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Coal Pricing in China

Issues and Reform Strategy

Yves Albouy

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Foreword

This paper by Yves Albouy is the second in the recently initiated series of China and Mongolia Department Working Papers.

The World Bank's economic and sector work program in China is a very active one ranging over a wide spectrum of topics from macroeconomics to health and education. Each year we publish a handful of our formal studies, but thus far most of the background papers and informal reports, many of them containing valuable analysis and information, have remained outside the public domain. Through the China and Mongolia Department Working Paper Series, we hope to make available to a broad readership among the China watchers and development communities a few of the papers which can contribute to a better understanding of China's modernization.

Mr. Albouy's study makes an important contribution to our understanding of the magnitude of coal price distortions producers and consumers face in China and how the distortions ripple through the Chinese economy. China has already made an impressive start on reforming its economy; the question of price distortions must now be faced and addressed in order to move the economy to a higher plane of development and efficiency.

Shahid Javed Burki
Director
China and Mongolia Department
Asia Region

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CONVERSIONS

1 Y	=	100 fen (f)
1 Gigacalorie	=	1 billion calorie (Gcal)
1 Giga Joule	=	1 billion Joule (GJ)
1 cal	=	4.18 Joules (J)
1 toe	=	10 Gcal = 42 GJ
1 tce	=	7 Gcal = 29 GJ
1 t. coal ROM	=	5.5 Gcal = 23 GJ

ABBREVIATIONS

CMA	-	Coal Mining Administration
CPS	-	Coal Pricing Study
CUS	-	Coal Utilization Study
DRC	-	Development Research Institute of the State Council
LRMC	-	Long-Run Marginal Cost
MOE	-	Ministry of Energy Resources
Mt	-	Million ton
MY	-	Million Yuan
ROM	-	run-of-mine
tce	-	ton of coal equivalent (standard coal)
Tcf	-	trillion cubic feet
toe	-	ton of oil equivalent

SUMMARY

i. The study assesses the magnitude of coal price distortions left in place by the dual track pricing approach to price reform implemented by China in the 1980s; it examines the economic and financial costs of these distortions and identifies the potential winners and losers of pricing improvements. Finally the report outlines a strategy for gradual price adjustments and liberalization in the coal sector.

Overview of the Coal Market

ii. China is the largest coal producer in the world with about 1 billion ton in 1989 of which 65 percent is steam or blending coking coal. Little of it is washed or screened in spite of its high ash content. More than 60 percent of the output is transported by railroad thus straining the capacity of the network; 45 percent comes from about 600 mines controlled by the central government; most of the rest comes from smaller mines controlled by local governments. These accounted for most of the incremental output which followed the introduction of a limited free market in the mid-1980s; but due to decreasing returns and poor operating conditions, future growth will depend more on larger mines than in the 1980s.

iii. Domestic coal demand absorbs most of the output; it is dominated by industrial/power plant boilers and furnaces (69 percent) followed by residential usage (22 percent). The intensity of coal use--which in China largely equates overall energy intensity--is expected to continue its downwards trend and demand is planned to increase at about 3 percent per annum, i.e., half the rate of GDP growth.

iv. Coal on the free market accounts for about 40 percent of the total and is traded at prices which vary geographically, some of them well above world levels because of import restrictions and transport constraints. These prices are more than double those of coals allocated according to Plan quota. This gap has recently widened and is the cause of increasing inefficiency, and rent-seeking. It also underlies the coal industry's need for financial assistance.

Impact of Coal Price Distortions

v. The Long-Run Marginal Costs (LRMC) at minehead and delivered at city gate are estimated at Y 100/t and Y 130/t respectively for China as a whole. Against these benchmarks, current prices are distorted by 40 percent for the "protected" consumers, who get most of their coal outside the free market. Economic losses incurred as a result are of two kinds:

Supply side: inefficient patterns of coal mining and transport, lack of coal beneficiation and mismatch of coal quality as well as, indirectly, slow development of alternative fuels such as natural gas.

Demand side: high degree of substitution of heat to other input and waste in the final use of coal because of low boiler efficiency, poor building insulation and insufficient amount of cogeneration of process heat and power. These losses were about 110 million tons in 1989.

vi. Low coal prices also induce important income transfers 70 percent of which are in the guise of subsidized physical input for coal mining and transport and 30 percent (Y 10 million in 1989) in the form of direct operating subsidies and low interest rates to the state-owned mines.

Principles of Coal Price Reform

vii. Border pricing is appropriate for coking/blending coal which is in short supply in China. For steam coal, however, China has the alternative of being a price setter on the world market or to limit its exports. In either case, the domestic resource cost of that coal is the marginal cost of mining and transport. But while LRMC is a useful reference, only a full price liberalization can ultimately provide appropriate price signals for the diversity of coal qualities and places of delivery in the Chinese marketplace. A rapid increase in coal prices should be combined with a gradual loosening of price controls. In the transition period, coal marketing expertise would need to be upgraded and disseminated at local levels.

viii. The study recommends that within two years, plan prices of steam coal be raised to about 80 percent of the LRMC-based price and that coking coal of export quality be priced with reference to the world market. With this next reform step, financial subsidies in coal mining and transport would be eliminated. Differences between "allocated" and "guidance" coal prices and between "old" and "new" coal would cease to exist. As price reforms are extended to other sectors, steam coal prices would settle around the full LRMC. Within five years, government allocations would be phased out and prices decontrolled.

ix. Accompanying reforms are recommended in the areas of revenue taxation, performance contracts, management, financing and regulation of the state mines, pricing and regulation of coal transport and to allow the full play of competition and autonomy among all enterprise in the coal sector.

Impact of Coal Price Reform

x. On the basis of current trends, welfare losses and financial subsidies for the period 1990-95 could exceed 700 million tons and Y 200 billion respectively. Price reform would ensure an efficient and sustainable development of the coal supply and demand, particularly in the areas singled out in para. 5. The 40 percent adjustment of coal prices on the protected market, which is recommended in the first two years would allow mines to self-finance about 40 percent of their capacity additions. Cost push would be notable for power generation, town-gas, lime, cement and iron smelting and would have to be passed on to the consumers; in other cases, costs impacts are smaller and would reduce profits because of price competition.

xi. Public expenditures would be inflated because of additional fuel outlay, subsidies, and contribution to investments for coal using administrations and state enterprises; but this is more than offset by the general increase in tax revenues and the elimination of subsidies to the coal industry. Financial assistance is thus fiscally feasible for the technical upgrading of selected coal using enterprises hardest hit by the reform.

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This paper was first prepared as part of the annual program of informal economic and sector work of the Department. The paper is based upon the information available to the study team as of October 1990.

Coal Pricing in China: Issues and Reform Strategy

I. INTRODUCTION

1.1 Trends in Energy Use. Over the period 1980-89, China's GDP grew at 8.7 percent per annum while commercial energy production was growing at 5.1 percent. The energy intensity fell from 1.5 to 1.1 tons of oil equivalent (toe) per $1,000 of GDP at 1980 prices. This 27 percent drop represents accumulated savings of some 2.5 billion tons of coal; that is, 30 months of current production. The energy intensity in 1989 is close to that achieved in 1970 by South Korea. The downward trend has several causes. One is the economic reform and growth of the last decade: although the share of light industry in GDP barely increased, output shifts occurred within sectors, e.g., away from metallurgy and towards higher value-added machine building. It is estimated that less than 40 percent of energy savings can be attributed to these structural changes. Conservation policies, initiated by the State Council in 1980 and supported by increases in energy prices, very likely had a greater impact. About 15 percent of energy investments were earmarked for conservation. In addition, many inefficient plants were shut down at the end of their physical life and replaced by better ones which also brought important savings. At the margin, other factors have played a part like the severe rationing of electric power or the rapid increase in the number of fuel efficient automobiles. In the coal sector, by comparison, shortages have been less severe, and the penetration of new technology has been slower. As coal is the major source of energy in China, energy conservation lies mostly in reducing the intensity of coal use.

