up to 20 per cent of fine particulate matter with a diameter range of 0.1~0.5 μm can enter the lung alveoli themselves. These particles have lasting effects on the respiratory system and can eventually lead to bronchitis, pneumonia, lung cancer and faucitis. Trace emissions from coal combustion such as stibium, tin, barium, cadmium, aluminium, iron and calcium can combine with harmful gases such as SO_2, NO_2 and chlorine and be absorbed by the respiratory tract and lung, causing bronchitis and pneumoconiosis.

III. Carbon monoxide (CO)

CO combines with the haemoglobin in red blood cells more readily than oxygen, reducing the amount of oxygen that enters the blood through the lungs. Exposure to air with 0.1 per cent CO for just an hour can cause headache and sickness.

IV. Ozone (O_3)

Ozone damages the small airways of the lungs. Exposure to high ozone concentrations causes respiratory inflammation, decline of lung function, and an increase in bronchial responsiveness. Investigations show that adult lung function would decline after 4 to 6 hours of exposure to 160 μg/m^3 of ozone. Children are even more sensitive to ozone exposure. Exposure to level of 210~1070 μg/m^3 can cause asthma attacks. Ozone can also irritate the eyes, resulting in eyesight degeneration. Every increase of 25 μg/m^3 in ozone concentration leads to an increase of 5 per cent in hospitalisation rates.

Ozone also lowers the body's immunity to infection and can destroy the effectiveness of some metabolic enzymes, leading to haemolysis. Experiments demonstrate that ozone has a genotoxic effect such as cell mutution in microbes, insect and mammal cells.

V. Nitrogen oxides (NO_x)

The most nitrogen-oxygen compound we have in the atmosphere include NO and NO_2. Nitrogen dioxide is more toxic, and it may pass thru respiratorial bronchi and alveoli, lowering respiratorial function and may even cause pulmonary emphysema. Humans may experience severe respiratory problem if exposed to levels as low as 4700 μg/m^3 NO_2. The research indicates that NO_2 may induce cellular inflammatory response and cause damage to lung tissues. It can also oxygenate alveolar surfactant and damage ciliated epithelial cells on the bronchi and alevoli, causing pulmonary edema. As entered the blood, NO_2 will become NO_2^- or NO_3^-, which may binds to the hemoglobins and forms methemoglobin, causing deoxygenation of tissues. The immunity may be affected.

In addition, the synergy of NO_2 and O_3 may increase the resistance on the respiratory tract, lowering the immunity.

VI. Acid rain

Acid rain is formed from SO_x and NO_x combining with water and oxygen in the air. The SO_x and NO_x emitted from coal combustion enters into the atmosphere, forming vitriol and nitric acid in combination with other chemicals. These constituents can stay in the air for several days and move hundreds and thousands of kilometers before falling on the ground in the form of acid rain. Acid rain harms human health as it can enter the lungs and cause lung inflammation and edema. It can also cause a decline in immunity and an increase in pharyngitis and asthma among children, and a rise in eye and respiratory disease among the elderly. Acid rain also harms natural ecosystems causing a change in the character and structure of soil, damaging water ecosystems and eroding buildings.

2.1.2 Damage to the water system

2.1.2.1 Coal extraction

The extraction of coal from the ground results in a drying up of ground water and a lowering of the water table. Large amounts of water are pumped from coal mines, damaging the equilibrium of water systems and causing water shortages in villages and towns relying on wells and ground water. This results in degradation of vegetation and worsens the land erosion of the coal mine area.

Of the 96 major state-owned coal mines, 71 per cent face water shortages and 40 per cent have a serious shortage of water. The damage to water resources is particularly serious in the major coal production areas of Shanxi, Shaanxi and the western part of Inner Mongolia, leading to irreversible losses. With further exploitation of coal, the water shortage problem will become even more severe.

Washing one ton of coal generally uses 4 to 5 cubic meters of water. Some 40 million cubic meters of water are used to wash coal every year[1]. The wastewater from coal washing contains a large amount of slime, mud, sediment and harmful heavy metals[2] . Coal mine waste water also contains higher levels of salt and sulfate than the standard for irrigation. However, farmers still use the water to irrigate, leading to hardening of the land and damaging agricultural ecology. Wastewater from the coal industry accounts for 25 per cent of total wastewater in China. Some 2.2 billion cubic meters of wastewater are pumped out each year of which less than 40 per cent is actually used for washing .

2.1.2.2 Water damage from coal transportation

Water used to suppress dust in open coal storage sites, extinguish self-igniting fires in coal piles and to wash adhesive tapes is often released into rivers and lakes without treatment, causing serious pollution. Rainwater that has flowed through coal piles containing large amount of coal powder or through spontaneously combusted coal piles also becomes polluted and often acidified.

2.1.3 Soil pollution

The extraction, processing and combustion of coal produces a large amount of solid waste, such as coal gangue and fly ash. Coal gangue is one of the largest sources of solid waste in China, occupying a large area of land for a long period of time. It also leads to air and water pollution and destroying large amounts of arable land. The weight of coal gangue produced each year is equivalent to 10 per cent of coal extracted. In 2006, there were 1,600 coal gangue heaps in China containing a total of 4.2 billion tons of gangue, occupying 260,000 Mu of land – increasing by 70 million tons and 3,000 Mu of land[3] each year.

2.1.4 Ecological degradation

Large-scale coal mining causes land subsidence and landslides. It is estimated that extraction of one ton of coal leads to an average of 0.2 hectares of land subsidence[4]. Up to December 3, 2006, 700,000 hectares of land subsidence had been caused by coal mines, creating RMB 50 billion worth of damage. Land subsidence damages human-made structures, roads, railways, bridges and electric power transmission lines in coal mining areas. In densely populated areas, subsidence forces residents to relocate. Generally speaking, about 2,000 people need to be relocated to produce 10 million tons of coal[5].

Subsidence also leads to landslides, seriously damaging the land resources and ecology of the mining area. The wastewater and residue from coal mining and washing pollutes large areas of soil, vegetation and water, damages biodiversity and reduces the number of wild animals and plants. Producing 100 million tons of coal leads to soil

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1 Zhang Qizi, Analysis of the Structural Change of Coal and Electric Power Industry in China, Economic News Reference, June 11, 2005.

2 Liu Caiying, Theory and Practice of Cost and Price of Coal for Sustainable Development, Collection Of Thesis from 2004 High Level Forum.

3 Zhao Xiaoping, Promote Restructuring of Energy Mix Through Energy Conservation and Emission Reduction, Finance World, Issue 3.

4 Li Shuzhi, Recultivation Technology of Land Destroyed by Coal Exploitation, Resources Industry, July 2000.

5 Liu Caiying, The Theory and Practice of Price and Cost of Coal for Sustainable Development, Collection of Thesis at 2004 High Level Forum.

erosion across 245 square kilometers of land.

The spontaneous combustion of coal gangue produces large amount of soot and poisonous gases such as SO_2,NO_X,CO_2 and CO seriously pollutes the air in the surrounding area and destroys ecosystems by causing trees, grasses and vegetation to wither and even die.

The ecosystems of 60 per cent of coal mine areas in China are threatened. Coal extraction destroys ground water and waterbed systems and reduces waterbed levels, resulting in serious water shortages and affecting agricultural production. In Shanxi Province, RMB100 billion is needed to restore the ecosystem and eliminate potential dangers to safety.

2.1.5 Heavy metals (mercury)

The average content of mercury in Chinese coal is 0.038~0.32mg/kg. In the 1990s, the emissions of mercury from coal combustion were about 302.9 tons, of which 213.8 tons was from fly ash and 89.07 tons from residue. Mercury causes serious pollution to soil. Each year, 12 million tons of food supplies are polluted by heavy metals such as mercury, at a cost of RMB 20 billion.

Methyl mercury can enter the blood stream directly after entering human body through food. When the mercury content of blood reaches 20~60 μg/100ml, the nerve system will begin to show symptoms of toxicosis. Eating food with a mercury content of 5~6mg/kg for just half a month will lead to poisoning. Eating food with a mercury content of 0.2~0.3mg/kg will bring on poisoning in half a year.

Mercury can accumulate in the kidney and liver and enter brain tissue. Methyl mercury is able to spread easily and enter many cells in the body. The main symptoms of slow mercury poisoning

include: lassitude, dizziness, insomnia, numbness, tooth root and pain in the extremities. It can further develop into movement disorder, loss of speech, deafness, blurred eyesight, reduced cognitive function and even death.

2.1.6 External costs of climate change

The release of CO_2 from coal compustion also contributes to climate change. According to China's *National Assessment Report on Climate Change* and the *Fourth Assessment Report on Climate Change* by the Intergovernmental Panel on Climate Change (IPCC), the major impacts of climate change on China includes the following:

Agriculture

1. Reduction of agricultural yield by up to 5 to 10 per cent by 2030, and reduction in the quality and nutritional value of agriculture products.

2. Expansion of the area of land affected by pests, together with a longer lifespan requiring farmers to invest more in nitrogenous fertilizer, which will in turn further harm the soil and the environment.

3. Worsening conflict between demand and supply of water used for agriculture.

4. Reduced precipitation causing more frequent and intensified drought and desertification, leading to loss of organic matter and fertility of soil.

Water resources

1. Less water stored in glaciers and snow, reducing runoff from rivers in areas with one sixth of the world's population.

2. Increased rate of flooding from rivers in areas with 20 per cent of the world population.

3. Sea level rise and saltification of underground water and river mouth water, reducing fresh water supply in coastal areas.

4. Rise in water temperature and the intensity of precipitation, increasing water pollution.

5. Fresh water systems affected, causing serious water shortages in some areas.

6. Serious impact on China's strategy for the sustainable use of water resources as the basis for sustainable econonic development.

Extreme Weather

Frequency and increased intensity of extreme weather caused by climate change will increase significantly. Extreme weather events such as storms, droughts, typhoons, and flash floods will exact heavy damages in terms of human and economic losses.

Incidences of extreme weather in recent years have damaged around 50 million hectares of agricultural land every year and led to an average annual loss of about 43 million tons of crops. Every year about 400 million people in China are affected by extreme weather, with average annual losses totaling about RMB 200 billion.

Health

1. Extreme weather events such as drought, flooding, cold spells and heat waves will increase death and injury rates.

2. The incidence of some infectious diseases will increase.

3. Reduced yields from crops will increase famine and malnutrition and affect the growth of children.

Ecosystems

1. Increase desertification.

2. Increase rate of forest fire.

3. Loss of permafrost, glacier retreat and shrinking of lakes in the Tibetan plateau.

4. Reduction of resources and biodiversity in the wetland in the Three-River-Plain, Heilongjiang province. Reduction in the area and quality of wetland in Yangtze Rive delta. Shrinking of inland lakes.

Beach systems

1. Rise in sea water temperature causing coral to bleach and die.

2. Rise in sea level, adversely affecting areas of salt marsh and mangrove.

3. Stronger tropical storms and sea level rise will erode beaches even more severely.

Two pieces of published research, the Stern Review and Garnaut Climate Change Review have attempted to provide an understanding of the economics of climate change. The Stern Review, published by the UK Government in October 2006, concluded that unabated climate change could cost the world between 5 and 20 per cent of GDP each year, while the cost of reducing emissions could be limited to around 1 per cent of global GDP. The Garnaut Climate Change Review predicted that climate change would wipe off around 4.8 per cent of Australia's projected GDP, around 5.4 per cent of projected household consumption and 7.8 per cent from real wages by 2100.

As there is very limited research on the economics of climate change in China, it is very difficult to estimate climate change impacts associated with coal use. This report does not therefore take into account the economic costs of climate change.

Table 2.1 Estimation of external environmental costs (2005)			
	Pollution and loss		External cost (RMB/ ton)
Environmental costs of coal mining	Airborne pollution of coal extraction and spontaneous combustion of gas and coal gangue	Loss of public health and welfare (extraction)	6.1
		Loss of agriculture production (extraction)	1.0
	Loss due to water shortage, wastewater and mine drainage		3.7
	Coal gangue storage and treatment		4.9
	Pollution to soil, rivers and lakes		1.1
	Loss of non-renewable resources		22.1
	Loss from water shortage due to water leakage in extraction		0.2
	Land erosion		8.5
	Loss to forest and biodiversity		5.4
	Damage to vegetation and decrease of water preservation by coal extraction		9.8
	Loss of wetland ecology		1.0
	Loss from land subsidence (land resource loss, agricultural loss, building loss and relocation compensation)		4.67
	Loss in buildings		0.8
	Loss in transport infrastructure		0.2
	Sub total		69.47
	Health		44.8
	Agriculture		25.7
	Industry, transportation, materials and infrastructure		2.7
	Shortened life and damage to buildings		4.1
	Water quality		12.7
	Pollution of heavy metal to soil		1.2
	Solid waste of coal burning and electricity generation		0.5
	Subtotal		91.7
Total			161.17

2.2 Calculations of external environmental costs

The following methods are used to estimate external costs in this report:

Human capital approach. This method is generally used to estimate the impact on human health caused by environmental pollution. It utilizes loss of income to evaluate the cost of premature retirement and death caused by pollution. According to the Marginal Productivity Theory, the value of shortened lifespan or reduced working hours is equal to his or her labor value. One's labor value is the present value of his or her future income, taking into account age, sex, education level etc.

