

The Impacts of China's Accession to the World Trade Organization (WTO) on China's Energy Sector

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1. Background

It was said to be a win-win game when the Minister of the China Foreign Trade Ministry and the Trade Representative of the United States toasted each other on the Sino-American bilateral agreement on China's entry into the WTO on November 15, 1999. Half a year later, a similar agreement was reached between the European Union and China. Climbing the two largest mountains to get to the WTO, China is approaching the endpoint of the marathon. China needs the world, and the world can not advance without the participation of China. Facing the challenges brought about by the new technologies and global mobility of capital, no country can develop further rapidly and healthily without adapting to this globalization of economy. This is also true for China, the largest developing country in the world. It is in great need of taking in the advanced technologies, large volume of capital, and policy experiences to facilitate its economic reformation, even political reformation.

Given access to the WTO, China will reap the following benefits:

- 1). Its products (exports and imports) can be treated by the multi-lateral, unconditional, and most-favored-nation clause in all the Party countries of the WTO;
- 2). Its export products and semi-products can benefit from the universal favored clause in most developed countries and will be under special consideration for developing countries;
- 3). It can use the special body and procedures for trade dispute of the WTO to resolve the trade disputes between China and WTO member countries. It will provide an open, impartial, and equal stage to resolve the disputes to protect the trade benefits of China;
- 4). It can participate in the drafting and decision-making of the trade rules of the WTO.

Of course, the rights and obligations are symmetric. China will recognize its stipulated commitments in the agreements:

- 1). It has to cut down its import tariffs. The present weighted average rate of the developed Parties of the WTO has been reduced from 40% to 3.7% in the past 45 years, but the tariff rate of China was 23% in the year 1996, and then was reduced to 17% in 1997.
- 2). It has to abolish its non-tariff measures, including export subsidies, export and import licenses, import quotas, and the like;
- 3). It has to promote the transparency of its foreign trade policy;
- 4). It has to open the service trade market and relax the limits on foreign investment;

5). It has to deepen and broaden its intellectual property rights.

On the whole, China will suffer losses in several sectors including agriculture, petroleum and chemicals, automobile, and other capital-intensive industries in the short term; but in the long run, China will benefit from the external trade environment, such as diversification of the export markets, universal favored clause, decision-making of the trade game rule. This paper focuses on the impact of China's access to the WTO on the energy sector. Section 2 delineates a Calculable General Equilibrium (CGE) model of China to discuss implications of entry into the WTO to China. Section 3 outlines China's economic adjustment due to access to the WTO and its impacts on energy demand. Section 4 analyzes the features of the residential energy consumption of China in the future 10-20 years and its interaction with China's access to the WTO. Section 5 specifies the challenges brought about by entry into the WTO on China's energy industries, including coal, oil, gas, and electricity. And Section 6 ends with conclusions and remarks.

2. Model Scenarios

2.1 The Economic Structure and Market Opening of China

Li *et al.* calculates the Social Accounting Matrix (SAM) of China based on the one country model (Li, 2000 [8]). The SAM outlines the economic structure and opening of the base year 1995. Based on their statistics, there exist large asymmetries between sectors in terms of their employment, trade share, and output. (1) The crop sector absorbs 45% of the total labors, but its output only accounts for 7% of the total, and its import and export volume only makes up for 2% of the total. Textile, clothing and leather industries account for only 3% of employment and 8.7% of total output, but their export volume hits 27% of the total. (2) Clothing, leather and electronics have the biggest export competition, over 30% of whose products are sold in the international markets. Textile, and light industry consumer goods rank second. (3) With regard to imports, the top two sectors are machinery and chemicals, which explain 19% and 13% of the total import, respectively. In the energy sector, the export share of coal mining is more than its import share, and there is only small volume of power export to Hong Kong SAZ, but for petroleum mining and refining, their import shares are much more than their export shares (Table 1). Non-Tariff Barriers (NTB) are the main protective measures for coal and petroleum mining considering their low nominal tariff rates. They notice the large discrepancy between the nominal tariff rates and actual ones due to the large quantities of machining trade and smuggling and pervasive tariff reduction and exemption. For example, in the clothing industry, the nominal tariff rate hits a high of 9.2 times the real one. We also calculate the whole real tariff rate based on the China Statistical Yearbook 1999. The results are illustrated in Table 2.