1.2 Future energy efficiency gains are likely in light of the continuing trends in the economy. This conservation effort will take place amidst an accelerated development of transport, an increased demand for space heating as incomes rise and the substitution of traditional fuels by commercial energy in rural areas. It will require increasingly large amounts of capital for mainly two reasons: decreasing returns (as the more expensive retrofits are carried out) and, in some cases, the recourse to solutions that bring additional environmental benefits even though they may be second best from a strict efficiency viewpoint. Reductions in the energy intensity have in effect slowed down from 4 percent per annum during the period 1981-87 to 2 percent in the late 1980s. It is clear therefore that, in order to continue at a sustained pace, energy conservation will have to rely more on pricing incentives than it did in the past.

1.3 Coal Pricing. Many of the inefficiencies in energy resources allocation and use and a number of financial and fiscal imbalances in China can be traced back to the pricing of energy and raw materials: with intermittent exceptions for petroleum products, energy has long been subsidized. Since the mid-1980s, average coal prices have increased modestly in real terms, but that was mostly because of a broadening free market; plan prices have trailed far behind and remain well under supply costs.

1.4 The structure of plan prices for coal is also inadequate: differences are too small to reflect transport costs; quality-related differentials also are too low resulting in the underpricing and the undersupply of high

grade coals; finally, distortions are also introduced by a series of ad hoc payments to producers.

1.5 Principles of the Coal Price Reform. A Coal Pricing Study (CPS) was completed in 1989 by the Bank and the Development Research Institute (DRC) of the State Council.1/ This study had concluded that in the long run only a market determination of prices would lead to an efficient and viable system of coal prices. It recognized however that as long as production and transport bottlenecks persist, some price controls would have to be kept and guiding prices set at about 80 percent of the long-run marginal cost of supply at a level sufficient to ensure the financial viability of coal mines. Exceptions would be made for washed coal of export quality and for certain blending coking coals for which border prices would be the reference. The study proposed a reform program that would result in price increases in the mid term and price deregulation in the long term.

1.6 The efficient pricing of coal would not affect its dominance over the Chinese energy sector whether as a primary fuel or as secondary energy for many end-users: with a cost of Y 20-30/Gcal, coal is twice as cheap as heavy fuel oil. Only natural gas could economically substitute for coal on a large scale; but its role will remain very marginal in the near future because of insufficient gas exploration and development.

1.7 The purpose of this paper is twofold: (i) to highlight the impact of remaining coal price distortions, and (ii) to suggest a strategy for the continuation of coal price reform. Section II presents an overview of the coal market and current pricing policies. Based on estimates of coal supply costs, Section III attempts to assess the welfare gains foregone as a result of inadequate coal pricing and the financial transfers entailed by existing coal price subsidies. Section IV suggests targets and principles to implement another round of coal price reforms in the next five years. Section V examines the potential impact of further reforms of coal prices on economic efficiency, on the incomes of the coal industry and of major coal users and on public finances. The paper closes with some thoughts on the reform implementation strategy (Section VI). Sections IV and V draw largely on the CPS which is based on 1986 data; Sections II and III rely on both the CPS and the Coal Utilization Study (CUS),2/ which is based on 1987 data. The estimates presented have been updated to end-1989 with the help of the DRC, but these calculations are fairly rough and only suffice to indicate orders of magnitude. The Annex contains assumptions and describes the methodology used.

1/ Coal Pricing Study, Report No.7377-CHA, World Bank, February 1989.

2/ Efficiency and Environmental Impact of Coal Use, Report No.8915-CHA, World Bank, September 1990.

II. OVERVIEW OF THE COAL MARKET

Coal Production and Demand

2.1 China's coal production has grown at about 6 percent per annum over the 1980s reaching 1,054 Mt in 1989. The major part of the output is steam or blending coking coal (65 percent), followed in importance by anthracite (21 percent), prime coking coal (10 percent) an lignite (4 percent). Coal is used mostly as run-of-the-mine (ROM); the ash content of steam coal delivered to power plants is typically 20-30 percent; sulfur content 1.2-1.7 percent with wide variations, although two thirds of the reserves are below 1 percent. In 1987, about 27 percent of coal was screened, 19 percent was washed, mostly coking coal.

2.2 Coal mining is widespread; in many areas, coal is produced reasonably close to the market. Major industrial centers in East, Northeast and South China are however increasingly reliant on supplies from North China, putting pressure on the transport network. The traffic tonnage on the railroad was 609 Mt in 1989; the traffic volume approached 500,000 Mt-km: 70 percent of it is by rail with an average distance of 550 km while the remainder is by waterways for an average distance of 2,100 km. The flow of coal out of the surplus regions was 11 percent of the total output in 1989, 55 percent of it went to East China.

2.3 Some 45 percent of total production comes from about 600 mines controlled by the central government; the remainder is from some 80,000 mines working generally shallow seams: 35 percent from the collective and individual mines, 20 percent from the mines owned by the provinces, prefectures and counties.

2.4 Local mine production was stimulated by the opening of a free market and other policies in the early 1980s. During 1983-85, local production grew at 15 percent per annum and in 1985 surpassed state mine production. This dynamic response was essential in meeting coal requirements. It also created problems: (i) mine safety is very poor; (ii) the mines are too small to support screening and washing equipment; and (iii) the proliferation of small mines is threatening the rational exploitation of larger mechanized ones.

2.5 Output growth has been much slower in the centrally controlled state mines: productivity and asset utilization are low; construction lead times are too long. As a result of this and of a slowdown in mining investments by the state in the last eight years, there is now a pressing need to accelerate the construction of new medium- and large-size mines, particularly in Shanxi and Inner Mongolia.

2.6 Less than 2 percent of the coal output is exported; there are also some imports caused by shortages of transport capacity and quality problems in the case of coking coal. The domestic market is dominated by industrial boilers, furnaces and kilns (43 percent), followed by power generation (26 percent), residential/commercial (22 percent), coking (7 percent) and transport (2 percent). Coal demand is expected to grow at 3.3 percent per annum in the 1990s; the share of power generation and residential are expected to increase.

Allocated Coal

2.7 Allocated coal is the coal from state, provincial and county mines distributed under state determined prices and according to the allocative priorities of central and provincial governments. In 1987, 88 percent of centrally controlled mine production was sold within the state allocation system. Provincial and county mines sell much of their coal under allocation, although pricing is more flexible.

2.8 In-plan coal prices are not firmly fixed. In the past few years, surcharges have been allowed above certain production levels. Production above quota (quotas were fixed over the period 1985-90) usually can be sold at a 50 percent surcharge. Production above annually set targets can be sold at higher prices (with or without ceilings). In addition, some state coal companies are allowed to negotiate higher prices with consumers for coal in special demand.

2.9 The allocation of plan coal is organized through an annual conference involving producers, large consumers and central government agencies. Negotiations are conducted, usually between participants who have had previous supply relationships stretching back for many years. The role of the central government may be fairly passive, except in allocations for major state enterprises with special requirements, in industries such as steel and electric power. But central authorities are in charge of arranging handling and transport of allocated coal. Routings usually follow patterns set up in previous years with only marginal changes; the process is not optimized. Rigidities in coal and transport allocation often lead to a suboptimal match of coal supply and demand.

Free Market Coal

2.10 Market coal is sold at negotiated prices. Collective and individual mines, representing the bulk of local mine production (and 35 percent of total production), sell their coal in the free market, as long as they can secure access to transport. Otherwise, they sell to the state mining bureaus. In deficit regions, for example Jiangsu or Liaoning, they are able to obtain very high prices. Official data on the total volume traded on the negotiated market are not available, but it is in the order of 40 percent. It is worth emphasizing that definitions of market coal vary. Cheap "market" coal in Shenyang may come from local mines outside the central allocation system but nevertheless may be subject to local price controls by provincial boards.