Willingness to pay. This method measures the utility variations brought about by benefit, for example better air, water etc. by investigating the maximum monetary amount that an individual would pay to obtain it.

Travel cost method. This method is based on the expense incurred in travelling to a site of environmental value, amalgamating the number of journeys made and their value into the total value of the site to the public. This method is widely used in estimating the value of biodiversity and other biological resources.

The external environmental costs in Table 2.1 come mainly from direct external losses. The costs of investment to avoid harmful emissions has a more direct impact on market price. Due to the lack of data for emission reduction costs, the following calculation was used to estimate these costs.

As the costs of preventative measures for reducing environmental impact rise, the costs associated with damaging the environment drop. The optimal prevention and compensation cost sit at the intersection of the two.

As it is quite difficult to calculate the marginal prevention cost and marginal private loss, the prevention cost has been estimated as being a half of the direct external loss in Table 2.2, which indicates the impact of prevention on the price of coal.

2.3 Preliminary estimate of external environmental costs

In condusion, the external costs of coal affect the price about 5.96 per cent.

Table 2.2 External environmental costs

Item	Direct external cost(RMB/ton)	Prevention cost (RMB/ton)	Deviation direction	Cost deviation (per cent)	Price deviation (per cent)
Environmental cost of coal mining	69.47	34.74	Low	7.7	2.57
Environmental cost of coal burning	91.7	45.85	Low	10.17	3.59
In total	161.17	80.59	Low	17.87	5.96

Chapter Three

Distortion costs from government regulations

3

The 'distorted costs of coal' refers to the costs resulting from weaknesses in the market. This includes the fact that resource prices are not determined by the market alone, that property rights are not defined clearly and that there are failures of the current legal system. All these cause a distortion in the coal price.

3.1 The impact of coal-electricity tariff automatic mechanism

From 2002 to 2006, power generation in China accounted for, on average, 48 per cent of coal consumption. In 2007, power generation accounted for 53 per cent of coal consumption.See Table 3.1.

3.1.1 Coal-linkage electricity pricing mechanism

In China, the coal price is determined by the market while the price of electricity is controlled by the state. Under the mechanism that links the two, if the price of coal rises 5 per cent or more in one six month period, electricity price is adjusted accordingly, with the electricity companies bearing 30 per cent of the cost above a 5 per cent rise. The remaining 70 per cent is reflected in the electricity price. If the coal price rises less than 5 per cent, the change is calculated in the next period or when the total change reaches or surpasses 5 per cent.

Table 3.1 Coal consumption (10,000 tons) and shares in different sectors

Year	2000	2001	2002	2003	2004	2005	2006	2007
Total production	134796	142811	155093	174129	195212	215000	238000	252300
Total consumption	127002	132202	145699	163742	186310	205635	220900	258000
Electric power	59193	64561	73284	85092	98692	108700	116500	130630
Iron and steal	16004	16582	18231	21362	25500	32900	35000	42349
Construction materials	25370	25794	27000	29048	32310	35304	36800	40495
Chemical	8020	8740	9700	9875	10808	11731	13400	13362
Total of four sectors	108587	115677	128215	145377	167310	188635	201700	226836
Others	18415	16525	17484	18365	19000	17000	16500	16000
Electric power (per cent)	43.91	45.21	47.25	48.87	50.56	51.28	52.74	52.99
Iron and steal (per cent)	11.87	11.61	11.75	12.27	13.06	15.52	15.84	17.18
Construction materials (per cent)	18.82	18.06	17.41	16.68	16.55	16.66	16.66	16.43
Chemical (per cent)	5.95	6.12	6.25	5.67	5.54	5.53	6.076	5.42
Share of the four sectors (per cent)	80.56	81.00	82.67	83.49	85.71	88.99	91.31	92.02
Growth rate of demand (per cent)	3.08	6.53	10.83	13.38	15.09	12.74	6.92	12.46

Source: figures from 2001 to 2005 and 2007 are taken from Zhaoshang Securities Reports, while figures for 2006 are from 2007 Mid Year Analysis on the Situation of Coal by Geng Zhicheng.

In a truly competitive market, producers cannot shift all the rising costs to downstream consumers due to demand elasticity. There is no study of the effect of price elasticity on electricity demand in China, but according to a research in the U.S., the price elasticity of electricity demand is -2.5 to 0 for households and -4.74 to 0 for commercial users (C. Dahl,1993). The current mechanism is more relaxed than a market-based system. Electricity producers bear 30 per cent of the rising cost of coal (and 100 per cent if the rise is less than 5 per cent). Taking into account the reduction in coal consumption for power generation due to advancing technology, the impact of the rise in coal price on electricity companies is minimal.

However, coal-electricity tariff automatic mechanism has inherent defects. In essence, the government still decides the price, though market fluctuation and costs are taken into consideration. When the government does not implement the mechanism, due to other non-market factors, the price distortion becomes significant. In 2006 and 2007, for example, the government did not implement the mechanism even though the coal price rose more than 5 per cent, in order to keep the price of end-use electricity stable. This makes the mechanism effectively nominal.

3.1.2 The impact of electricity price control on coal price

Price control of electricity affects coal price in the following two ways:

1. The coal market is a relatively competitive market while the main downstream demand for it is a monopolistic market controlled by five big power groups. The downstream monopoly therefore has the power to keep the price of coal for electricity generation low.

2. Government control of the electricity price directly results in rising electricity demand and declining supply leading to power shortages.

As coal for power generation accounts for over 50 per cent of the total coal demand, the growth of demand for coal in general will also be reduced due to decreasing power demand. Other conditions being unchanged, the growth of the coal price in the market will decline in the end. However, with coal demand rising rapidly for other uses, the declining trend of coal price will be offset. The coal price for the whole market will then rise.

This is why the growth rate of the coal price for electricity generation never exceeds the average growth rate of the overall coal price since it was opened to the market in 2002. The price of coal for power generation compared with the average coal price is also declining, and has been 10 per cent less than the average coal price in previous years. As coal for electricity accounts for 48 per cent of the total coal consumption, it can be estimated that the average price of coal is undervalued by 4.8 per cent. See Figure 3.1.

3.2 Impact of government controls on coal price

Although the market basically determines the coal price, government controls affect it indirectly. Such controls include regulating and managing the entry of coal mining enterprises into the market, encouragement and restrictions on coal imports and exports, strategies and planning of coal enterprises and major corporations, as well as controlling the legal environment for coal enterprises and environmental protection policies.

3.2.1 Control on start-up of coal mining enterprises and its impact on coal price

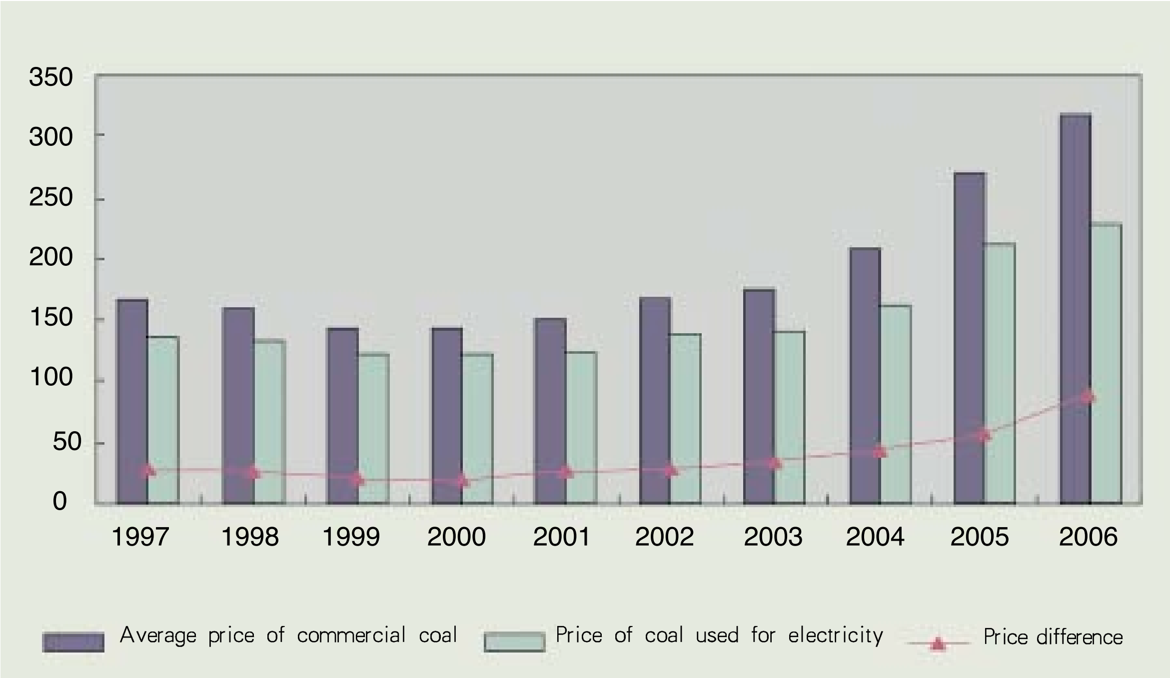

Figure 3.1 Price of coal for electricity generation and commercial coal

Laws and regulations relating to the start-up of coal mining enterprises include the *Safe Production Law, the Law of Coal* and the *Law of Mineral Resources* etc..

In practice, coal mining enterprises have to apply for six certificates from different government agencies. The certificates include Operation Certificate of Industry and Commerce, Certificate of Safety Qualification of the Head of the Mine, Certificate of Mining Permission, Certificate of Qualification of Head of the Mine, Certificate of Safe Production Permission and Certificate of Permission on Coal Mining. Request on Six Certificate has raised barrier to market entry for coal mining industry. This adds to the costs of entry for coal mining enterprises, reduces the number of enterprises entering the industry. This results in a reduction in supply compared to what it might otherwise be and therefore a rise in coal price. There are also cases of owners of mining enterprises bribing officials to pass inspection.

The ratio of mines with all the six certificates is quite low. For example, of the 194 mines in Zhangjiakou in Hebei Province, only 31 (16 per cent) have all the six certificates. Of the 87 coal mines in Weixian County, Hebei Province, only 6 mines (7 per cent) have all the six certificates. Of the 31 mines in Jinyuan district of Taiyuan city, Shanxi Province, only two (6 per cent) have all the six certificates.

3.2.2 Coal mine safety supervision and its impact on safe production and coal price

The cost of workforce injuries in coal mining is the most important of the many social problems caused by the coal industry in China. Compared with industry in general, the problem of miner's injuries is widespread and shows up in the following ways.

After many years of mining, mines extend in depth and operating surface with workers needing in excess of two hours descent to get to the workplace. When this is added to the actual operating time, miners work for more than 12 hours everyday. The labor is also intensive (average labor intensity level 3 - heavy physical labor) for all types of work at the mine face. Miners thus work underground intensively for a long time with dust and noise, which causes over-fatigue and brings an early loss in working capacity. The result is reduced employment time and shortened lifespan.

The high rate of special injuries, disabilities, diseases and deaths is high. The unique production conditions and working environment make the special injuries rate much higher than for industry in general. Taking Shanxi as an example, from the 1st of October 1996 to the end of 2003, about 42,986 people suffered grade 1 to grade 10 injuries in coal mining companies. For every million tons of coal produced, 18 workers suffered disablities.

Of these, 9,690 workers (23 per cent) had grade 1 to grade 4 disabilities, including 2,907 people who must live with carers. Another 13,759 workers (32 per cent) had grade 5 to grade 6 disabilities and 19,538 workers (45 per cent) had grade 7 to grade 10 disabilities. During the same period a further 17,290 workers died.

As shown in Table 3.2, between 2000 and 2006 there were 18,516 accidents and 31,064 deaths in Chinese coal mines. This counted for 27 per cent of all industrial accidents and 40 per cent of all industrial deaths over the period.

In 2005, with just 37 per cent of global coal output, China had 80 per cent of global coal mine fatalities. The death rate per million tons of coal is 70 times higher in China than in the USA, 17 times higher than in South Africa, 10 times higher than in Poland and seven times higher than in Russia and India. In addition, 300,000 people suffer from coal mine pneumoconiosis, acounting for about 50 per cent of Chinese pneumoconiosis patients. On average, nearly 5,000 new pneumoconiosis cases are reported in national coal mines every year, and 2,500 people are killed by the disease each year.

After being injured, coal miners not only have to deal with the expenses for medical and nursing care but also with a drop in income as a result of less or no work. Part of the income loss is dealt with by other miners and their relatives and by the coal companies themselves, but part of the lost of income is dealt with by society.

Using the human capital approach to estimate economical loss caused by over fatigue and special injuries, the loss of income to Datong Coal Mine Group in Shanxi Province is RMB 427.554 million (per year). This is broken down as follows: loss caused industrial injury and disability is RMB 163.088 million; loss caused by industrial deaths is RMB 6.0915 million; loss caused by industrial disease is RMB 57.322 million. It is estimated that the average cost of industrial injuries is RMB 145,300 per miner in China.

Table 3.2 Death rate for each million ton of coal produced since 2000 in China

Year	2000	2001	2002	2003	2004	2005	2006
Death rate	6.096	5.07	4.64	4.17	3.1	2.836	2.041

Source: State Administration of Work Safety.