Table 1. The Output, Import, and Export Tariff Rates of Selected Industries of China 1995 (%)

	Coal Mining	Oil & Gas Mining	Textile	Leather	Electric Power	Petroleum Refining	Automobile
Output	0.85	0.96	5.12	1.39	1.87	1.44	1.54
Import	0.05	1.63	7.90	1.51	0.02	1.60	1.56
Export	0.62	1.37	12.87	5.23	0.24	0.63	0.38
Export/Output	6.7	13.9	21.0	33.33	1.0	3.4	2.4
Import/Domestic Use	0.7	17.9	13.5	11.39	0.1	9.7	11.1
Nominal TR	12.0	1.5	58.7	30.8	3.0	9.5	78.1
Tariff Equivalent of NTBs	45.7	45.7	24.3	18.4	-	15.0	26.3

Source: adapted from Li *et al.* (2000)

Table 2. The Real Tariff Rate of China 1970-1998

Item	1970	1975	1980	1986	1988	1990	1992	1994	1996	1998
Import Tariff (100 M RMB)	7	15	34	152	155	159	213	273	302	313
Import Volume(100 M RMB)	56	147	299	1498	2055	2574	4443	9960	11557	11622
Real Tariff Rate(%)	12.5	10.2	11.2	10.1	7.5	6.2	4.8	2.7	2.6	2.7

Data Source: China Statistical Yearbook 1999.

Table 2 tells us that the real tariff rate is much lower than the nominal rate in China because of the incomplete tariff system. The year 1978 to 1986 saw between 12% and 15% of the real tariff rate, and this rate was gradually reduced to between 2.5% and 2.7%. The tariff structure of China reflects its features as a developing country; that is, the capital-intensive and final consumption sectors are highly protected.

2.2 Model Characteristics and Simulation Scenarios

We employ a recursive dynamic CGE model with 41 production sectors, 10 classes of households, and 5 types of input factors to explore the impacts of China's entry into the WTO on its economy in quantitative terms. We only analyze four elements: (1) tariff rate reduction of industrial production; (2) the Gradual cancellation of NTBs of Industrial production; (3) agricultural trade liberalization, i.e. acceleration of agricultural and food import quotas and their cancellation by the year 2005; and (4) the phase-out of the Multi-Fiber Agreement (MFA) quotas of textile and clothing under the Uruguay Round Agreement. Therefore, we only consider partial factors of China's entry into the WTO and do not consider barrier reduction on service trade and foreign investment, intellectual property rights protection, guarantee on market entry, and so on.

The model considers six options to simulate the impacts. The first option is the base case

without trade policy reform and other policy measures, which provides a reference for the other five policy options. The first policy option (indicated as E2 in Table 3) simulates the trade liberalization under the Uruguay Round Agreement excluding China; the second policy option (E3) delimits the case where China commits to reduce its tariff rates and cancel NTBs. By the year 2005, the average nominal tariff rates on industrial production will be cut down to 10%, and for the sectors with commitments to cross out their NTBs, they will be phased out in the period from 1997 to 2005; the third policy option (E4) underlines the agricultural product liberalization; and the fourth policy option (E4) lays stress on the abolishment of the MFA; and the last one (E5) incorporates the above mentioned four elements. The policy options and their specifications are summed in Table 3.

Table 3. The Simulation Options

Experiment	Options
E1	Base Case: — The real GDP and agricultural output are exogenous — TFP growth rate is endogenous — The import quota growth rates of agricultural sector and food sector are 3% — The export quota growth rates of textile and clothing are exogenous — In the year 1997, the tariff rates are reduced in accordance with new policy, the NTBs are reduced by 10%; — In the year 2010 the trade surplus is gradually reduced to 30% of the base year
E2	Free trade under Uruguay Agreement excluding China — TFP growth rate is exogenous and the same as that of the base case — The world prices of import and export are exogenous
E3	Tariff rate reduction and NTBs cancellation + E2 — 1998-2005 the tariff rates are reduced by 40% against the 1997 levels — 1998-2005 NTB equivalents of 9 sectors are reduced to 0
E4	Agricultural liberalization + E2 — 1998-2004 the growth rate of import quotas in the food and agricultural product sectors is 5% annually — by the year 2005, import quotas are replaced by 10% tariff rate
E5	Gradual Cancellation of the MFA + E2 — 1998-2004 acceleration of MFA quotas — by the year 2005, the export tariff equivalent of textile and clothing are 0
E6	The whole entry option E3+E4+E5

Source Li *et al.* (2000)

3. Economic Restructuring and Its Implications for Energy Consumption

Based on the simulation using a CGE model, the real GDP and social welfare revenue in terms of Hicksian Equivalent Variations will increase by RMB195.5 billion yuan and 159.5 billion yuan (in 1995 price), respectively, and account for 1.53% and 1.24% of the current GDP in 2005, in contrast to non-WTO countries. The household consumption will be increased by 0.58% due to free trade, and investment will be expanded by 1.75%. Relative to consumption and investment, foreign trade gets a much larger enlargement, of which export and import will rise by 26.9% and 25.8% respectively (Table 4). This large gain of GDP is due to the efficiency improvement resulting from the resource re-allocation brought about by the international comparative advantage. The abolishment of the Multi-fiber Agreement (MFA) will promote

the competitiveness of China's clothing and textile sectors, and consequently it will result in export expansion in these sectors. Taking the productivity increase resulting from trade liberalization into account, China's GDP growth rate will increase 1 percentage point compared with the reference case without accession to the WTO. And therefore, the real GDP will grow by 13 percent in comparison with the reference case in the year 2010.