2.11 A variety of supply mechanisms have been evolving between consumers and producers: direct purchases from local mines close by or from state mines in coal surplus areas of the country which have above target supplies; investments in mines or long term supply arrangements; purchases through "middlemen" arranging transport; and barter trade.

Price Ranges

2.12 The relatively narrow free market absorbs supply and demand pressures throughout the economy. Prices, therefore, sometimes fluctuate sharply. Overall, they have risen in the last four years, faster than general inflation. Market prices in areas like Shanghai and Jiangsu are at or exceed

international levels. Prices at minehead for centrally owned mines were on average: Y 45/t for allocated coal, Y 90/t for guidance prices and Y 130/t for coal sold on the free market. The range of delivered coal prices for steam coal are shown in Table 2.1 for three major consuming areas and one major producing region, Shanxi (cf. CUS).

Table 2.1: PLAN VS. FREE-MARKET PRICES FOR STEAM COAL, 1989 /a

	Plan	Free Market
Beijing	55-70	140-150
Shenyang	45-70	80-180
Jiangsu	65-80	220-280
Shanxi	34-50	110-140

/a These are indicative prices gathered during visits to the cities cited and discussions with coal-purchasing companies and users. Shenyang is located in a coal-producing area but one that cannot supply all needs. Beijing has limited production but is located only 500 km from Datong, a major coal center in Shanxi. Jiangsu is a major coal-deficit province although some coal is produced in the north at Xuzhou and in neighboring provinces; coal delivered to the area from North China incurs high marginal transport costs.

2.13 The price differential between market and plan coal has widened in the late 1980s because of the shortages of coal throughout China in 1988/89 as well as inflationary pressures not reflected in "plan" prices. Wide differentials in prices are not a problem per se in a coal market as large and diverse as China's. The problem is that the differences come not from economic or quality variations but from arbitrary factors--whether the coal is sold on the allocated or free market and transport is available.

Impact of the Dual Price System

2.14 The tiered price system has two theoretical advantages. First, at the margin, consumers pay a price that is closer to the true economic value of coal, introducing economic efficiency in the use of the resource while avoiding the income shock associated with applying such a price to all production. Second, as production increases, the average price of coal increases. In practice, however, starting in 1986, the ministry found it more expedient to average the premium for all the coal sold by CMAs, except for sales to households. This blurs and complicates the economic signals received by consumers. Also, the level of revenues and their rate of increase built into the tiered pricing system are insufficient. Direct and indirect subsidies therefore continue to be required to cover operating costs and finance investments.

2.15 Several years after the introduction of the dual pricing system, a large amount of coal is still sold under conditions that encourage inefficient and wasteful practices. First, as the gap between plan and market prices widens, some consumers make wasteful decisions on the assumption that their quota will be raised--or as leverage for having it raised. Second, they tend to use whatever coal they can get under the plan allocation system, irrespective of whether the quality or sourcing makes economic sense. Price controls operating for certain consumers serve to hurt the supply of coal to those consumers. A case in point is the household sector which often does not receive high quality or lump anthracite. Other users, such as ammonia plants, buy anthracite at higher free-market prices, while traditional price controls apply in the household sector. Third, the rigidity of plan prices causes more volatile price adjustments in the free market--particularly in periods of shortage--because of the narrower base for adjustment. A broadening of the free market would reduce the amplitude of price fluctuations and that, in turn, would facilitate adjustments to changes in supply and demand, encouraging consumers and suppliers to be more responsive to those changes by adjusting their behavior.

2.16 Finally, multiple prices allow for quick profits through reselling low-priced coal at market prices. This may result in greater economic efficiency, but the additional revenue generally does not accrue to the producer. Above all, these quick profits are a corrupting influence which undermines public confidence in government and in the drive for economic reform. This perverse impact of dual pricing, although unquantifiable, is so important that it cannot be overstated.

III. IMPACT OF COAL PRICE DISTORTIONS

3.1 It is important first to clarify the definitions of price distortion and of their impacts. Coal markets in China are often relatively narrow and very sensitive to local variations in transport availability, hence data about market prices are often unavailable or outdated. In line with the analysis of the CPS, it is assumed here that in the long run, competitive prices of most coals would be based on the Long-Run Marginal Cost of supply (para. 4.1) and distortion is defined as the difference between the actual prices and LRMC-based prices. Also, a distinction must be drawn between the financial and economic impacts associated with the distortions. The financial impact is defined as the income transfers originating in the low coal prices to the users; these transfers are partially offset by subsidy payments made by the Government to coal mines and other sectors producing low-price input to the coal industry. The economic impact consists of supply-side and demand-side inefficiencies in the allocation and use of resources. The full cost of these inefficiencies is not quantified insofar as the LRMC-based prices internalize the environmental cost of coal mining but not of coal use. Economic welfare losses are grouped below under five headings of which the first three are related to the supply side:

(a) inefficient pattern of coal mining and transport;
(b) lack of coal beneficiation and mismatch of coal quality;
(c) inappropriate choice of coal over other fuels;
(d) inefficient conversion of coal into end-use energy; and

(e) suboptimal demand level of end-use energy.

Coal Supply Costs

3.2 According to the Coal Pricing Study, the long-run marginal cost (LRMC) for mining Shanxi coal is Y 107 per ton at economic prices after adjusting roughly for the 1987-89 inflation. Using this LRMC and the LRMCs of coal transport as a basis, the delivered LRMC of coal in 13 regional markets was estimated; for the country as a whole, it averages Y 130/t ROM.3/ This methodology is justified by the fact that Shanxi constitutes, at the margin, the cheapest source of steam coal for major consuming areas. To be competitive with Shanxi coal, minehead prices at all CMAs would average Y 100/t ROM; incremental costs at most CMAs are 20 percent higher on average with exceptions in the Northwest and distant Southwest. The LRMC of delivered coal results in wider regional differentials than the one included in the 1986 regulated price schedule which does not reflect the costs of transporting coal from the north (Table 3.1). Since then, it appears that differentials for coal to power plants have evolved to reflect transport capacity shortages while continuing to include income transfers to poorer areas.

Table 3.1: REGIONAL PRICE AND COST DIFFERENTIALS OF STANDARD COAL
(Base: North = 100)

	Price index		LRMC index	
	General (1986)	Power (1989)	Economic	"Financial"/a
Northeast	103	93	120	110
East	101	173	116	115
South	100	121	112	115
Northwest	97	71	107	104
Southwest	102	101	156	139

/a In calculating the "financial" LRMC, capital is still shadow priced at a 10 percent discount rate, but other inputs are kept at the "financial" prices of 1986.

3.3 Most of the price subsidies originate in the "protected" coal users defined as those who procure most of their needs at or close to plan prices; these consumers are less likely to make decisions on the basis of efficient coal prices defined at this point as the economic supply cost. Some data for this protected market have been gathered by DRC, but it is incomplete and tentative. The share of protected coal is variable across uses: 80 to 100 percent of requirements for coking, railways, urban households and power generation, much less for industries. The protected market segment is estimated to have absorbed 52 percent of total output in 1989 (550 Mt): 65 per-

3/ The calorific value of ROM coal averages 5.5 Gcal/tonne (22 GJ); for standard coal used in energy statistics, it is 7 Gcal/tonne (29 GJ).

cent of it was coal allocated under the plan (80 percent of the total plan quotas) and 35 percent was sold at guidance prices.