China has adequate laws and regulations relating to the prevention and handling of accidents in coalmines. There is however difficulty in implementing them.

Firstly, there is no responsible body to implement the laws. For example, in the document *Safety Law of Mines and its Implementation Rules*, safety education and training is well stressed and rules governing working hours are stipulated. However, it relies on the mine management to implement it.

Secondly, though there are provisions on responsibility, the government supervision system is ineffective. The system of 'central government supervises, local government monitors and enterprises hold responsibility' is applied, which in practice means the party actually involved in the safe coal production is also the last check.

As a result, ineffective supervision is found in almost every major coalmine accident. And as a result of weak supervision, coalmine enterprises tend to cut investment in safety measures in order to reduce their production cost. It is reported that major state-owned enterprises fell short by RMB 68.9 billion in their investment in safety measures[1] in 2005.

According to the 2004 Regulations on *Cost of Safety Management in the Production of Coal,* different types of coal mines collect a safe production fee from RMB 2 to RMB 10 per ton according to their production scale and conditions. In 2004, Shanxi Province raised the safe production fee for major enterprises from RMB 10 to RMB 15 per ton of coal. In reality, most enterprises collect higher fees of up to RMB 35 per ton. These fees are not normally used effectively due to weak supervision.Safe production fee standards of listed coal companies in China is shown in Table 3.3.

In the U.S. and Germany safe production costs account for 25 to 30 per cent[2] of the total cost of coal production, equivalent to 17.5 to 21 per cent of coal prices in the period 2000-2006, with an average of 19.25 per cent. In China, however,

1 Debt of Safety Investment is Over 50 Billion RMB,New Beijing Daily, January 18, 2005. Major Coal Mining Companies Owe 68.9 Billion RMB of Safety Investment, Shanghai Securities, February 27, 2006.

2 Yang Shiyong, Zhu Xueyi, Benefits and Harms of Over Collecting Safe Production Fee from Listed Coal Mining Companies, Coal Economy Research, 3rd Issue, 2007.

safety costs account for only 3.5 per cent of the price of coal. Coalmining companies in China therefore invest 15.75 per cent less of their coal price in safety than countries with mature market systems. Based on a demand and supply price elasticity index of 0.33, it can therefore be inferred that China's coal price is under-valued by about 5.25 per cent.

3.3 Distortion of the factor prices

3.3.1 Undervaluation of land

The cost of land in China is mainly reflected in its rental value. The rent paid for agricultural land is between RMB 200 to RMB 700 per Mu per year. Land close to the city can reach RMB 1,500 per Mu per year. Considering that land rent will keep rising with urbanization, RMB 600 can be taken as the baseline for agricultural purpose and the lower limit for rent for mines.

Market reforms are already moving beyond the Land Administration Law governing compensation for land acquisition. In Foshan, Guangdong

Table 3.3 Safe production fee standards of listed coal companies in China (RMB/ton)

Company	2004	2005	2006
Xishan Coal Mine	15	15	15
Shenhuo	5	5	5
Jingniu	8	8	15
Zhengzhou Coal	6	15	30
Lanhuo Kechuang	15	15	15
Yanzhou Coal Corporation	8	8	8
Guoyang New Energy	15	35	35
Panjiang Gufen	15	25	25
Shanghai Energy	5~8	5~8	5~8
Hengyuan Coal Power	5	≈ 10（4% of sales）	≈ 10（4% of sales）
Kailuan Holdings	5	15	15
Yitai B Share	5	5	5
Luan Huaneng	15	30	30
Jingyuan Coal Power	8	8	8
Pingmei Tianan	8	30	30
Datong Coal Industry	15	15	15
Meiqihua	15	15	15
Average	10.25	15.6	17

Province, for example, compensation for acquisition of arable land reached RMB 75,000 per Mu, which is close to the market price for land.

Using Foshan's land acquisition price of RMB 75,000 per Mu as a baseline, and building in a 2 per cent discount rate, the rent for the land over 20 years is RMB 1,500 per Mu per annum.

In reality, most coal mines in China were built before 1987. There are few new large or medium sized coal mines. Therefore, most coal mines in China do not pay for land use, or pay very little. Land cost is not accounted for in the costs of most coal mining companies' financial reports[1].

Based on findings from the *Report on Destruction and Restoration of Mine Environment*, medium and large sized mining companies occupy a total of 754,061.2 hectares of land nationwide, with coal mining companies accounting for 67.3 per cent of that. Coalmining companies therefore occupy 507,483.2 hectares of land (7,612,247.8 Mu).

Assuming that rent on this would be RMB 1,500 per Mu per annum, we can conclude that RMB 11.42 billion each year is not accounted for in the production costs of state-owned coal mining companies.

In 2005, major state-owned coal mining companies produced 1.02 gigatons of coal. If these land rental costs were counted, state-owned coalmining companies would therefore incur an extra cost of RMB 11.2 per ton of coal. As state-owned mining companies account for 18 per cent of total coal production, the under-valuation of their land costs affect coal price.

As a result, it can be concluded that the undervaluation of land used leads to a 2.5 per cent lowering of the cost of coal production. According to price elasticity of demand and supply, the price is overvalued by 0.8 per cent.

3.3.2 Undervaluation of coal resources

The owners of coal resources are normally entitled to royalties. In China, royalties have not been collected for a long time as mines are owned by the country and mined by state-owned companies. However, as market reform becomes deeper and land ownership starts to become an issue when extracting resources, the interests of coal mining corporations may not be compatible with those of the country.

The government has started to build a system to collect royalties from companies extracting resources. It is, however, chaotic and of limited effect for historic reasons. The fees collected at the moment are lower than they should be for the value of the resources extracted.

The fees include a resource tax, resource compensation fee, resource exploration right fee, mine extraction right fees and bidding on rights of exploration and extraction of coalmines. As estimated in Table 3.4, the total fees collected are between RMB 6 and RMB 10 per ton.

The coal resource exhaust value is RMB 62.64 per ton in 2002; taking into consideration of current measures, coal resource exhaust value is RMB 54.64 per ton, resulting in an underestimation of 19.65% in costs and of 6.55% in price.

3.4 Social burdens of coal mining

1 The Problems and Solutions of the Formation of Cost of Coal, the Macroeconomics Research, Issue 3, 2007; Qian Pingfan, Research on Optimizing Framework of Cost Calculation of State Owned Coal Mining Companies,China Coal, Issue 9, 2004; etc..

Table 3.4 Amount and means of levying coal resources taxes and fees		
Type of tax or fee	Sum	Means of levy
Resource tax	RMB 2~4 / ton	Based on quantity
Compensation fee of coal resource	1 per cent of the sale	Based on sale
Fee on mine exploration rights	No high than RMB 500/ km^2	Based on area of the mine
Fee on mine extraction rights	RMB1,000 /km^2	Based on area
Prices on fee on mine exploration rights and extraction rights	RMB 2~4/ ton	Based on reservation
Total	RMB 6～10/ ton, equivalent to 1.3%～2.2% of coal price in 2005	

Sources: Temporary Regulations on Resources Taxes of PRC., Law; Mineral Resources and Regulations on Mine Exploitation Rights, other materials from the internet.

enterprises and their impact on the price of coal

Currently, large state-owned coal mining companies still have to shoulder the cost of operating hospitals, schools, canteens and even tax bureaus, police stations and finance bureaus.

According to a report released by the National Reform and Development Commission in August 2006, the former national level state-owned coal mining enterprises still pay RMB 10 billion a year for their social functions, with "most enterprises slow in separating their social functions from business"[1].

With the annual production of major state-owned coal enterprises at one billion tons (2005), it is possible to calculate the average social burden to be RMB 10 for each ton of coal produced by state-owned companies, with major state-owned enterprises such as Datong Coal Group, Yanshuo Coal Group, Jiaozuo Coal Group, Luan Coal Group and Jinmei Coal Group paying RMB 14 per ton of coal for these social roles.

Most coal mining enterprises still need to pay for employees' housing, health care and educational services, but if efficiency could be improved and costs cut by separating some services from the enterprises themselves, coal mining companies would be able to halve of the cost (RMB 7 per ton). Therefore, based on 2005 figures, state-owned coal mining enterprises bear an extra RMB 7 per ton of social burden. This means that the overall cost of coal is overvalued by 1.55 per cent. According to price elasticity of demand and supply, the price is overvalued by 0.5 per cent.

3.5 The impact of China's judicial compensation system on coal price

3.5.1 Minimal use of judicial system in accident compensation

Several laws and regulations such as the *State Indemnity Law*, the *Civil Procedure Law* and the *General Principles of Civil Law* relate to compen-

1 NDRC, Analysis on coal industry trend in first half year of 2006, Xinhua News, 30th August 2006.

sation for the death and injury of coal workers in accidents in China. The injured workers are entitled to health care compensation and a compensation fee for psychological damage. The families of deceased workers are also entitled to a compensation. Generally speaking, compensation fees for death are higher than for injury, excluding health care compensation.

Theoretically, compensation fees for death should be the amount of future income at a discount rate. Suppose the average age of workers dying in coal mine accidents is 35, retirement age is 60 and monthly salary is RMB 3,000, then the future income with a 2 per cent discount rate will be RMB 716,901.

However, several provinces set the compensation for death in coal mining accidents at RMB 200,000 regardless of age. Based on a death rate of 2.041 persons per megaton of coal in 2006, RMB 2.5 billion less than the correct compensation was paid, leading to an undervaluation of RMB 1.05 per ton of coal.

Court cases are practically absent in cases of death and injury of coal miners. There are a few cases of compensation being paid to the families of miners who died in coal mining accidents at less than RMB 200,000. For example, in 2007, the Subordinate Court of Bolin District of Taiyuan city and the Court of Taiyuan city ruled that the family of one miner who died in a private coal mine should get just RMB 95,000 in compensation[1].

3.5.2 The external environmental costs on the surroundings of coal mines that can be compensated directly

Coal extraction damages water resources, causes subsidence, pollution and ecological damage in the surrounding area. Damage to local residents and businesses can be negotiated or solved through judicial process. The direct compensation payments, as part of the external costs of coal, are different from the costs of preventative or restorative measures to avoid environmental damage. If the compensation payments are larger than the prevention costs, the mining company will have an incentive to strengthen preventative measures. In reality, defects in the judicial compensation process in China mean that it is hard for the aggrieved party to get full compensation. As a result, the damagers will have no incentive to invest in prevention (or restoration). There is also no incentive for prevention when the government collects a deposit for mine environment restoration, as the process is not effectively internalized.

With regard to environmental accidents, laws such as the *Environmental Protection Law,* the *Law of Solid Wastes Pollution Prevention* and the *Law of Waster Pollution Prevention* are involved. Based on these laws, lawsuits can be filed against coal mining companies for damaging the environment. However very few are ever filed. The suits that do enter judicial procedure are those in which the accused violates a criminal law and is prosecuted by the state.

The handling of coal pollution accidents is typical of the status of environmental cases in China. Of the few cases of environmental civil action, only one has been successful– the Environment Torts Suit of 111 villagers of Group 4 of Renan Village of Liangping Qixing Town against Renan Villiagers' Committee and three coal mining companies. Although environmental accidents are one of the major sources of disputes in coalmining, the aggrieved party rarely considers seeking legal assistance. There is also no open record of civil suits of coal environmental accidents handled by the courts.

The true environmental cost of coal mining, as with the true cost of safe production, is therefore overlooked. The production cost of coal is undervalued as the coal mining companies do not bear the true cost of environmental accidents.

3.6 Preliminary estimate of cost and price distortion of government control on coal

Due to the complexity of the economic system, it is impossible to predict all changes in the cost and pricing of coal. The purpose here is to analyze factors affecting coal prices in a static situation, i.e. other factors being unchanged, the extent of the above distortions of the coal price.

The following Table 3.5 sums up the price distortion factors caused by institutional defects.

1 How Much Does the Life of a Miner Cost?, Shanxi Market News, June 21, 2007. http://www.daynews.com.cn/scdb/wb/237673.html.

Major factors that distort the coal price can be corrected gradually by market forces if the relevant property, administrative and judicial systems are optimized.

A conservative conclusion would therefore be that coal price is undervalued by 17.73 per cent in China due to the cost and price distortion of government control over coal production.

Table 3.5 Quantitative Price Distortion Resulting from Government Control on Coal Price

Price Distortion	External cost (RMB/ ton)	Cost deviation (per cent)	Price deviation (per cent)
Electricity price influence on coal price	65	15.27	5.09
Lack of safety investment	71.03	15.75	5.25
Under-compensation for deceased miners	14.53	1.61	0.54
Low cost of land	11.2	2.5	0.8
Low price of coal resources	54.64	19.65	6.55
High social burden of coal enterprises	-7	-1.55	-0.5
Total	209.4	53.23	17.73

Chapter Four

Cost of coal transportation and its external costs

4

4.1 The impact of transportation on the price of coal

4.1.1 The importance of transportation costs in coal pricing

The main coal resources in China are concentrated in the west and the north, especially in the provinces of Shanxi, Shaanxi and Inner Mongolia. Demand for coal is heaviest in the coastal developed areas in the east and south. The long standing transportation framework has thus catered for moving coal from the west to the east and from north to south.