3.4 The average procurement price on the protected market is variable with the user: closer to LRMC for large power plants than for smaller and older ones. For this market as a whole, the delivered price is estimated at Y 80/t, corresponding to a minehead price of Y 65/t. With respect to the LRMC, the subsidy is therefore Y 50/t delivered and Y 35/t at minehead. Other consumers outside this market enjoy subsidies on the small share of plan quotas which is allocated to them, but the extent of this subsidy has not been investigated; for the purpose of estimating financial subsidies and after comparing them with observed figures, plan prices for these customers have been assumed equal to the average procurement prices of protected consumers.

Supply-Side Economic Losses

3.5 Inefficient Patterns of Coal Mining and Transport. There is no evidence that the low price of coal has depressed the overall coal mining output below its optimal level. The combination of market forces and government intervention has ensured that relatively adequate targets were met with few exceptions during the overheated economic growth of 1988. Even then, the problem seems to have been one of transport capacity shortage which increased inventories at mine sites and forced mining to slow down. To some extent, this shortage can be traced back to the low price of coal rail freight, an important element in the policy of coal price subsidization. A major cost of rail transport shortages is to hinder the development of more rational patterns of coal trade and mining; ideally, the rail tonnage of low cost and cleaner coal from the North could expand by 50 Mt and displace local coals, the net savings would be Y 1 billion a year (Y 20/t). Another consequence of coal transport subsidies is the underutilization of waterways. A third one is examined below and has to do with the inordinate amount of ash transported over long distances, because it is perceived as cheaper than washing the coals.

3.6 Subsidies for coal mining also remove incentives for the efficient operation of the state mines which produce primarily to meet a contracted plan quota. Further increases in quotas would therefore augment the scope for mining inefficiencies as long as plan prices are kept low. More generally, the lack of adequate rules and pricing mechanisms ensuring the accountability and autonomy of state-owned mines is bound to affect adversely their productivity and efficiency.

3.7 Lack of Coal Beneficiation. A notable inefficiency here is the transport of high ash-content coal over long distances. The long-run cost of increasing the amount of washed steam coal is about Y 15/t. Washing typically reduces transport requirements by 12 percent; i.e., Y 4/t for 1,000 km of rail haulage; other benefits (Y 8-12/t) include savings on ash removal, ash disposal and maintenance expenditures and increases in boiler reliability. On this basis, it appears that a larger share of steam coal exported by surplus regions should be washed at a benefit (especially where transport capacity shortages exist and translate into a doubling of the opportunity cost of transport). Other inefficiencies arise from the mismatch of coal quality with user specifications; they can be traced back to the low quality differentials in plan prices and in the administered allocation of coal. Minemouth genera-

tion from coal fines is lagging in part because of insufficient quality differentials and this is an indirect impediment to coal washing. Carbon losses could be reduced by coal screening and pelletization of fines. At a cost of about Y 2.5/t, coal screening can save about 2.5 percent of the coal used in industrial and household boilers. Screening all the "protected" coal for these users would entail carbon savings equivalent to 5 Mt of coal for a net economic gain of Y 160 million. Other benefits have not been costed here: a notable one is the pollution by households deprived of better, cleaner coals, particularly anthracite.

3.8 Inappropriate Choice of Coal over Other Fuels. Indirectly, subsidized coal prices hamper the development of natural gas. China's known recoverable reserves of natural gas are estimated at about 33 trillion cubic feet (Tcf) and its full geological potential at 1,000 Tcf. Production is only about 500 billion cf per year. More gas could be developed for an incremental cost of Y 5 per 1,000 cf (Y 17/Gcal) equivalent to coal at Y 94/t. But the economic loss incurred for not developing natural gas does not lie only in its very slim edge over coal in terms of production costs; besides its more benign environmental impact, gas use often requires lower capital and maintenance costs and as a result, it would be cheaper than coal for a price as high as Y 10 per 1,000 cf in many applications. Because of the high netback value of gas, producing annually an additional Tcf of gas would entail savings of Y 5 billion/year in the economy. Yet as long as coal prices remain at or under the cost of developing gas and as long as the other advantages of gas are not reflected in the anticipations of suppliers and users alike, these savings are not realized.

Demand-Side Economic Losses

3.9 Inefficient Conversion into End-Use Energy. These inefficiencies reached some 86 Mt in 1989 (Y 11.1 billion); the cost of the coal conservation measures proposed below to eliminate this waste would be offset by savings in the capacity costs of heat and power systems (see Annex).

3.10 Coal prices heavily influence industrial boilers' efficiency and insulation/regulation of space heating. Improved boilers could save 10 to 30 percent of the coal, but typically this investment costs Y 70/t of coal saved annually and consumers who are charged the plan coal prices would recover their investment only over a ten-year period which is not a sufficient incentive. This retrofit implemented on the protected market would have saved some 55 Mt in 1989.

3.11 Building insulation is particularly poor: simple retrofit of existing windows and walls would save 17 percent of the heat requirements, improvements for new buildings 32 percent. After accounting for the savings in the fixed costs of heating installations, these improvements are very economical for new buildings; for existing ones, they are covered when coal prices exceed Y 70/t. These improvements implemented on the protected market would have saved about 14 Mt in 1989.

3.12 Large-scale power development is based on relatively high "economic planning" prices of coal and hence tends to be correct. By contrast, the potential for biases in day-to-day operation is relatively large: polluting and inefficient plants supplied with subsidized coal will tend to be used more

than new and better ones; this bias has been small as long as power shortages required all assets to be fully utilized, but if dual pricing continues unchecked, the uneconomical operation of old power plants could grow to be a major source of administratively created energy waste.

3.13 Cogeneration of industrial process heat and power is not developed as much as it should because coal and most of the power continue to be low priced. Typically the retrofit of an industrial boiler with a turbogenerator would increase its coal consumption by 40 percent but save more than twice that amount in the power sector. Because of savings in power capacity costs, this retrofit would provide important capital gains whatever the coal prices; but since, with few exceptions, power tariffs do not as yet reflect the cost of capacity, the retrofit is viable only if coal prices exceed Y 100/t. A retrofit program of that kind, which would have increased by 10 percent the coal intake of industrial boilers on the protected coal market in 1989, would have led to coal savings of about 16 Mt and capital cost savings of about Y 4.6 billion in the power sector, enough to cover the net capital outlays for all the other conservation measures considered in paras. 3.10 and 3.11.

3.14 Suboptimal Demand Level of End-Use Energy. Paras. 3.9-3.13 were concerned with measures which reduce losses in the conversion of coal to end-use energy without lowering the demand for that energy. But that demand is also affected by the price. Price elasticities for cooking are small; for heating needs, they are also small once the impact of energy conservation investments has been accounted for as done above. A wider range of factor substitution is available in the industrial sector; improvement and switches in industrial processes, changes in the industrial output mix are sensitive to relative prices. The existence of important coal price subsidies has slowed down such developments and kept the demand for process heat lagging at relatively high levels. A short-run price elasticity of -0.05 and a long-run one of -0.3 have been observed for some economies in Europe. In China, for the particular case of industry and transport, a long run price elasticity of -0.15 has been assumed leading to a welfare loss of 23 Mt and Y 0.6 billion for 1989.

3.15 To summarize, the most directly quantifiable economic impact of coal price distortions are on the demand side and have to do with the high energy intensity caused by its low price. Inefficiencies in coal supply entailed by the inadequate price structure and allocation of various coals are difficult to gauge. Finally, an indirect consequence of coal low prices is the small share of natural gas in the energy balance. Table 3.2 recapitulates some rough estimates of the welfare losses in 1989; it also presents a summary of the financial impacts examined below.

Financial Impact of Coal Price Distortions

3.16 Coal Users. Low coal prices represent important income transfers from coal producers and transporters to coal users. With an average price subsidy of Y 50/t (para. 3.3), consumers on the protected market received about Y 28 billion in 1989. Other consumers who get most of their coal from the free market also get low price coal and may have received Y 5 billion in 1989. The total subsidy is Y 33 billion.

3.17 Coal Industry. A major source of transfers to coal users is the gap between the costs incurred by the coal industry and the prices it is allowed to charge (Y 65/t on average).4/ The cost of coal mining to the industry is however not the same as the minehead economic price (Y 100/t on average). This is because under the current price system, many input to mining are generally below their economic cost. According to the CPS, coal mines would cover their financial cost of operation and development with revenues of about 80 percent of the economic cost. With respect to this financial target at minehead (Y 80/t), the transfer from coal mines to consumers averages Y 15/t and amounted to Y 10 billion in 1989.

3.18 Upstream Industries. Price distortions for equipment, energy and other input to the coal industry averages Y 20/t and amounted to Y 13 billion; this subsidy is passed on to the consumers along with the one extended by the coal industry.

3.19 Transport Sector. This sector, particularly rail, contributes the complement of subsidy of Y 10 billion to obtain the total received by consumers in para. 3.16. It does it in two ways. First, the transport price subsidy applied to the considerable coal traffic represented about Y 4 billion in 1989; second, the combination of transport shortages and excessive mining in high cost areas (para. 3.5) represents a loss of traffic of perhaps 170,000 Mt-km, that is about Y 6 billion. This is in effect a transfer from the transport sector to the least cost-effective mines which is passed on to consumers.

3.20 Regional Transfers. Interregional coal trade generates transfers mainly from the exporting North to Northeast and Southwest China. This transfer is estimated at some Y 3.5 billion in 1989 based on the gap between the economic and actual prices at minehead in the North and the tonnage of subsidized coal exported by this region.

3.21 Government. The above subsidies extended to consumers are having an adverse impact on the finances of the coal and transport sector and some industries upstream. To some extent, they are offset by subsidy payments from the government that are either direct or in the form of low-interest loans and tax breaks. In 1989, direct subsidies to mining amounted to Y 3.9 billion; they were mainly extended by the central government and channeled mostly to state mines. Interest rate subsidies can be estimated at Y 4 billion; the total does not quite amount to the Y 10 billion estimated in para. 3.17; this is perhaps because the financial target of Y 80/t would not only allow state mines to barely subsist as they do now but also finance a substantial share of their investment. Finally, it is worth noting that state-owned enterprises and administrations account for 80 percent of the coal consumption on the protected market and thus received the bulk of the consumers subsidies; under the current system of ownership and taxation, this mean that a large part of the subsidies payments to the mining sector and railways is recouped by the

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4/ Centrally controlled mines on average sell 85 percent of their output quota at plan prices (Y 45/t) and 15% at guidance prices (Y 90/t); to obtain a revenue of Y 65/t, their sales at market prices (Y 130/t) have to exceed 10 percent of their quota, a rare occurrence.

government through reductions in fuel outlays and ultimately higher profit remittances.

Table 3.2: ESTIMATE OF ECONOMIC AND FINANCIAL IMPACTS
(Year 1989)

Economic Losses	Mt	Y billion	Financial Transfers (Y billion)			
Total	113	12.36				
Supply side			To:		From:	
Mining and transport	0	1.0	Consumers	33	Mines	10
Screening & Washing	5	0.2			Upstream	13
Choice of fuel	n.a.	n.a.			Transport	10
Demand side			Mines	10	Government	10
Conversion:					of which:	
.building insulation	14	1.18			.direct	3.9
.boiler efficiency	55	3.31			.interest	4.0
.cogeneration	16	6.71			.adjustment	2.1
End-use energy demand	22	0.56				

IV. PRINCIPLES OF COAL PRICE REFORM

4.1 Border pricing of all Chinese coal would not be appropriate. China's coal exports are small in terms of world trade (3 percent). As the LRMC of coal production and transport are likely to stay well below international coal price levels, China has the potential to expand exports once it meets domestic demand and overcomes transport constraints and quality problems. As it does, it can become a price setter rather than a price taker.

4.2 The most efficient strategy for China would be to control coal export volumes so as to maximize its producers' net benefit. With exports already determined, the opportunity cost of increased domestic consumption is the LRMC rather than the border price. So the LRMC is the correct reference for domestic coal pricing. The exceptions to this rule should be confined to washed coals of export-quality grade and certain blending coking coal. These coals should be priced on the basis of border prices, since their opportunity costs are linked to the price of exportable coking coal.5/

4.3 While moving towards more efficient coal prices, two features of the coal industry should be taken into account. One is the dual nature of the sector, as evidenced by differences in producer access to equipment, transportation, and finance and by the degree of price regulation. The large state mines have preferential access to inputs and transportation, but these mines must sell most of their product at low prices, often to very distant consumers. By contrast, local mines operate without access to railways but supply a

5/ See CPS, op. cit., p. 31, for a detailed discussion of this issue.

smaller fraction of output at regulated prices; they usually average lower production costs with the result that, in coal-rich regions, market prices are low. A second characteristic of the coal industry is the fragmentary nature of markets. With planned allocation, producers and users have little need to develop marketing channels that optimize the match between the characteristics of a given coal and the needs of potential users and the underdevelopment of transport facilities limits any matching.

4.4 Given the large number of coal producers and users in China, supply and demand in regional markets should determine prices. Under this scenario, rail transport would be the only link in the coal supply chain subject to regulation. Tariffs would be regulated to ensure that the railways did not use their monopoly position to appropriate producer and consumer surpluses, but there is still a risk that other transport modes could behave as monopolies where transport capacity is short.

4.5 Coal prices present regulatory authorities with other difficulties. These stem from the diversity of coals produced and the absence of techniques to assign economic values to quality characteristics such as ash, sulfur, moisture, and volatile content. LRMC pricing and other administered pricing methods have limitations. While they can guide overall coal price levels and provide insights for coal development plans, they do not allow for the finer definition of coal prices. To achieve this, market forces must come into play.

4.6 In moving away from the existing pricing system, a fairly rapid increase in plan prices should be combined with a gradual loosening of price controls with the double objective to have consumers use coal more efficiently and put the coal industry finances on a healthy footing. In the transition period, officials would have time to decentralize coal marketing expertise at provincial and local levels.

4.7 Recommended Strategy. In a first stage, plan prices should be raised to about 80 percent of the LRMC-based price at minehead. Prices at city-gate would similarly be adjusted to 80 percent of the LRMC. Washed coking coal of export quality and certain blending coking coals would be priced with reference to world market prices. In reaching this interim target, plan prices for allocated steam coals should catch up with guidance prices (Y 90/t on average) and these unified prices should be applied to "old" and "new" coal. It would imply, on average, a 40 percent increase over the prices on the protected market in 1989; a little less after correcting for the inflation in 1990. This adjustment could be made in two years. Surcharges for above-quota coal would then be eliminated, and coal from a given source would carry a uniform price equal to today's guidance price. With a rising proportion of coal sold at levels close to market-clearing prices, government allocations would be phased out and a gradual deregulation would take place (within five years). At the start, the basic raw coal price would be set, but producers and users could negotiate prices with respect to quality within a broad range around reference prices. The first two years of price adjustment would eliminate the financial subsidies extended to coal users by the coal and transport sectors. As price reforms are extended to other sectors of the economy, coal prices would likely settle around the full economic LRMC which is, on average, 60 percent above the procurement prices currently observed on the protected market.

4.8 Environmental preoccupations have been thus far subsumed in the efficiency objectives of the coal price reform. They are already addressed in two ways. First, the pricing targets considered above do cover the cost of mitigating the environmental impact of coal mining and the reform would transfer to the mining areas--particularly the Shanxi province--important incomes to deal with this very acute problem. Second, the reform would overall encourage the supply of better quality or washed coal and natural gas. However, efficient pricing also has limitations and would run counter to environmental objectives if adequate regulations and pollution levies were not enforced to promote the use of cleaner coals which would be sold at a premium. This levy approach is preferable to "adjusting" coal prices according to their impact on the environment; such manipulations would reintroduce administered price differentials in an already very complex price structure which, as pointed out, only the market will be ultimately able to sort out.