Table 4.1 shows the price of coal as it is transported from Datong, Shanxi to Shanghai and Guangzhou through Qinhuangdao. The overall non-coal cost (transportation fee, tax, revenue, etc.) make up 55 to 60 per cent of the coal price for the end users. Some 1.382 billion tons of coal were transported by railway in 2006, which constituted 58 per cent of national coal production. These transportation costs, especially the railway transportation costs, play a decisive role in the overall coal pricing system.

4.1.2 Railway transportation

The Chinese railway is a government-owned monopoly. There are no market rules, which lead to problems such as excessive pricing. The transportation capacity of Chinese railways is insufficient to satisfy the need of the entire coal industry, so the shortage of supply further increases the high cost of rail transport.

As the transportation fee is decided by the railway bureau rather than the market, it is often the money given to rent-seeking railway officials which increases the price rather than other costs. The ever increasing cost of railway transportation, however,also contain many lawful, though unreasonable, factors.

The Railway Construction Fund constitutes the largest part. This is the government fund for railway construction. Since its imposition in March 1991, the fund has mainly been used for medium to large-scale construction projects. According to national regulations, the charge levied for the Railway Construction Fund is RMB 0.33 per ton-kilometer of coal transportation. Railway transportation has always been a massive constraint for the coal industry. With increasingly insufficient transportation capacity, the costs are continually increasing. It is estimated by the China Coal Association that RMB 170 billion was paid to the railway construction fund by coal companies from 1995 to 2006, and RMB 22 billion in the single year 2006, the equivalent to 33 per cent of the total profits of national coal enterprises in that year. Coal mining companies

Table 4.1 Price comparison along the coal chain (RMB/ton)

High quality steam coal	Datong (pit head price)	Qinhuangdao (exit price)	Shanghai (delivery price)	Guangzhou (delivery price)
Sep., 2006	250~255	420~440	505~515	515~525
Nov., 2007	265	480~500	580~590	610~620

Sources: Office of the National Energy Leading Group (www.chinaenergy.gov.cn) and China Western Coal News (http://cn.cwestc.com).

on average pay RMB 7 towards the railway construction fund.

Besides inappropriate transportation fees, the slowness of railway development also seriously limits the normal usage of coal. The expansion and transformation of current lines by the Railway Department has relieved the shortage of railway transportation capacity to some degree, but it is still insufficient. Besides the coal supply scarcity as a result of coal price control, the backward railway transportation system was another important factor behind power shortages in the summer of 2008.

4.2 External environmental costs of coal transportation

4.2.1 The external costs of road transportation

The external costs of railway and waterway transportation mainly come from environmental factors such as noise, waste gas and coal dust.

There are two categories of external costs associated with road transportation. The external environmental costs of road transportation include the spreading of coal dust, vehicle emission and congestion caused by the rising numbers of trucks. Costs and price distortion of government control comes mainly from damage to roads and accidents resulting from overloading.

4.2.2 The comparison of external environmental costs of road, railway and waterways

4.2.2.1 External costs of noise and emissions

Based on data from the *External Costs of Transportation* by the China Academy of Railway Sciences in 2002, see Table 4.2, the following figures were calculated according to the various forms of transport.

The total external costs of transport (noise, emissions and so on) are about RMB 34.05 per ton, or RMB 17.02 per ton for the cost of prevention, which is equivalent to a price level in 2002 of 6.12 per cent. According to the elasticity of demand and supply flexibility, the price of transportation is under-valuated by 2.04 per cent.

4.2.2.2 The external cost of spreading coal dust

One special external environmental cost associated with coal transportation is the spreading of coal dust. Coal dust spread in the process of transportation can harm human health when inhaled, damage buildings and incur external cleaning costs.

Water and land transportation together usually account for a loss of 3 to 5 per cent, which is the normal rate of loss for these transport modes. Road transportation of coal is likely to incur larger

Table 4.2 External costs of coal transportation by different means of transportation in China, 2002

	Railway	Road	Waterway
Freight(RMB/millions)	32,248	3,300	7,009
External costs(RMB/ton)	2.08	2.1	4.5

losses. It is estimated that coal dust loss along the road each year can reach 60 million tons.

However, due to the lack of research, it is hard to estimate the exact cost of coal dust spreading.

4.3 The non-environmental external costs of coal transportation

These costs are referring to external costs resulted from weakness in the regulation system. These include damages caused by overloading.

4.3.1 Damage to roads by overloading

The external costs of damage to roads by overloading are not effectively internalized, even if the owner of the truck is fined for overloading. The fine is not necessarily spent on fixing the road in

question nor would it fully cover the damage to the road.

Experiments show that an overloaded vehicle with two times more coal than the set limit will cause 16 times more damage to the road than a properly loaded truck. But if the truck is overloaded by three times the agreed weight, it will cause 80 times more damage to the road. The more the truck is overloaded, the more damage it causes.

The life-span of a road designed to last for 15 years is reduced by 90 per cent to just 1 year of use, if all trucks are overloaded with twice their weight limit. According to the *Ministry of Transportation Highways Division*, China pays RMB 30 billion annually to repair damages on roads and bridges caused by overloading[1].

According to Statistics on *Transportation in China*, 13,418 million tons of coal were transported in 2005. The cost of repair per ton of coal is therefore RMB 2.24.

4.3.2 Traffic accidents caused by overloading

Overloading puts pressure on the systems of a truck, leading to frequent and serious traffic accidents.

Based on data from *External Costs of Transportation System*, the external costs of highway traffic accidents is about RMB 0.0021 per ton-kilometer. With effective management to reduce loads, external costs can be reduced to RMB 0.00105. According to official statistics, more than half (55 per cent) of traffic accidents involving trucks are attributable to overloading.

1 Speech at National TV Conference of Handling Overloading Vehicles by transportation minister Zhang Chunxian, May 2004.

Table 4.3 Average transportation price before and after banning overloading areas (RMB/ton-km)				
	Jiangsu Province (2003)	Hubei Province (2004)	Shanxi Province (2003)	Tianjin (2004)
Before banning overloading	0.3	0.25	0.2	0.22
After banning overloading	0.52	0.45	0.53	0.45

The external cost of traffic accidents is therefore about RMB 0.0012 per ton-kilometer.

The average external cost of traffic accidents is RMB 0.95 per ton for the length of the 790 kilometer highway from Taiyuan to Qinhuangdao. The average external cost of traffic accidents on the 630 kilometers highway from Datong to Qinhuangdao is RMB 0.76 per ton.

4.3.3 Another way to calculate external cost of overloading

The cost of transportation is less if trucks are overloaded. However, as the government has taken measures to avoid overloading, the incremental transportation price has become the internalized external cost of overloading. See Table 4.3.

We can see from the data above that the price difference before and after the ban was between RMB 0.2 and RMB 0.3 per ton. This can therefore been seen as the external cost of overloading. Taking RMB 0.25 per ton-kilometer as an average, it can be calculated that the external cost of overloading in coal transportation is about RMB 16.25 per ton. Based on the 2005 price, transportation is 3.6 per cent and therefore under valued by 1.2 per cent.

4.4 Preliminary estimate of external costs of transportation

In conclusion, the external costs of coal transportation is in Table 4.4.

Table 4.4 External costs of coal transportation			
Distortion	External cost (RMB/ton)	Cost deviation (per cent)	Price deviation (per cent)
Environmental costs of coal transportation (noise, emissions etc.)	34.05	6.12	2.04
External costs of overloading	16.25	3.6	1.2
Railway Construction Fund	-7	-2.52	-0.84
Total	43.30	7.20	2.4

Chapter Five

Analysis of current measures to internalize external costs

5

5.1 Analysis of measures to internalize external costs

5.1.1 Internalizing external environmental costs by levying taxes and fees

5.1.1.1 Currently, the main environmental compensation fees in China include:

1.Pollution fees

From July 1st 2005, a fine of RMB 0.6 per pollution unit of SO_2 released was levied on emitters.From July 1st, 2004, a charge of RMB 0.6 per pollution unit of NO_x was also levied. From July 1st, 2004, if there are no special facilities to contain fly ash, coal gangue and tailings, or the facilities do not meet environmental protection standards (with no anti-leaking and anti-dusting equipments), a solid wastes pollution fee is levied. The rate is RMB 30 per ton for fly ash, RMB 5 per ton for coal gangue and RMB 15 per ton for tailings. A fee RMB 0.7 per unit of pollutant was imposed on mine wastewater.Pollutants emissions fee rate is shown in Table 5.1.

2. Land erosion compensation fees

Current compensation fees are as follows:

I. A compensation of RMB 0.2 to 0.4 per square meter is charged for land erosion, based on occupation area and the damaged area of land.

II. A fine of RMB 0.3 to 0.5 per square meter is levied for damage to land and vegetation caused by mining and other industrial activities (if the mining company does not restore the landscape itself). A fee of RMB 2 to 5 per square meter is levied for disposal of solid waste. The fee can also be calculated at RMB 0.5 to 0.8 per ton of waste.

3. Shanxi forest fund

According to *Regulations on Levying Forest Fund* (No. 35 Regulation of 1995 Shanxi Province), a forest fund tax is levied by local tax bureaus. The tax rate is: RMB 0.05 per ton of coal for national level stateowned mines; RMB 0.1/ton of coal for local state-owned mines, collectively owned mines, private mines and mines of other ownership.

In 2006, the Province also started collecting RMB 0.15 per ton of coal for reforestation specifically around the coal mining areas in 2006.

4. Fund for mine environment restoration

By 2008, 21 provinces in China had started col-

Table 5.1 Pollutants emissions fee rate

Pollutant	RMB / unit of pollution	Unit of pollution equivalent (kg)
SO_2	0.6	0.95
NO_x	0.6	0.95
Soot	0.6	2.18

The volume of pollution equivalent = emission volume (kg)/pollution equivalent of the pollutant.
The pollution equivalent of SO_2 and NO_x is 0.95kg, and the pollution equivalent of soot is 2.18kg.

lecting funds for mine environment restoration. In Shanxi Province, the required contribution is RMB 10 per ton of coal.

5. Sustainable coal development fund

As of April 2007, Shanxi Province introduced a sustainable coal development fund, with RMB 5~15 per ton for steam coal, RMB 10~20 per ton for non-smoke coal and RMB 15~20 per ton for coke.

5.1.2 A analysis of effectiveness of collecting environmental taxes and fees

I. The coverage of taxes and fees is not comprehensive. The pollution charges and other administrative fees mainly target medium and large sized companies and are not effective for some township enterprises and small mines.

II. The rate of taxes and fees is comparatively low. The rates are not based on the value of natural resources and the losses associated with their exploitation. The low rates provide little incentive for enterprises to protect the environment. To be effective, a pollution emission charge should not be lower than the prevention cost of emissions. Before 2003, however, pollution emission fees were just 50 per cent of the cost of pollution control and treatment and some were even lower than 10 per cent of the cost of pollution treatment.

III. Fee collection is not well managed and lacks effective supervision.

IV. Comprehensive compensation fees need to be optimized. Funds for environment restoration of mine areas and sustainable development funds have the function of providing comprehensive compensation. However, the system is not fully implemented and the amounts levied are relatively low.

5.1.3 Internalizing external environmental costs through emissions allowances trading

On November 14, 2007, the first emissions allowances trading center in China opened in Jiaxing City, Zhejiang Province.

Under the procedures, companies request emission allowances. The exchange center reviews the request. After the buyer receives an environmental impact assessment from the environmental bureau, the exchange center signs a *Major Pollutants Emissions Trading Contract* with the buyer and collects payment. The environmental protection bureau then issues a *Pollutant Emissions Trading Certificate*.

An emitter may submit a selling request to sell a part of its emissions allowance. The emissions credit exchange center will review the request and, after confirming the credits, sign a Contract of Selling Emissions Allowances of Main Pollutants and pay the seller. Enterprises must trade allowances through the exchange center. The current trading price of SO_2 is RMB 20,000 per ton.

The major obstacles to the development of pollution emissions allowances trading:

I. A lack of legal basis

So far, there is no law on the legal status of emissions allowances in China. The *Law of Environmental Protection* (1989), *Law of Air Pollution Prevention* (revised in 1995) and *Law of Water Pollution Prevention* (revised in 1996) have clear provisions about registration of emissions, but that is only one part of emissions allowances trading.

Lack of legal basis makes it hard to use the mechanism fully.

II. Determining the total emission volume

The prerequisite for setting up emissions allowances trading is to control the total emissions volume. First and foremost, we need to calculate accurately and scientifically the largest volume permitted in a certain emissions controlling areas. However, local authorities have not given up their economic development plans, resulting in serious conflicts between economic development and pollution control. Setting total emissions volume becomes a difficult task. In some areas, the agreed levels of emissions volumes are broken frequently, weakening the whole emissions allowances trading system.

III. Forming a market-based price for emissions allowances

The price of emissions allowances cannot reflect the real market price due to the absence of a trading system and insufficient information. The current trading of emissions allowances is conducted with the help of State Environmental Protection Bureau, local environmental protection bureaus and local governments. The trading price is lower than the average cost of pollution control and treatment. The original allowances, after being allocated, become scarce resources. The market is controlled by the supply side, leading to inadequate supply.