Accompanying Reforms

4.9 The tax rate and, where applicable, the performance contracts currently applied to the coal sector would need to be reviewed in line with improved sector financial performance. An important aspect here is the provincial/central government relationship. Provincial governments currently receive the 3 percent product tax on coal sales, while profits from centrally controlled mines belong to the central government. Depending on the provincial economic structure, increased coal prices could cut provincial tax revenues if net income falls too much for coal-using provincial industries. In such cases, provincial policy may be to keep coal prices artificially low. A sound tax system should aim at minimizing such distortions. Finally, the concessional terms of loans for coal development should continue to be phased out and rules permitting private-sector equity investments should be introduced.

4.10 Enterprise reform would help ensure the success of the coal price reform. Coal mine administrators should be vested with full financial responsibility and decision-making authority in such areas as personnel, investments, and use of after-tax income. Management emphasis would shift from maximizing tonnage output to maximizing net income. Better productivity and utilization of the existing asset base in centrally controlled mines would result. Provided that safety practices and control of mining areas in the provincial and collective mining sectors are improved, these various reforms would bring in closer correspondence the production costs of mechanized and unmechanized mines. In the long run, individual mines should be able to be fully autonomous and compete against each other without cross-subsidization.

4.11 In the short and medium run, however, large state mines will retain a position of monopoly and their level of revenue will need to be regulated by the government. This regulatory function should be streamlined to the essentials. It should be clearly separated from the prerogatives of the government as an owner. This separation--and distance--between owner and regulator can be created by vesting ownership and diversifying it in bodies that have no relationship with the regulators. The regulatory functions typically should be under the responsibility of core government agencies--Ministry of Finance or State Price Bureaus (with the technical support of the Ministry of Energy); this is dictated by the need to harmonize the regulatory process across vari-

ous sectors, while still customizing the more technical aspects of performance evaluation to the needs of each particular sector.

4.12 Transport, its capacity allocation and expansion, and its pricing will play a pivotal role in the transition to a less regulated coal price structure. Wider coal markets will exist only to the extent that local producers and users face choices with respect to purchasers and suppliers. Studies of transportation pricing should establish cost-based tariffs for rail and waterway transport of coal. Such tariffs would promote least-cost coal producer-user linkages and ensure that delivered coal prices are more rational. They should be regulated in a way similar to the one suggested in para. 4.11.

V. IMPACT OF COAL PRICE REFORM

Economic Impact of Price Reform

5.1 Raising plan prices to economically efficient level would be a major step towards eliminating the welfare losses mentioned in Section II. Most of these losses are growing with the size of the protected market. Assuming that it remains a constant share of the total output and thus grows at 3.3 percent per annum, welfare losses would exceed 700 Mt (Y 80 billion) for the period 1990-95. The economic benefits of completing the reform started in the mid-1980s would be large; the areas of improvement are recapitulated below.

5.2 On the demand side, the major impact would be to support and extend the energy conservation effort which is key to a sustainable development strategy in China. Raising plan price levels for coal is particularly relevant to the following:

(a) Improving boiler operation;
(b) Replacing inefficient boilers;
(c) More industrial plants retrofits;
(d) More heat and power cogeneration for industries;
(e) Raising the efficiency of household stoves; and
(f) Better building insulation and heating/cooling installations.

5.3 Raising the plan prices of coal and letting geographical and quality differentials reflect the cost of coal mining, beneficiation and transport would also rationalize the energy supply in several ways, namely by:

(a) Enhancing productivity in state-owned mines;

(b) Substituting local coals by Shanxi coal in areas where it is economically competitive;

(c) Fostering more screening, washing, pelletization of coal and mine-mouth power generation to utilize greater amounts of coal fines;

(d) Allowing a better match of coal quality to boiler specifications; and

(e) Prompting the development of natural gas.

Financial Impact of Price Reform

5.4 It is difficult to predict what will be the future financial cost of coal price subsidies if the present pricing policies are maintained. Indirect subsidies on interest rates and other inputs to the coal industry could be on the wane as other sectors of the economy are reformed, but direct subsidies would then be rising in real terms; these are projected at Y 5.4 billion for 1990, 38 percent above the 1989 figure. Overall, indirect and direct subsidies could exceed Y 200 billion for the period 1990-95.

5.5 Coal Industry. According to the Coal Pricing Study, an immediate switch to the interim pricing target would reduce the number of CMAs operating at a loss to very few; the proportion of state-mined coal produced at a loss would also fall dramatically. In the study, forecasts of the consolidated financial performance of centrally controlled CMAs were made for a base case scenario assuming reforms over a two-year period. In this scenario, the sector would show a rapid return to more normal levels of financial viability. The price increase would allow one-third of the total sectoral investment program to be financed internally and would reduce debt financing of investments in new mining capacity to 60 percent. Implementation of a slower price reform scenario would have a markedly negative impact on projected sector finances. In particular, most investments in new capacity would continue to be 100 percent debt-financed.

5.6 Industries and Households. A simplified input-output analysis in the Coal Pricing Study shows that a 40 percent increase in coal prices on the protected market would have mostly an impact on the financial conditions of thermal power and town-gas production (where town gas is based on coal) with cost increases of 10 percent on average. Electricity costs at the retail level would increase notably less (5 to 8 percent). Lime, cement, and iron smelting industries would incur cost increases of about 6 percent. Railroad freight and the pulp and paper industry show the lowest cost increases at 2 percent. These are averages, but the range of variation is also worth noting: the cost of high voltage electricity in the North could raise by 15 percent, the cost of pig iron by 12 percent. The changes in the profitability of these sectors is examined below.

5.7 Cost pushes in the raw material industries, chemical industries and power generation will likely be passed on to the consumers, since these sectors are regulated on the basis of their average cost to meet profitability criteria. However, the ripple effect of price rises for these commodities is likely to be insignificant. This is particularly true for electricity which represents less than 5 percent of total output cost in most industries.6/ Price rises for machinery, light industrial products, textiles and articles for daily use are less likely because of competition. For instance, the cost of machinery would rise 5 percent, tax remittances and retained earnings for this industry would drop by 5 percent; for ship building, costs would rise

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6/ East China Power Pricing Study, Report No. 6993-CHA, World Bank, February 1988.

3 percent, taxes and retained earnings drop about 6 percent. The profits and taxes from light industry, textiles and food would be reduced by 6 percent.

5.8 Coal price increases (and town gas price increases where applicable) would have only a minor impact on average household expenditures. According to the Coal Pricing Study, based on 1986 assumptions, a minemouth coal plan price increase of 100 percent would translate into a 64 percent increase in the cost of delivered coal; the additional cost would amount to only 0.7 percent of the average income of urban dwellers and at most 1.4 percent of that of rural residents.

Impact of Price Reform on Public Finances

5.9 According to a recent Chinese study,7/ an increase of 100 percent in coal prices would produce a 137 percent surge in the tax remittances by the coal sector. After this price adjustment, public revenue is raised by about 4 percent through the levy of product and value-added taxes plus 2.6 percent through profit tax receipts. This coal price increase would, on the other hand, inflate public expenditure by 5.2 percent because of additional subsidies to loss-making enterprises, contributions to investments and fuel expenditures by administrations. The general price level and the amount of tax revenue for the economy at large would increase by 11 percent. The impact on public finances of a steep rise in the plan price of coal would be globally positive; it would enable the State to help the most affected industries pass the hurdle of the price adjustment. The study suggests two ways to do it:

(a) Selective cuts in tax rates: currently, turnover taxes make for a large share of public revenues, but the tax rates vary greatly. Selective tax cuts are possible on a limited scale but they would complicate the tax system which sorely needs streamlining. This method would also lack transparency.