IV. Inability to monitor emissions effectively

An accurate and continuous emissions monitoring system is the guarantee of successful implementation of emissions trading. An environmental monitoring network has been set up in China but the equipment and technology are insufficient. The polluting enterprises self-report and administrative agencies select and check at random. Continual monitoring of emissions is rare, making it hard to master the real emissions situation. Among the smoke monitoring system of thermal power plants, most are certified by environmental protection associations. Among 75 thermal power plants, only 3 have their smoke monitoring system inspected by qualified agencies[1].

V. Difficulty in allocating emission allowances

How to allocate emissions allowances to enterprises fairly is a subject of heated debate. For example, some allocations between new and old enterprises are not fair. Meanwhile, rent seeking might occur between enterprises emitting pollutants and environmental protection agencies allocating emissions allowances. These practices will reduce the incentives for enterprises to cut their emissions.

5.1.4 Impact of internalizing the external environmental costs on coal price

5.1.4.1 Impact of internalizing external environmental costs of coal extraction. See Table 5.2 and Table 5.3.

5.1.4.2 Impact of internalizing external environmental costs of coal use on coal price

The current external environmental costs of coal combustion are mainly compensated by pollution emissions fee. Only SO_2 is targeted through an emissions fee. The rate is about RMB 12.6 per ton of coal. See Table 5.4.

5.1.4.3 Impact of current measures to inter-

1 Zhang Ke, 200 Million RMB Wasted, 80% of Smoke Monitoring Systems of Thermal Power Plants Do not Function, First Finance Daily, August 8, 2005.

Table 5.2 Comparison of external costs and current compensation level in coal mining (2005)				
Phase	External environmental cost (RMB/ton)	Estimated prevention cost (RMB/ton)	Current compensation and prevention cost (RMB/ton)	Remaining external cost (RMB/ton)
Mining	69.47	34.74	Land erosion compensation fee 0.7(0.5~0.8)* Forest fund 0.2 Deposit of mines environment restoration fee 10 Coal sustainable development fund 17(14~20)*	6.84
Subtotal	69.47	34.74	27.9	6.84

* Note: Average of compensation or prevention fee

Table 5.3 Impact of external environmental costs of mining on coal price (2005)			
Item	Remaining external cost (RMB/ton)	Cost deviation (per cent)	Price deviation (per cent)
Environmental cost of mining	6.84	1.53	0.51

Table 5.4 The impact of current internalization of external costs of coal use on coal price				
External environmental costs (RMB/ton)	Current tax (RMB/ton)	Remaining external cost (RMB/ton)	Cost deviation (per cent)	Price deviation (per cent)
91.7	SO_2 emission fee 12.6	79.1	7.37	2.46

nalize external environmental costs on coal price

The external environmental costs include intergenerational costs and environmental costs. There are no current measures to internalize intergenerational cost in China. Measures have been taken to internalize external environmental costs such as levying pollutant emission fees. However, the fees are substantially undervalued compared to the true costs. Although a SO_2 emission tax is levied, a CO_2 tax is not yet imposed.

In general, the measures for internalizing external costs are far from adequate to compensate for the damage cause and reduce emissions. See Table 5.5 for details.

5.2 Internalizing external costs and price distortion from government control

5.2.1 Property rights

The current system for pricing property rights is

Table 5.5 External environmental costs on price after partial internalization of external costs				
Item	Remaining external cost (RMB/ ton)	Deviation direction	Cost deviation (per cent)	Price deviation (per cent)
External environmental costs of mining	6.84	Low	1.53	0.51
External environmental costs in combustion	79.1	Low	7.37	2.46
External transportation costs	43.3	Low	7.21	2.4
Total	129.24	Low	16.11	5.37

SO_2 environmental taxes in other countries

SO_2 environmental tax

Czech Republic: imposes tax on automotive fuel and other energy products. The tax rate is 0.1 euro / ton SO_2.

Denmark: imposes tax on mineral fuel with more than 0.05% sulfur. At the same time, it imposes a tax on power stations that possess with an electricity production capacity of more than 1000kW and also use biological waste containing sulfur as fuel. The tax rate is 200DKK/ kg sulfur. Sulfur tax has been exempted for fuels used in power stations since 1996.

Italy: the tax was adjusted according to the following rule from 1998 to 2005: From 46 euro/ ton to 129 euro/ton for oil with high sulfur content and from 23 euro/ton to 62 euro/ton for oil with low sulfur content.

Lithuania: imposes tax for all air pollutants, including SO_2.

Norway: has imposed tax on SO_2 since 1970. The products covered include mineral oil (diesel oil, fuel oil), light oil and heavy oil. The tax rate is calculated according to sulfur content for fuel containing more than 0.25% sulfur.

Sweden: imposes tax on coal, fuel oil, aero oil and peat. The tax rate is 3.45 euro/ kg SO_2 for coal, coke, oil and peat 1.38 euro/kg SO_2 for aero oil. Oil with less than 0.1% sulfur can be exempted from tax and allowance is given if desulphurization methods are used.

NO_x environmental tax abroad

Estonia: imposes NO_x pollutant discharge tax and the tax rate is 0.1 euro/ton.

Lithuania: imposed environment pollution tax for all air pollutants (including NO_x) in 1999.

Norway: imposes tax for domestic aero fuel, combustion furnace and gas turbine.

Poland: imposes discharge tax for sulfide and oxynitride (calculated in NO_x) and the tax rate is 80 euro/ton. The tax is paid directly from enterprises' profit so that the company cannot transfer the cost to consumers.

Slovakia: imposes tax on pollutants including NO_x.

Sweden: imposes NO_x tax on boilers, gas turbines and fossil fuel power plants that generate more than 25GW·h every year. The tax rate is 4.6 euro/kg and the tax is calculated according to the total energy produced and the energy producing efficiency.

Energy Tax

a. Austria: imposed tax on natural gas and electricity in 1996 and the tax rate is 0.0436 euro/m^3 and 0.007 euro/(kW • h). The tax revenue was used in energy saving, environment protection and public transportation all over the country. The tax on electricity was increased to 0.015 euro/ (kW • h) in 2000. The revenue was mainly used in energy saving and environment protection. In 2000, 66 million euro was used in energy saving and environment protection, 14.1 million euro was used in local public transportation. The county also imposed energy tax on mineral oil. There are some exemption policies in energy tax.

b. Belgium: the rate is calculated based on the tax rate for heating oil. These are: 550 Belgium franc/1000L for gasoline and kerosene; 340 Belgium franc/1000L for heating oil; 520 Belgium franc/ 1000L for paraffin; 690-700 Belgium franc/1000L for liquefied gas; 0.01367 Belgium franc/ 1000L for natural gas; and 55 Belgium franc/ 1000L for electricity (low voltage imported electricity).

c. Denmark: the tax rate is 47 DKK/GJ. The most frequent used fuel tax rates are: 3.808 DKK/L for unleaded gasoline; 2.286~2.565DKK/L for diesel oil/ kerosene; 1.79 DKK/L for heating oil; 1.60 DKK/m^3 for natural gas; 47DKK/GJ for coal; 0.536 DKK/ (kW • h) for electricity and 0.471 DKK/(kW • h)for heating electricity.

d. France: the main energy tax is on oil, automotive fuel and other energy products.

e. Germany: imposed energy tax on all electricity, natural gas and petroleum users in 1999. Tax can be exempted for CHP with the efficiency of more than 70%. The tax rate for automobiles using natural gas will be reduced before 2009.

f. Netherlands: energy tax is mainly imposed on natural gas, electricity and mineral oil used by household and small companies. Tax is collected from users with an annual natural gas consumption of more than 1 million m^3 or an annual electricity use of more than 10 kW • h. Tax is exempted for power stations that utilize natural gas as fuel.

g. Rumania: has imposed a 10% energy tax on electricity since 1994. The country imposes 2% energy tax for heat energy. The tax revenue is used as a special fund for the development of energy system.

h. Czech: imposes tax on automotive fuel and other energy products and the tax rate is 23.3 euro/ ton.

i. Belgium: imposes tax on all energy products including automotive fuel.

j. Norway: imposes 0.00036 euro for each kW•h to compensate the loss in electricity transmission and distribution. On the other hand, the tax income is also used in information projects and network construction.

k. Norway: has imposed tax on mineral oil, natural gas and petroleum in production in since 1991. The country has started to impose tax on coal and coke since 1992. In the same year, tax was also collected for automotive fuel and the tax rate is 0.099 euro/L for petroleum and 0.049 euro/L for kerosene.

l. Denmark: increased the energy tax rate by 0.006DKK/ (kW • h) as electricity saving fund.

m. Netherlands: the expenditure of the environment projects originates from tax. The tax rate cannot exceed 2% of energy fees and the total fiscal budget is about 250 million florins.

Carbon tax abroad

Denmark: imposes a carbon tax on fuel (including automotive oil), natural gas, coal and electricity. The tax rate is 13.5 euro/ton CO_2. Other taxes and allowances could offset this tax.

Finland: imposes a carbon tax on coal, natural gas, peat, heavy oil and light oil (excluding automotive oil) at a rate of 3.7 euro/ ton CO_2. No tax exempt policy.

Georgia: the tax rate is 0.05 Laaree/ ton CO_2.

Italy: imposed energy product carbon tax policy in 2004.

Netherlands: imposes fuel tax on mineral oil, coal and natural gas. The tax rate is calculated based on the carbon content and calorific value. A similar tax policy is imposed on uranium.

Poland: imposes tax on automobile fuel and other energy products. The tax rate is 0.035 euro / ton CO_2.

Slovenia: has imposed a carbon tax since 1996.

Sweden: imposes tax on fuel (including gasoline and kerosene), coal, coke, natural gas, liquefied gas and domestic aero fuel. The tax rate is 0.037 euro/ kg CO_2.

United Kingdom: has imposed a climate change tax on energy use apart from domestic consumption except for residential use (industry, commerce, agriculture and public sector) since Apr.1st, 2001. The proposal is to improve energy efficiency to meet the emissions reduction target for the United Kingdom in the Kyoto Protocol. The tax rate is the same as that declared on Nov. 2nd, 1992. Tax is calculated according to the calorific value. It is about 0.07 penny/ (kW·h) for liquefied gas, 0.15 penny/(kW·h) for natural gas and coal, 0.43 penny/ (kW·h) for electricity.

inadequate. The external cost is therefore the market price of the property right minus the current fee.

5.2.1.1 Property rights of coal resources

Two systems still coexist in relation to the property rights of coal mines. The property rights of only 20,000 out of the 150,000 coal mines are actually obtained through the market[1]. The rights of most coal mines are gained free or cheaply. Reforms are being carried out to correct this.

In November 18, 2002, after 34 rounds of bidding, Xinjiang Guanghui Corporation Ltd. won a 20 year mining right to the Haishan coal mine of Kexun County of Xingjiang for RMB 49 million. This was the first case of bidding for coal extraction rights in China.

In April 2006, the State Council approved the experiment of a sustainable development policy for the coal industry in Shanxi Province. The policy stipulates that the Central and Shanxi Provincial Government enjoy a 20 per cent and 80 per cent share of income from property rights respectively.

In November 2006, the Implementation Plan of Deepening Reform Experiment of Resource Tax System by the Ministry of Finance, Ministry of Land and Resources and National Development and Reform Commission was ratified by the State Council. The experiment started in eight major coal production provinces and autonomous regions such as Shaanxi, Inner Mongolia, Henan and Shanxi.

With a few exceptions, all the exploration and mining rights for new coal mines now have to be gained on the market though bidding and auction.

1 Liu Wei, The Absence of Cost of Coal Resources and Compensation Policies, China Economic Information Net, August 22, 2007.

Enterprises that obtained coal exploration rights and mining rights from governments free of charge must appraise the remaining value and pay it to the government. If the enterprise cannot pay the full amount immediately, it can get approval from the administrative department for part payment within the effective timeframe of the rights.

So far, property rights reform has focused on smaller coal mines. It has not touched the more sensitive large state-owned coal mines. Moreover, the bidding market is not well developed. For historical reasons, the property rights of medium and small-sized coal mines are very complicated. Some are invested by governments of cities, counties or towns; others are invested by villages and joint ventures of villages and towns; a few are even invested by individuals. The property rights of small and medium sized coal mines are transferred frequently among investors, further complicating their status.

5.2.1.2 Property rights of land

As the land is undervalued, the opportunity cost of coal enterprises occupying land cannot be fully compensated. Currently, a land recultivation fee is used to internalize this part of the external costs. Land recultivation means enterprises and individuals have the responsibility to conduct land recultivation. When they are unable to do it themselves, they are required to pay land recultivation fees to the government, which uses the fee to recultivate the land. See Table 5.6.

Though a special fund for recultivation of land has been set up by the government, it is rarely effective. Late payment of the fee is common. Land recultivation has improved from 2 per cent before the implementation of the Regulation on Land Recultivation to 12 per cent at present. However, land destroyed by coal mining is increasing by 700,000 Mu annually, 60 per cent of which is good arable land.

5.2.1.3. Environmental property rights

I. Water resource compensation fee

The fee for water resources varies from place to place. In Shanxi Province, water resources compensation fees are levied at RMB 2 per ton for coal extraction, RMB 3 per ton for coal washing and RMB 4 per ton for coke production. Local tax bureaus collect the fees.