(b) Regressive subsidies: lump sum transfers could be made equivalent to the additional fuel costs incurred on the first year of the price adjustment and reduced by 20 percent every subsequent year. The study estimates that such help would absorb only 1 to 2 percent of public revenues.

5.10 With the 40 percent interim price adjustment proposed in para. 4.7, two conclusions stand out: (i) the impact on public finances is positive and, (ii) as a result, regressive subsidies can be afforded for selected industries either in the form of grants or concessional loans. These subsidies are not only fiscally feasible, they may also prove economically desirable if they fund technical upgrading in those sectors left with an obsolete capital stock and poor growth prospects as a result of higher coal prices.

7/ Ma Bin et al., "China's Price Reforms and State Finance," mimeo received from the Development Research Center of the State Council, Beijing, 1989.

VI. CONCLUDING REMARKS

6.1 Coal price reform is key to reducing further the energy intensity and rationalizing the energy supply in the Chinese economy. The dual pricing policy introduced in the 1980s has outlived its usefulness and is proving increasingly costly, both in terms of economic losses and financial transfers. The movement towards a unified system of market driven prices should be resumed without delay to take advantage of the current reduction in supply and demand imbalances. The reform should not take more than five years. As an interim step, an action plan could be implemented within two years, with the immediate result of eliminating financial subsidies to the coal users and improving the transparency and the efficiency of the allocation process for coals of different qualities and origins.

6.2 The most adversely affected sectors would be power generation, town-gas production and iron smelting; but targeted financial help to wean them away from subsidized coal is fiscally feasible and economically desirable. Local experiments with the elimination of plan quotas and preferential prices for raw materials have been carried out--e.g., in Shijiazhuang, Hebei province--with a full and mechanical compensation of customers for higher procurement prices, that is, without any fiscal benefit or economic advantage from technical upgrading. Even then, that liberalization had at least two advantages. First, by letting users free to choose their supplier, it stimulated competition with regard to pricing and matching better their quality requirements. Second, it eliminated discrimination and the need to seek a "backdoor" access to commodities in short supply.

6.3 The coal and transport sectors and indirectly the development of natural gas stand to benefit greatly from the completion of the coal price reform. Provinces in the North would increase their revenue and would have the means to develop China's best coal under sound environmental conditions. Risks exist that the full economic and financial benefits on the supply side would not be fully realized because of rent-seeking behavior by enterprises in this sector. Monopoly cost-plus pricing cannot be avoided for rail transport and gas distribution; it must be carefully regulated. For enterprises engaged in coal mining and beneficiation, the elements for a vibrant and competitive market already exist in China with two important exceptions: (i) a level playing field when it comes to access and prices for their input, output and fiscal regime and (ii) autonomy and accountability for their management decisions. For those enterprises which will continue to enjoy a position of monopoly, price regulation should be kept but it should be rationalized and simplified in order to achieve objective (ii). Substantial progress must be made in these areas in order to avoid a cost-price spiral that would endanger price reform.

6.4 The next step in the coal price reform process should be the execution of an action plan for the next two years to achieve the interim target defined above (para. 6.1), namely increasing plan prices to cover the "financial" LRMC of mining and rail transport and setting the stage for widening the role of coals markets. Because of the need to stimulate efficient mining and trading patterns, this action plan should apply nationwide or at least for the major coal producing and using areas. It should blend in the elements of enterprise reform that are key to its success (paras. 6.2 and 6.3). In light

of the above, the following sector-specific topics should be studied in detail:

(a) the economic and financial impact of the proposed price increase on coal-intensive sectors and large enterprises;

(b) the design of financial help in the form of grants or loans directed at the technical upgrading/restructuring for selected enterprises;

(c) a streamlining of the performance evaluation and price regulation system for state mines; and

(d) ways to transform the coal allocation administration into a more efficient system of coal marketing enterprises.

Coal Pricing in China: Issues and Reform Strategy

Assumptions for Assessing the Impact of Low Coal Prices

1. Decrease in Energy Intensity and Coal Savings. Energy savings are calculated on the basis of GDP figures at 1980 dollar prices and of the difference observed between each year's energy intensity and that of the base year 1980 (1.5 toe per $1,000). The savings are as follows (in toe):

1981	1982	1983	1984	1985	1986	1987	1988	1989
36	54	77	111	145	184	229	275	275

The total savings accumulated over the period 1981-89 are 1,385 Mtoe or 2,530 t of ROM coal.

2. The Long-Run Marginal Cost (LRMC) of mining coal has been calculated in the Coal Pricing Study (CPS) at 1986 prices. About 33 percent of the mining cost is labor, 67 percent material and equipment. For the four years 1986-89, it is assumed that labor costs inflated according to the consumer price index (52.8 percent) and other costs followed the GDP index (29.7 percent); the composite index is 37.3 percent. The same index is used to adjust the LRMC of coal transport; the results are in line with the findings of the 1990 Guangdong Transport Study. From the CPS Table 4.6, para. 4.44 and Annex 10, the following LRMC-based prices have been derived for steam coal at minehead and delivered at city-gate (Table 1).

Table 1: COAL SUPPLY COSTS
(Y/ton ROM as of 01/01/90)

Area	Minehead	City-gate	Of which transport	tce/t ROM
Datong	107	-	-	1.00
North	94	120	13	0.88
Northeast	94	120	13	0.73
East	102	131	24	0.83
South	99	127	20	0.83
Southwest	131	168	61	0.79
Northwest	95	121	15	0.83
Average	100	130	23	0.83

Note: All costs in this paper are calculated with a 10 percent per annum discount rate.

3. Transport costs include loading/reloading on train (Y 1/t) plus (fen) f 3.3/t-km (Annex 7 of CPS) and coal losses worth about Y 2/t. Shipping on waterways include additional charges: Y 6.2/t for rail/sea transfer, f 2.6/t-km and f 1.0/t-km for transport by river and sea, respectively. The transport costs from Datong to consuming areas in the North are pitched at Y 13/t ROM (300 km of rail haulage).

4. Protected consumer data has to be reconstructed from partial information as to their procurement under the Plan and under guidance prices. In 1989, about 460 million tons (Mt) or 43.6 percent of the country's output was allocated under the Plan. Protected consumers must have received about 360 Mt of this coal and purchased some 190 Mt at guidance prices; that is, respectively, 65 percent and 35 percent of their needs. The substantial share procured at guidance prices allows other consumers to receive coal under the Plan (100 Mt in 1989 or 20 percent of their needs). It raises the average procurement price on the protected market to Y 65/t at minehead (Y 80/t delivered). The rough shares of the protected market by main using sectors are shown in Table 2 below.

Table 2: SIZE OF PROTECTED MARKET (1989)

Sector	Demand (Mt ROM)	Protected market	
		Mt ROM	%
Power generation	268	142	83
Industrial boilers	325	130	40
Other industries	100	20	20
Coking	74	59	100
Railways	24	24	100
Households	263	79	30
Total	1,054	549	52

5. Patterns of Coal Mining and Transport. A coal transport study optimizing these patterns shows that the North should export to other regions some 240 MT or 17 percent of the country's output of 1,400 MT in the year 2000. This percentage should be smaller in the early 1990s, but it can still be assumed that 165 Mt, instead of the actual 115 Mt, should have been transferred with a net cost savings of (165 - 115) x Y 20/t = Y 1,000 million.