II. Pollution emissions fee for coal gangue

Regulations on Levy of Pollution Emissions Fees and Standard and Methods of Calculation of Pollution Emission Fees came into force in 2003. If there are no special facilities to contain fly ash, coal gangue and tailings, or the facilities do not meet environmental protection standards (with

Table 5.6 Land recultivation fee

Province	Name	Rate
Jiangsu	Deposit of land recultivation	1000~3000 RMB/Mu
Shanghai	Land recultivation fund	5000 RMB/Mu
Henan	Fee for land recultivation	2000~2500 RMB/Mu
Shanxi	Fee for land recultivation	10~20 RMB/m^2
Liaoning	Fee for land recultivation	10 RMB/m^2

no anti-leaking and anti-dusting facilities), a solid wastes pollution fee will be levied. The rate is RMB 5 per ton for coal gangue. Generally speaking, one ton of coal produces 0.2 ton of coal gangue. The fee for coal gangue is therefore equivalent to RMB 1 per ton of coal.

5.2.2 Defects in the judicial system

5.2.2.1 Internalizing through government taxes and fees

Shanxi Province stipulates that RMB 5 per ton of coal is collected for work transformation. The money is used to support enterprises moving out of the coal industry, workers seeking new jobs, technical training and social welfare. The fee is collected monthly, owned by the enterprises, supervised by the government and deposited in a special account.

5.2.2.2 Direct compensation to the aggrieved party by the damager

I. Compensation for house relocation in subsidence area

When coal mining activity results in land subsidence, damage to houses and the drying up of wells, local residents may need relocation. The general principle is that the damager pays for relocation. Coal mining enterprises responsible for the problem need to pay a compensation fee for damaging the land and the associated infrastructure as well as a relocation fee to local residents. However, the compensation standard for relocation of local residents affected by subsidence is quite low. With rising costs of construction materials and labor, rural residents are often unable to build new houses without extra subsidies from the government.

II. Compensation for damaged roads

Overloading when transporting coal by road is quite common, causing serious damage to roads. Considering the external costs resulting from coal transportation, local governments usually ask local coal enterprises to bear the partial cost of renovating or building new roads. In this way, the external costs from coal transportation by road is internalized in the cost of coal enterprises.

5.2.2.3 Internalizing external costs through administrative measures

I. Safe production supervision system

The State Administration of Coal Mine Safety and its subordinate agencies are now independent supervisors with no economic or institutional links with the coal mines they are supervising.

In June 2003, the *Regulation on Coal Mine Safety Supervisors* and the *Regulation on Administrative Reconsideration of Coal Mine Safety Supervision* came into force. In July, the *Regulation on Administrative Penalty of Coal Mine Safety Supervision* came into force. In November, *Guidelines of Appraising Coal Mine Safety* came into force.

In November 2003, the State Council's Safe Production Supervision Commission was set up to strengthen the leadership of safe production.

II.Control of overloading in coal transportation

Transportation, public security and road administration agencies are in charge of monitoring overloading during coal transportation. The Road Administration Agency is responsible for levying a compensation fee for overloading. Transportation and public security bureaus are responsible for the handling of overloaded trucks, with the

Table 5.7 Overloading vehicle types	
1	Two-axle vehicle, weight of the vehicle and goods over 20 tons
2	Three-axle vehicle, weight of the vehicle and goods over 30 tons (coupling axle is counted as two axle, tri-axle is counted as three-axle, the following is the same)
3	Four-axle vehicle, weight of the vehicle and goods over 40 tons
4	Five-axle vehicle, weight of the vehicle and goods over 50 tons
5	Six-axle vehicle and vehicle with more than six-axle, weight of the vehicle and goods over 55 tons
6	Though under the above limit, but load weight surpass set limit

Ministry of Transport handling the first five types and public security agencies handling the sixth type as shown in Table 5.7.

Due to the lack of a long-term mechanism to control overloading, various kinds of overloading reappear after having been cracked down on. The limitation of the legal system is unable to provide a legal basis for controlling overloading.

5.3 Analysis of the above measures of internalizing external costs

5.3.1 The undervalued compensation fees for external environmental costs and resource values

Based on research results, we can conclude that the external costs of coal mining, processing, transportation and combustion are higher than the current system of compensation fees and taxes. In particular, the external costs of SO_2 and other pollutants from coal burning are not adequately compensated for through taxes and trading.

5.3.2 Unclear aim of taxes and fees

The aims of some taxes and fees are not clear; default and embezzlement exists. There is also the issue of companies defaulting on their fees or embezzling them. The damaged resources and local residents do not receive proper compensation.

5.3.3 The ineffectiveness of safe production supervision and control of truck overloading

The current safe production supervision and control on the overloading of trucks is unsuitable for the long-term. The relevant agencies lack an effective coordination system, resulting in self-centered implementation of laws and chaotic management. The absence of effective supervision of supervisors offers opportunities for illegal fee charging.

5.3.4 The difficulty of extending emission allowances trading nationwide

Several prerequisites are required in order to spread emissions allowances trading nationwide:

I. Defining the total emissions volume based on regional environmental capacity.

II. Conducting an initial allocation of emission allowances among regions.

III. Setting up an open, fair and just emissions trading market with enough information.

IV. Carrying out continuous supervision systems for the polluting emissions of enterprises.

The difficulties of meeting these conditions are substantial in China and cannot be overcome in the short-term. The cost of carrying out emissions allowances trading is relatively high, reducing the advantage of cost reductions from emissions trading itself.

Chapter Six

Policy recommendations to determine the true cost of coal

6

This chapter proposes measures to internalize the external costs in the coal industry in China.

For external environmental costs, the recommended measures are to impose energy and environment taxes and to improve the system of compensation for the use of coal resources. For these external costs resulting from governmental control and price distortions, there should be a deepening of the market-oriented reform of the coal industry and improvement of the guidelines on rules and responsibilities. The last part of this chapter introduces a roadmap for a proposed package of measures.

6.1 Deepen market-oriented reform of the coal industry

The purpose of the market-oriented reform of the coal industry is to establish a competitive market and to make the coal price truly reflect the economic and social costs of production. The current coal price system is imperfect as a result of price distortions caused by over-regulation and under-regulation by government. Four steps could be taken to improve the situation:

6.1.1 Abolishing the coal-electricity tariff automatic mechanism

Because power generation in China mostly depends on coal, price fluctuations in coal have always been a main consideration in setting the grid tariff. Since 2005, the National Development and Reform Commission (NDRC) has been pushing for a coal-electricity tariff automatic mechanism, where the power companies could demand an increase in the grid tariff with any increase in the price of coal. Such a mechanism sends the wrong message to the coal industry that the price increase of coal could be completely taken up by the power companies. As a result, this policy reduces competition in the coal market.

In fact, of all China's energy resources, coal is the most abundant and its distribution is very wide. There are many different producers and consumers in this market, which makes it difficult to form a monopoly. Therefore, a completely competitive coal market could be established. In 2006, NDRC in fact discarded the dual-track system for coal prices and opened up market competition for coal for electricity. This was supposed to be a chance to deepen market orientation of the industry. However, if the coal industry is able to put competition pressure on the power companies through a linked coal-electricity tariff automatic mechanism, the coal price would certainly be distorted.

Moreover, the linked coal-electricity tariff automatic mechanism also sends the wrong messages to the power sector. In order to tackle the increasing coal prices, the power companies have been calling for the price linkage mechanism to take off, so that the conflict between the market-priced coal and the 'state-priced electricity' could be resolved. Before the state gives up control of the grid tariff, the coal-electricity tariff automatic mechanism is seen as a means of alleviating the pressure of price rise in raw materials. However, the extent to which the competition among the power companies could absorb raw materials price rises has been neglected.

In sum, under the linked coal-electricity tariff automatic mechanism, the prices of both the coal market and the electricity market are distorted, which leads to lower social and economic efficiency. The only way to correct the price of coal for the electricity market is to abolish the mechanism and deepen the market reforms of both the coal market and the electricity market.

6.1.2 Establish fair entry into the coal

extraction market

The direct and indirect production costs vary among different coal mines. Part of these costs can be reduced through competition. In order to stimulate competition, the principle of fair entry into the market should be adopted for coal mining. Although the government has so far been unwilling to allow access for smaller companies, if it ensured that safety standards were met then smaller companies could compete for royalties and have the opportunity to grow their businesses and intensify production.

6.1.3 Using market prices to allocate land use

Related procedures to the above include public bidding for national coal mines; encouraging leasehold transactions in order to form a leasehold market; charging state-owned enterprises the market price for land use; and ensuring that the price of collective land in the countryside is determined by the rural collective.

6.1.4 Improving railway transportation

Railway transportation is an important factor behind the price distortion of coal. Policy suggestions have two aspects.

The first is that government regulation should be enhanced to reduce the unreasonable cost in transportation as a result of the monopoly of the railway bureau. The Railway Construction Fund should be abolished to reduce the railway transportation fee for coal.

On the other hand, the railway transportation bottle neck has greatly increased the already unreasonable transportation price. Limited capacity has become a barrier to the market-orientated transformation of the coal industry. The government should invest more to improve transportation capacity.

6.2 Improve the system of compensation for the use of coal resources

The system of compensation for the use of rights in the prospecting and mining of coal resources should be improved to promote reasonable development of coal resources and to improve the recovery rate of coal resources. The corresponding tax and expenses policy on coal resources should be adjusted to distribute the cost of coal resources in a reasonable manner and make the price of coal production reflect its true value.

As well as improving its implementation, the resources tax rate also needs to be increased.

Currently, coal resource related taxes and expenses include resource compensation fees, prospecting tolls and mining rights fees. Resource compensation fees are based on sales and prospecting toll and mining rights fees are based on the area mine covers. There is some overlap between these two. Mine usage fees should be adopted to unify and replace them.

Resource compensation fees, prospecting tolls and mining rights are determined by the government. They are not only lower than the market price but also unable to reflect the variation in revenues and external costs. The pricing of the mine usage fee should therefore be determined by the market – that is, a bidding process should be carried out by mining companies in order to determine the price of mining rights.

Rather than sales, the proven coal reserves could be used as the basis of mine usage fees in order to encourage coal mining companies to improve their recovery rate. The detailed collection method proposed is as follow:

Purpose: To reflect the ownership of the coal mine resource. By restricting ownership, the government encourages mining, increases recovery rates and also avoids coyoting (mining without excavating the overlying soil) and damage to the environment.
Fee Base: Proven reserves of the coal mine. Collecting fees based on reserves is the key in realizing the purpose of the mine usage fee.
Objects of Collection: Coal mine proprietors.
Fee Rate Determination:Exploration and mining rights are determined by the highest bidder, or by the government for existing mines.
Collection Authorities: Bidding or collecting should be organised by resource management departments such as the provincial bureau of State Land and Resources and the income should be brought into fiscal revenue.
Manner of Collection: Bidding should be used for newly developed coal mines. The current market bidding price should be referred to for current coal mines.
At the same time as collecting mine usage fees, the government should also improve supporting procedures. The procedures should include establishing a market and creating innovative financial tools for prospecting and mining rights. These procedures would increase market competition for prospecting and mining rights and determine the real value of coal mine resources. A neutral coal mine valuation system should be established as soon as possible. The government should make sure that all evaluations for mine prospecting rights (such as the degree of difficulty for prospecting, maximum prospecting cost and value comparison method, etc.) are performed by professional organizations.

6.3 Impose energy and environment taxes

Compared with emissions trading, taxing has the advantage of low operation cost.

6.3.1 Energy tax

Energy tax is levied based on the energy (calorific value) of the fuel which is used to produce it.

The main intention is to reduce energy consumption, increase energy saving and efficiency, improve the energy structure and reduce the effect of greenhouse gases and other pollutants.

Other taxes may need to be reduced in order to ensure a revenue neutral tax. The distortion resulting from other taxes, for example VAT and business tax, could also be decreased and the so called ‘double bonus' for the economy and the environment could be achieved. In this sense it is a no-regrets measure for the government to impose an energy tax.

The main problems in designing an environmental tax include: tax rate, time and procedures of imposition, tax reduction and restitution, impact on different regions, industries and groups in the society.

In a developing country such as China, the designing an energy tax must consider the impact upon people with lower incomes. The impact of an energy tax is always larger for poorer people as their energy expenses constitute a larger part of their income. As a result, allowances or deductions and exemptions from the tax should be considered in the design.

The strategy of gradual implementation has been employed in designing energy tax in many countries so as to avoid severe impacts caused by the imposition of the tax, increase the feasibility of implementation, reduce and monitor negative effects and to obtain the best environmental enhancement effect with the least cost.

In designing the energy tax, the government should do its best to buffer the impact of the environment tax on the international competitive strength of industrial products. The government should especially consider the impact on competitive strength and imported products for industries and goods for which quite a lot of trading is expected. For certain industries with high energy costs, preferential tax treatment should be considered. Although this may lead to continuous high emissions, agreements could be signed as a supplementary condition between high energy cost companies to increase efficiency. This has proved to be an effective method in improving the environment in other countries.

In most countries, the revenue from energy taxes is mostly incorporated into the overall taxation system for redistribution. The revenue neutral nature of the tax is maintained to reduce the distortion produced by other taxes and to realize the so called ‘double bonus’. However, part of the tax income could be used to fund the improvement of energy efficiency programs and the development of renewable energy to achieve both economic efficiency and environment benefits.

Finally, an energy tax can never be carried out by itself. It should always from part of a package of environmental and energy policies and its effects should be supportive. As a result, other policies are needed alongside the imposition of the energy tax to achieve the best result.

The detailed collection method for energy tax is as follows:

Taxation Objects: Coal, petroleum and natural gas.
Tax Preference: Exemption for renewable energy; low tax rate natural gas or tax rebate for energy utilization as a raw material.
Taxable Areas: Coal mine, oil field, natural gas exploitation, unconventional energy exploitation enterprises.
Import Link: Levy by the customs authorities.
Tax Base: Depending on the quantity.
Payment Date: Method 1: pay taxes once a month and payment should be made 15 days after the end of the month; method 2: pay taxes once each half year and payment should be made 15 days after the end of last half year.
Taxation Place: Headquarters of the enterprise or the site where energy is produced or used.
Tax Rate: Could be increased gradually. The tax rate in this research is recommended as follows. Considering the bearing capacity of enterprises and social acceptability, a low tax rate could be a good start, such as RMB 30 per ton for standard coal. The tax rate could be increased to a higher level later.

6.3.2 Environmental tax

Environmental tax is mainly aimed at the environmental external costs caused by coal consumption. The major emissions from coal, carbon dioxide and sulfur dioxide from combustion are mainly discussed here. These two pollutants significantly affect human health by either directly or indirectly polluting the environment. However, this imputation can hardly be identified, so governments should function for the public welfare. The environmental tax should be imposed on emissions from coal consumption. Since the price elasticity of coal demand is approximately -1, sellers and consumers pay the tax almost equally. Damage to the environment caused by coal use can be at a regional, national and global level (such as climate change). As a result, the environmental tax should be allocated between the central and local governments, and the ratio should be proportional to regional external environmental costs and global external environmental costs caused by coal use.

It is recommended that the sulfur dioxide tax is set at RMB 44.8 per ton coal (based on purchasing power parity in 2006) which is about 9% of the retail price for coal. The specifics are as follows:

Sulfur dioxide tax

Taxation Purposes:To internalize the external cost of sulfur dioxide emissions.
Taxation Objects: Enterprises (mainly power plants) using coal as the primary industrial fuel.
Tax Base: Sulfur dioxide emitted by large and medium-sized power plants; coal purchased for small coal burning power plants with emissions that are difficult to detect.
Taxation Department: The Inland Revenue Department, mainly to local finance.
Tax Rate: 9% of coal prices.
Tax Usage: Tax on sulfur dioxide should be earmarked for the government installation of sulfur dioxide emissions monitoring system, as compensation for damage caused by sulfur dioxide and for subsidies to enterprises that reduce sulfur dioxide emissions significantly.

CO_2 tax

With the rapid increase in China's CO_2 and other greenhouse gas emissions, China plays an increasingly important role in the world efforts to deal with climate change. Pressure is great to effectively control emissions of CO_2 and optimize the energy structure. Therefore, early determination of a carbon dioxide taxation program could send a clear signal to domestic industries, enterprises and consumers, which would be of help in developing China's low carbon development path. The proposed tax rate of CO_2 and the timetable is in Table 6.1.

Specific programmes are as follows:
Taxation Purposes: Internalizing the external costs of carbon dioxide emissions.
Taxation Objects: Coal consumers, retailers instead of the consumer tax and turned over.
Tax Base: Coal consumption (carbon dioxide tax should tax on all fossil fuels, only considered coal here).
Taxation Department: National tax bureau, mainly to the central financial authority.
Tax Rate: 10.4% of the retail price for coal.
Tax Method: Calculate the average carbon content of coal. Tax restitution could be given to certain industries that don't burn coal.
Tax Usage: Used in the research for new energy, as compensation for marketization.

It should be noted in taxation programs that due to competition between coal mines in different regions such as Inner Mongolia and Shanxi, local protectionism may be undertaken by local governments. These governments may levy lower energy tax and environmental taxes in order to maintain the competitiveness of the local region. To avoid this problem, there is the need for the central government to pass legislation on energy and environment taxes to establish a national unified tax rate.

In the implementation, the government can increase energy and environmental taxes while cutting the equivalent amount of other taxes, such as value-added taxes, business taxes and other indirect taxes. Although the average taxation level

Table 6.1 Carbon dioxide tax proposal (RMB/ton)

	2005	2012	2020	2030
Carbon tax	0	100	150	200

remains unchanged for the whole community, in this approach, the effect of an energy and environmental tax is not weakened. In turn, as a result of the reduction in indirect taxes, the economy is stimulated.

6.4 Improve liability rules

6.4.1 Liability rules of safety incidents in coal production

According to the fault principle, liability for accidents should be judged by considering the input in terms of security precautions. Enterprises that have invested enough in safety equipment so that the safety standards are met would bear less responsibility than those that have not. The party most at fault should assume more liability for enterprises and workers.

The level of compensation for coal mine safety accidents should be estimated by the general calculation method in the insurance market. This means that the compensation should be estimated according to the loss caused by the accidents. In principle, the compensation for death in mining accidents should be based on the average income and the remaining expected working time to calculate the present value of the overall future income.

Coal production enterprises should ensure funds for technological transformation of coal security by extracting coal mine production safety fees maintenance fees and repair fees in accordance with the laws. At the same time, coal producing enterprises could transfer the liability of coal mine safety accidents into a mandatory insurance system for all mine workers. Since the accident rate in coal mines is relatively high, the insurance premiums will be high for injuries and deaths in coal mines.

6.4.2 Liability rules for overloading and road accidents

The external costs of overloading coal transportation includes damage on the road surfaces and increased risk of accidents. For the former, the cost can be internalized by adopting additional aggravated pricing for overloading weight. For the latter, the fault principle should be adopted to determine responsibility for the accident. The overloading party should bear greater responsibility in road accidents caused by overloading.

6.4.3 Liability rules for damage to surrounding water, air and landscape

Damage to the surrounding environment caused by coal mines, including damage to water, air and ecosystems, should be seen as a general tort and *General Principles of Civil Law* should be applied to confirm tort liability. Residents near mines belong to a relatively vulnerable group and legal aid should be applied in the proceedings.

6.5 Policy road map to internalize the external costs of coal

There are two factors which affect the implementation of the internalization policy of external costs. The first one is implementing conditions, including external conditions and the difficulty of implementation of the policy itself. The second one is the size of the impact resulting from the implementation of internalization. Analysis of the impact of the policy implementation could provide some general guidelines. However, coordination among different policies is the main consideration on the specific operating level. Moreover, regardless of their effects, policies should be introduced as long as they meet feasible implementing conditions.

6.5.1 Recommended policy road map to internalize the environmental costs of coal

The imposition of tax is an important way to internalize the external environmental cost. It is important to place the designing and introduction of these taxes and fees in the wider context of the ongoing national tax/ fee system reform of the country. It is therefore critical to understand the conditions of introducing various taxes, and how they are associated or complemented.

In the current conditions in China, it is important to promote resource taxes and fees to improve the system of compensation for the use of resources owned by the state. However, as coal resources are unevenly distributed, it is difficult to determine a uniform tax rate for the whole country. The current low tax rates on resources do not reflect the true value of the coal resource properly. Meanwhile, an energy tax imposed on coal resources should be coordinated with resource taxes and fees. In designing the policy road map, it is recommended that the current coal resource tax be changed into a coal resource fee (royalty) with an increase in the level of current royalty. In addition, the energy tax should be levied from 2010.

According to the analysis in the previous part of this report, under the existing conditions, it is difficult to carry out large-scale emissions allowances trading in China. By contrast, it will be easier to operate once legislation for environment and energy taxes are in place to reduce pollutants (such as SO_2, CO_2, etc.). Therefore, the emissions trading mechanism could be implemented after a thorough study and a mature proposal.

The detailed policy road map is in Table 6.2.

6.5.2 Recommended policy road map to internalize the external costs of government control and price distortion of coal

The effect of internalizing the cost of government control and price distortion is more significant than that of internalizing the external environment costs. The former would increase the coal price by 18.09 per cent, which is higher than the 5.01 per cent of the latter. In terms of difficulty of implementation, the main measure used by the government in internalizing the cost and price distortions is a 'market means in broad sense', which is easier than a 'government means in broad sense'.

Further market-oriented reform of the coal industry is a further deepened market-oriented reform in China, which not only contains market-oriented reform experience from other industries, but also has the basis of market-oriented reform. Through the momentum of the reform, the cost will be raised for coal mines, but the income will also be increased with the implementation of the internalization measures on government control and price distortion. Some of the cost will be transferred to consumers,making it is easier for coal mines to accept. Nevertheless, measures to internalize the external environment costs mainly by taxation, would increase overall costs, something which should be largely afforded by corporations.

The detailed policy road map is in Table 6.3.

Table 6.2 Recommended policy road map to internalize the environmental costs of coal

Measures on coal price system reform	Objects	Specific policies	Timeline of implementation
To improve the system of compensation for the use of the coal resource	To reasonably reflect the value of the coal resource. To improve the recovery rate and avoid coyoting and damage on environment. At the same time coal enterprises could reasonably afford the cost of coal resource	To increase the mine toll	Starting in 2009
		To levy energy tax	Taxation from 2010
To levy energy tax and environmental tax	To reduce emissions of greenhouse gases, SO_2 and other environment pollution. To reduce energy consumed, to increase energy saving, to improve energy structure and to raise energy usage efficiency	To levy SO_2 tax	To levy SO_2 tax instead of SO_2 fee from 2009
		To levy carbon tax	To determine the taxation plan, the tax will be imposed from 2012, and will be further raised in 2020 and 2030

Table 6.3 Recommended policy road map to internalize the cost of government control and price distortion of coal

Measures on coal price system reform	Objects	Specific measures	Implementation schedule
To deepen market-oriented reform of coal	To diminish the distortion caused by excessive government control of coal market	To abolish the coal-electricity tariff automatic mechanism, gradually establish the competitive tariff system for the power generators	To be abolished in 2009
		To establish a fair coal extraction entry system	To be implemented before 2010
		To amend the market price formation mechanism of land factor	To be implemented before 2010
		To abolish the Railway Construction Fund	To be abolished in 2009
		To improve railway transportation capacity for coal	To complete relevant 11th Five-Year Plan of Enhancement of coal transportation before 2010, and to further improve the coal transportation system in the next Five-Year Plan
To improve liability rules	To increase safety input and to reduce coal mine accidents	To clarify and implement liability rules for coal production safety accidents	To be implemented before 2010
	To reduce damage to road surface and traffic accidents caused by overloading	To clarify and implement liability rules for overloading and road accidents	To be implemented before 2010
	To reduce damage to surrounding environment caused by coal mines	To clarify and implement liability rules for damage to surrounding water, air and landscape	To be implemented before 2010

Chapter Seven

Impact of internalizing external costs of coal on social welfare and GDP

7

7.1 The total price change resulting from internalizing external costs of coal

The price of coal will rise by 23.1 per cent after internalizing all the external costs. See Table 7.1 and Table 7.2.

Internalizing the external costs of coal is an institutional change, it will use institutions with internalization measures to replace institutions with no internalization measures. When external costs are reflected in the pricing system, the system will seek cheaper alternatives such as prevention measures and renewable energy to replace coal. Experience proves that prevention costs are substantially lower than the direct external loss. Therefore, in the long run, the external costs needing to be internalized in an economy will be reduced dramatically.

7.2 Impact of internalizing external costs of coal

7.2.1 Impact of internalizing external costs of coal on GDP

Putting the above price change of 23.1 per cent in the Computable General Equilibrirm Model we get the following data in Table 7.3.

Table 7.1 Cost and price deviation resulted from internalizing external costs of coal

External costs	Deviation direction	Change in price after internalization	Cost deviation (per cent)	Price deviation (per cent)
External environmental costs	Low	Increase	16.11	5.01
Cost distortion of government control	Low	Increase	54.3	18.09
In total	Low	Increase	70.41	23.1

Table 7.2 Price change resulting from internalizing external costs of coal

Item	Sub-item	Price change (per cent)
External environmental costs	External environmental costs in mining	0.51
	External environmental costs in burning	2.46
	External environmental costs of transportation	2.04
Cost and price distortion of government control	Suppression of coal price by electricity price control	5.09
	External cost of safety control	5.25
	External costs of coal miners' health	0.54
	External cost from under valuation of land factors	0.8
	External cost from under valuation of resources value	6.55
	External cost from social burden of enterprises	-0.5
	Railway Construction Fund	-0.84
	External cost of overloading in transportation	1.2
Total		23.1

Table 7.3 Impact of internalizing external costs on macroeconomy	
Item	Impact (per cent)
GDP	-0.069
Depreciation	-0.074

It shows that the rise of coal price resulting from internalizing external costs of coal will reduce GDP slightly by 0.069 per cent.

7.2.2 Impact of internalizing external costs on income distribution

Although GDP is only affected slightly, the disposable income of major sectors of the economy such as enterprises, government and residents will face bigger changes. See Table 7.4.