6. Coal Beneficiation. The Coal Utilization Study (Annex 10) estimates the cost of coal washing on the following basis: Y 30/t for capital costs, Y 3/t for operating costs, and an 8.3 percent increase in mining costs. This translates into an average incremental cost at minehead of Y 0.64/GJ or Y 14.7/t ROM. The benefits of coal washing include transport cost savings. Over 1,000 km this cost is Y 36/t (of which Y 3/t for handling and losses), savings are Y 4.5/t (12 percent). Other benefits are savings in ash disposal and maintenance costs for boilers (Y 5/t); ash removal in the flue gas is needed in all cases for the fine particles which washing generally does not remove, but washed coal still saves a fraction of the maintenance cost for ash removal equipment (electrostatic precipitators, filter bags) where these

exist, that is Y 1 to 3/t. Boiler availability also increases with washed coal. For a power plant, this benefit translates into lesser needs for new capacity: at an annualized cost of Y 600/kW, a 2 percent increase in reliability saves Y 12/kW in the process of burning clean coal for 6,000 hours/year (3 t ROM); so power plants' reliability benefits amount to Y 4/t of washed coal. It is about half that amount for industrial boilers.

7. Coal screening has an average incremental cost of Y 2.5/t and saves about 2.5 percent of the carbon content (Annex 10 of the CUS). The cost of carbon saved is therefore 2.5/0.25 = Y 100/t. Industry and households in the protected market consumed 209 Mt in 1989; screening would have saved 5.2 Mt of carbon worth 5.2 x Y 130 = Y 680 million at a cost of Y 520 million.

8. Improved boilers typically cost Y 300,000 per Gcal/hr of capacity (Y 260/kWt), that is Y 35,300 annualized over a 20-year life at 10 percent per annum. With an efficiency of 80 percent, they consume 1/0.8 x 5.5 = 0.23 t/Gcal as against 0.37 t for older boilers having efficiencies of 50 percent. Annual savings for industrial boilers operated 4,000 hours/year are therefore 0.13 x 4,000 = 520 t ROM worth Y 67,600 at supply costs but about half that amount if coal is valued at the protected market price. The investment is recovered in five years in the former case, nine years in the latter. Put another way, the cost of the retrofit is Y 35,300/520 = Y 68/t of coal saved annually.

9. Building insulation for new buildings (windows, walls and roofs) saves about 12 GJ for an average apartment; that is 32 percent of its annual needs (37 GJ); the cost of the retrofit is about Y 1,000 or Y 10 per GJ annually saved. This investment not only saves coal but reduces the size of the heating system, both inside the building and outside (district boilers, piping and heat exchangers), which cost annually Y 20/GJ. The net benefits of the insulation are thus Y 10/GJ, that is Y 230/t plus the coal savings of Y 130/t. For existing buildings, improvements in walls and windows save about 7 GJ at a cost of Y 800 or Y 13 per GJ annually saved. This investment saves coal and reduces the size of the heating system shared with other buildings (district boilers, etc.), but not the radiators and piping of the building itself. The fixed cost savings are Y 10/GJ, hence a net cost of Y 3/GJ (Y 66/t) which is offset by coal savings when those are counted at supply costs. For a mix containing 5 percent of new buildings, the net cost of building insulation is about Y 45/t.

10. Cogeneration of heat and power can be quickly increased with backpressure turbines retrofitted on industrial boilers producing process heat. The output of heat and power are in a fixed ratio, typically 15 to 6. With a boiler efficiency of 75 percent, producing power will increase coal consumption by 6/0.75 = 8; but producing these same units of power with a power-only plant, which has an efficiency of 33 percent, would cost 6/0.33 = 18. Thus, cogeneration saves in the power sector 2.25 the additional amount of coal spent in the industry sector. Cogeneration also saves capital, namely the boiler capacity that would be required for a turbogenerator of equivalent output in the power sector. For instance, a turbine of 6 MWe operated 4,000 hours/year will save (18-8) x 4,000 hr x 3,600 s = 144 GJ of heat; the boiler that would be required in a power-only plant would have a capacity of 18 MWt and cost Y 600/kWt, that is an annualized cost including operation and mainte-

nance of about 18 x Y 98 = Y 1,764. Capacity savings per GJ saved amount therefore to 1,764/144 = Y 12.3/GJ or Y 283/t of coal.

11. Economic benefits foregone from lack of conservation are calculated on the basis of paras. 6-9 above and for the protected market defined in para. 4. Table 3 below summarizes the calculation; it shows a net gain on conservation measures of 91 Mt. Excluding coal screening, which is related to the supply side, the net gains from conservation for consumers amount to 86 Mt and Y 10.3 billion.

Table 3: ECONOMIC BENEFITS FOREGONE DUE TO LOW COAL PRICE
(Feasible coal savings on the protected market)

Coal supply cost in Y/t ROM (23 GJ/t): 130
Average coal price in Y/t ROM: 80

Demand reductions
Price elasticity: -0.15 9.06% 22 Mt ROM Y 562 million

Impact of conservation: 16.50% 91 Mt ROM Y 11,360 million
Of which:

Sector	Total demand	Protected market Share (%)	Protected market mln t	Coal screening /a Share (%)	Coal screening /a mln t	Building insulation /b Share (%)	Building insulation /b mln t	Improved boilers /a Share (%)	Improved boilers /a mln t	Addition of BP turbines /b Share (%)	Addition of BP turbines /b mln t	Total coal savings Share (%)	Total coal savings mln t
Power	268	83.0	222	0.0	0.0	0.0	0.0	0.0	0.0	13.1	29	13.1	29
Industrial boilers	325	40.0	130	2.5	3.3	0.0	0.0	30.0	39.0	-10.0	-13.0	22.5	29
Other industry	100	20.0	20	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0
Coking	74	100.0	74	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0
Railway	24	100.0	24	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0
Households													
New	13	30.0	4	2.5	0.1	32.0	1.2	30.0	1.2	0.0	0.0	64.5	3
Existing	250	30.0	75	2.5	1.9	17.0	12.8	20.0	15.0	0.0	0.0	39.5	30
Total	1,054	52.1	549	1.0	5	2.5	14	10.0	55	3.0	16	16.5	91
Economic value (Y million)	137,020		71,414		679		1,820		7,172		2,113		11,783
Conservation costs													
Y/ton	-		-		100		45		70		-283		5
Y million	-		-		522		636		3,862		-4,597		423
Net gain (Y million)	-		-		157		1,183		3,310		6,710		11,360

12. High Level of Heat Consumption. The coal price distortion with respect to the LRMC is 62 percent, an increase of that size on the protected market for industry and transport would shrink demand by 0.15 x 62 percent = 9.3 percent. In 1989, that would have represented savings of 0.093 x 248 Mt = 23 Mt and an increase in consumer surplus of 23 x (130-80)/2 = Y 575 million.

13. Subsidies are calculated first with respect to the economic LRMC of Y 130/t delivered and to the prices of Y 80/t for protected consumers and for the Plan coal supplied to other users; that is, 650 Mt x Y 50 = Y 32,500 million. At minehead, the subsidy is Y 35/t and amounts to Y 23 billion in total.

14. Financial subsidies are calculated next with respect to the financial LRMC of Y 80/t at minehead and to the minehead prices of Y 65/t for protected consumers and for the Plan coal supplied to other users; that is, 650 Mt x Y 15 = Y 9,750 million.

15. Rail transport subsidies originate mainly in the difference between the LRMC of f 3.3/t-km and the rail freight rate of f 2.1/t-km. Allocated coal certainly accounts for a disproportionate amount of the traffic volume and guidance coal would likely correspond to the remainder; therefore, the total is estimated at 350,000 Mt * km x 0.012 = Y 4,200 million.

16. Mining Subsidy from the North. Exports to other regions were about 130 Mt in 1989; the LRMC at minehead is estimated at Y 94/t. About 16 Mt was exported abroad and a comparable amount sold at near market prices. It is estimated that 100 Mt was sold with an economic subsidy of Y 35/t.

17. Interest Rate Subsidy. Nominal rates for coal projects were, on average, 2.4 percent in the 1980s. With an average inflation of 8 percent, these rates should have been at least 12 percent and interest payments which account for Y 1/t should have been Y 5/t, a net subsidy of Y 4/t.

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