Table 7.4 Impact of internalizing external costs on income distribution		
Item	Sector	Change (per cent)
Disposable income	Enterprise	3.088
	Government	1.186
	Rural residents	-0.41
	Urban residents	-0.57
	Foreign sectors	5.904
Consumption and investment	Citizen consumption	-0.52
	Government consumption	0.740
	Fixed investment	1.343

The disposable incomes of urban and rural residents will fall slightly. But, as discussed earlier, a partial loss of income can be compensated for by cutting personal income tax while raising energy and environmental taxes. Therefore, inequity in income distribution is not a significant problem.

7.2.3 Impact of internalizing external costs of coal on economic structure

Naturally, with a 23.1 per cent rise of coal price, coal production and consumption will face the biggest impact. It is estimated that coal production by 11.9 per cent and consumption by 9.6 per cent. See Table 7.5.

Table 7.5 Impact of internalizing external costs of on coal production and consumption	
Item	Change (per cent)
Production	-9.616
Import	68.051
Export	-58.506
Consumption	-6.852

Table 7.6 Impact of internalizing external costs on production of some industries	
Sector	Change (per cent)
Coal extraction and washing	-9.616
Oil and natural gas mining	0.826
Metal ores mining and dressing	-0.571
Oil refinery, coke and nuclear fuel industries	2.859
Equipments and instruments for office use	1.248
Electric power and heating production and supply	-1.084
Fuel gas production and supply	-4.573

The renewable and alternative energy industries that replace coal production such as oil, natural gas mining and processing, coke and the nuclear fuel industry will grow slightly. The industries using coal as fuel, such as fuel gas production and supply, heating production and power and supply will decline slightly. See Table 7.6.

The prices for alternative energy industries replacing coal and industries using coal as raw materials will rise slightly. See Table 7.7.

7.2.4 Impact of internalizing external costs of coal after five years

As mentioned earlier, measures to internalize the external costs of coal would be carried out over

Table 7.7 Impact of internalizing external costs on price of some sectors

Sector	Change (per cent)
Coal extraction and washing	23.060
Oil and natural gas mining	1.788
Metal ores mining and dressing	1.011
Textile	0.792
Wood processing and furniture industry	0.828
Oil refinery, coke, nuclear fuel	2.460
Chemical industry	1.212
Non metal mining production	1.899
Metallurgy industry	1.605
Metalwork industry	1.138
Special equipment	0.963
Transportation equipment production manufacturing	0.865
Electric machinery manufacture	0.928
Communication equipment, computers and other electronic equipments	0.867
Instruments for office use	0.917
Electric power and heating production and supply	4.891
Fuel gas production and supply	7.190
Water production and supply	1.036
Construction industry	0.900

five years. The effects will therefore be apparent shown in five years' time.The negative impact is minimal, however, making the measures more feasible and manageable.

We can see from Table 7.8 that the annual impact on GDP is just -0.0149 per cent. The disposable income of rural residents is reduced by 0.013 per cent, and that of urban residents by 0.02 per cent. These changes are minimal and even lower than those resulting from normal calculation errors. Therefore, if the measures to internalize external costs of coal were carried out over five years, the reform would be almost unnoticeable.

7.2.5 Impact of internalizing external costs of coal on China international competitiveness

Generally speaking, if the conditions in other countries remain relatively unchanged, the measures taken by China to internalize the external costs of coal will lead to a 23.1 per cent rise in the price of coal. This will increase the costs of production and reduce international competitiveness. However, we should note that the market reform in China is not complete. The factor prices of coal and coal price remain undervalued. Compared with countries with full marketization, the coal price in China is substantially lower. This is not a fair situation.

Table 7.8 Annual impact of measures of internalization within 5 years

Item	Change (per cent)
GDP	-0.0149
Disposable income of rural residents	-0.013
Disposable income of urban residents	-0.02
Citizen consumption	-0.06
Coal production	-2.329
Coal import	11.821
Coal export	-17.368
Coal consumption	-1.558

Many countries have levied carbon, environmental and energy taxes such as fuel tax to cover external environmental costs. The retail prices of alternative energy are much higher than those in China, and the coal price is determined fully by the market, the coal price in other countries is substantially higher than that in China. See Figure 7.1.

Compared with the relatively low price of coal in Japan, the steam coal price in China is 49 per cent lower and coke 58 per cent lower. Therefore, even if China raises its coal price by 23.1 per cent as a result of internalizing its external costs, China's coal price will still be lower than those of most countries.

Under higher coal prices, enterprises and citizens will take measures to save coal, avoid wastage and increase coal use efficiency. As a result, per unit production of energy consumption will be reduced, leading to reduced cost and increased competitiveness.

Strategically, internalizing all the external costs of coal will provide a true cost for coal and the correct price comparison between coal and other resources. This will help improve resource allocation and increase social efficiency and eventually increase China's international competitiveness.

The internalization of the external costs of coal will help enterprises and citizens produce and use

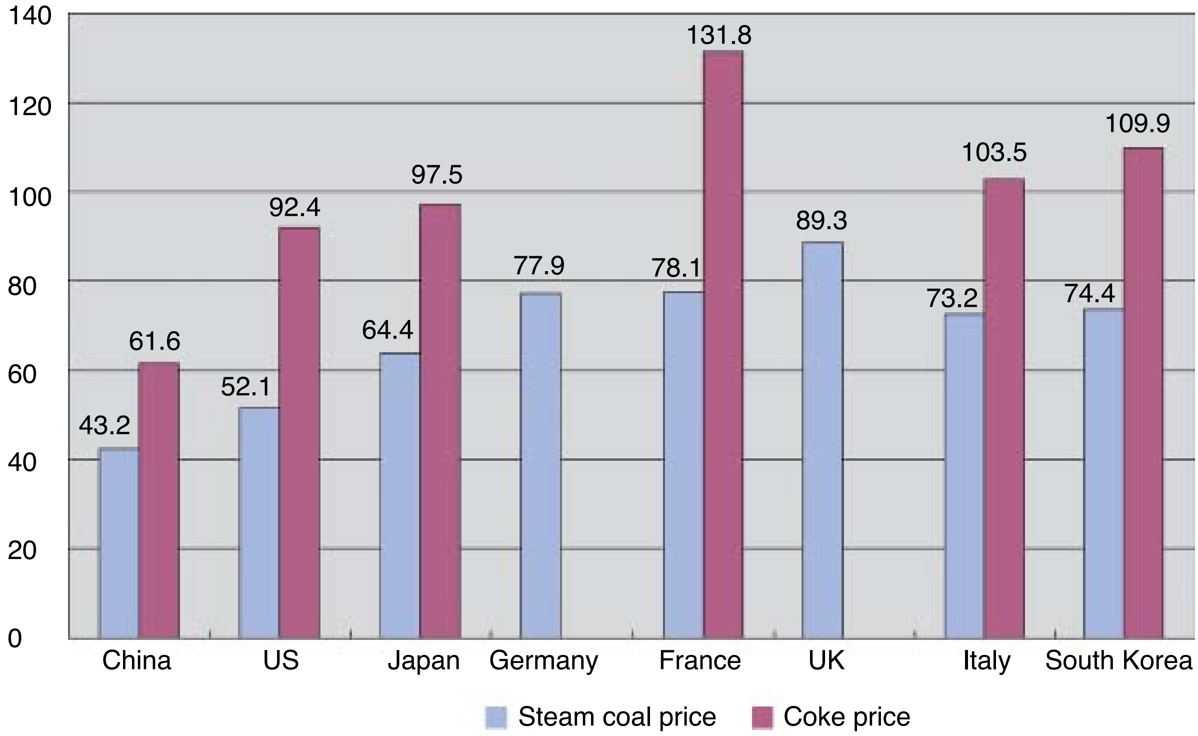

Figure 7.1 Comparison of 2005 coal price in different countries (US$/ton)

Sources: Energy Prices & Taxes - Quarterly Statistics, First Quarter 2007, Part II, Section D, Table 18, and Part III, Section B, Table 15, Paris: International Energy Agency, 2007.

coal in a better way in comparison to other forms of power generation.This will help China's sustainable economic development and strengthen long-term competitiveness.

7.2.6 Impact of internalizing external costs of coal on social welfare

Based on the earlier analysis earlier, we have summed up the direct external costs of coal minus the external costs of coal in Table 7.8. As China has taken some measures to internalize external costs, it can be assumed that the measures have increased the ability to prevent loss and reduce direct external costs. This reduction is twice the amount of prevention cost. The remaining direct external loss accounts for about 140.22 per cent of the coal price. See Table 7.9.

If you multiply 140.22 per cent by with the average coal price at RMB 498 in 2007, the direct external costs per ton of coal work out at about RMB 698. As the sales volume of coal in 2007 was 2.5 gigatons, the direct external cost is about RMB 1745 billion. If we assume that the measures to internalize the external costs are effective, then this external cost will disappear and should instead be regarded as a rise in social wealth.

On the other hand, internalizing the external costs need investment. This amounts to the total of prevention costs. In this report, by subtracting the cost of measures to internalize external costs, the prevention cost accounts for 70.11% of the price of coal. Based on RMB 498 per ton of coal in 2007, the prevention cost to internalize external costs is RMB 349 per ton. As the coal price

Table 7.9 Direct external costs and remaining cost			
Item	Direct external lost (per cent)	Current prevention cost and effect (per cent)	Remaining cost (per cent)
Environmental costs of mining	7.7 × 2	6 × 2	3.4
Environmental costs of use	10.17 × 2	3 × 2	14.34
External environmental costs of transportation	6.12 × 2	–	12.24
Impact of electricity control on coal price	15.27 × 2	–	30.54
Low efficiency of safety control	15.75 × 2	–	31.5
Lost in coal miners' health	1.61 × 2	–	3.22
Under-valuation of land factors	2.5 × 2	–	5
Under-valuation of resources	19.65 × 2	–	39.3
Social burden	-1.5	–	-1.5
Over loading etc.	1.09 × 2	–	2.18
Total	158.22	18	140.22

will rise by 23.1 per cent after internalizing external costs, production will drop by 9.6 per cent. Based on 2007 production level, production will be reduced to 2.3 gigatons. Therefore, the cost of internalizing external is about RMB 802.7 billion. Subtracting the cost from the benefits, the total added social wealth is about RMB 942.3 billion.

References

[1] Cui Minxuan, et al. Energy Development of China 2007. Social Sciences Academic Press, 2007.

[2] Daniel J.Dudek, et al. Economic Analysis of SO_2 Emission Control in Power Sector in Yangtze River Delta in China // Research of Environmental Sciences, Issue 4, 2005.

[3] Daniel J.Dudek, et al. Development and Challenges of SO_2 Emission Trading in China // Environmental Protection in Power Sector, Issue 2, 2007.

[4] State Administration of Coal Mine Safety. China Coal Industry Year Book. China Coal Industry Publishing House, 2006.

[5] Huang Shengchu, et al. China Coal Development Report 2006.China Coal Industry Publishing House, 2007.

[6] Heng Yu. Annual Costs of SO_2 Emission Amounts to RMB 500 Billion // Elite Reference, 12th August, 2006.

[7] Li Shuzhi. Recultivation Technology of Land Destroyed by Coal Exploitation // Resources Industry, July 2000.

[8] Li Weina. Coal Mining Security Monitoring System in China // Caijing, 28th December 2004.

[9] Li Yanfang, Tang Fang, et al. Legal Cases of Environmental Protection. China Remin University Press, 2006.

[10] Robert Cooter and Thomas Ulen. Law and Economics. Joint Publishing, 1991.

[11] Roger Perman, et al. Natural Resources and Environmental Economics. China Economy Press, 2002.

[12] Lv Zhongmei, et al. Analysis on Environmental Legal Cases. High Education Press, 2006.

[13] Qian Pingfan. Research on Optimizing Framework of Cost Calculation of State Owned Coal Mining Companies // China Coal, 2004.

[14] Sheng Hong. Externality and Institutional Improvement // Management World, 1995.

[15] Tong Xiaoying. Analysis on Reform in Emission Fees // Corporate Economics, Issue 12, 2002.

[16] Wang Xiaoling. International Comparison of SO_2 Emission Tax and Impacts on Emission Reduction // International Tax, Issue 5, 2002.

[17] Wang Ya. Control on SO_2 Emission from Emitter // China Environmental News, 6th November 1999.

[18] Yang Shiyong, Zhu Xueyi. Benefits and Harms of Over Collecting Safe Production Fee from Listed Coal Mining Companies // Coal Economy Research, 3rd Issue, 2007.

[19] Yue Fubin. The Problems and Solutions of the Formation of Cost of Coal // The Macroeconomics Research, Issue 3, 2007.

[20] Zhang Qizi. Analysis of the Structural Change of Coal and Electric Power Industry in China // Eco-

nomic News Reference,June 11, 2005.
[21] Zhang Ke. 200 Million RMB Wasted, 80% of Smoke Monitoring Systems of Thermal Power Plants Do not Function // First Finance Daily, August 8, 2005.
[22] Zhao Xiaoping. Promote Restructuring of Energy Mix Through Energy Conservation and Emission Reduction // Finance World, Issue 3.
[23] Zheng Yuxin. Economic Analysis on Environmental Impacts. Social Sciences Academic Press, 2003.
[24] Zheng Xingzhou, et al. Control on Coal Production and Change in Technologies // China Coal, Issue 4, 2004.

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