Table 4. The Chief Macro-Economy Simulations of China's Entry into the WTO
(Percentage change relative to E2, %)

	E6	E3	E4	E5
Social Welfare (% GDP)	1.24	0.02	1.14	0.02
GDP	1.53	0.15	1.02	0.20
Consumption	0.58	0.05	0.42	0.01
Investment	1.75	0.02	1.60	0.04
Export	26.9	3.53	5.13	8.74
Import	25.8	3.14	4.49	8.38
Government Revenue	3.51	-0.72	4.46	-0.01
City and Town Household Income	4.56	-0.15	5.08	-0.06
Rural Household Income	-2.05	0.18	-2.67	0.05
Trade Conditions	-1.57	-0.47	-0.76	-0.58
Real Exchange Rate	1.85	2.39	3.39	-1.10
Self-Supplying Rate of Food	92.3	97.5	92.5	97.5

Source: Adapted from Li *et al.* (2000)

The efficiency improvements are unevenly distributed among sectors; the permission for foreigners to enter domestic markets will bring about the decrease in the output of the agricultural and automobile sectors which are heavily protected before. For example, the rice output will be cut down by 1.4 percent, its import will increase by 5.6 billion yuan in the year 2005, and the wheat output will decline by 9.0 percent at the same time. The capital-intensive sectors such as electrical machinery, electronics, and instruments will shrink because of their lower competitiveness in the open market. And the output of all the energy sectors including mining refining, and secondary energy will be reduced by 1.2 to 4.8 percent. In contrast, the energy-saving and labor-intensive sectors including clothing, textiles, leather, and food production will expand in their output and export.

Almost all the energy-intensive sectors (called heavy sector) will shrink, their output; exports will decrease but imports increase. The biggest change happens in the automobile industry, whose output will be lowered by 15.1 percent and import raised by 105.1 percent relative to the reference case. Whereas, as an exception, the chemical industry will augment in its output and export and import, and its import will gear up by 26.8 percent and export will grow up by 14.4 percent in the year 2005. There is only a small change in the structure of consumer goods and services because of the small changes in their Armington prices (composite price of both

domestic supply and international supply). On the whole, the biggest changes take place in the wheat, cotton, wool, grain, and oil products. Their consumption will be enlarged due to their lower international prices, in particular the lower prices of imports from the American market. The consumption volume of capital-intensive sectors will decline due to the increase in their prices resulting from the increase in the user costs of capital.

According to the literature (Zhou & Zhou (1999)), we suppose that the energy intensity of output will be cut by 20% from 1997 to 2005, and we assume that the energy-savings are evenly distributed among sectors. Therefore, we can use the energy intensity of output in the year 1997 as a basis to forecast the value in the year 2005. The results are shown in Table 6. We merge the sub-industries from Table 5 to get the same industry categories as Table 6, and thus it is easy to work out the energy consumption changes in all sectors when China enters the WTO. It is illustrated in Table 7. The calculation results tell us that the intermediate energy consumption of the economy will grow, although output declines take place in sectors with high energy intensities including mining and quarrying, electric power and steam production, metallurgy, and machinery, but not the chemical industry, yet the energy-savings due to economic restructuring are much lower than the energy consumption increase because of output expansion in light industry including foodstuffs, textiles, garment, and leather and fur processing, and the chemical industry. As a result, the comprehensive effect leads to an increase in the total intermediate energy use. But the increase volume is very limited, only 133 thousand tons of coal equivalent (Tce). If we take the Energy Research Institute's forecast as the reference case (Zhou & Zhou (1999)), the change only accounts for 0.0075% of the total energy use of 1770 million Tce. It is so small that it could not be taken into account.

Table 5. Changes in Output, Employment, Trade, and Price in Policy Option E6 with Entry into the WTO

	Output		Employment		Import		Export		Price	Consumption
	Billion yuan RMB	%	10,000 Person	%	Billion yuan RMB	%	Billion yuan RMB	%	%	%
Rice	-4.6	-1.4	-246.1	-2.8	5.6	300.	0.0	12.0	-8.6	0.76
Wheat	-17.2	-9.0	-540.3	-14.2	26.8	206	0.0	73.3	-36.4	17.09
Other Crop	0.3	0.1	1.6	0.0	10.4	226	0.0	0.2	3.0	-2.34
Cotton	-11.7	-12.6	-498.2	-22.6	45.0	427	0.0	209	-67.2	90.22
Non Crop	11.3	1.8	151.1	1.9	0.7	10.9	0.1	1.1	4.8	-5.15
Forestry	1.3	1.1	5.4	1.4	1.1	10.7	0.0	-2.2	7.6	-8.20
Wool	-3.0	-37.0	-10.0	-37.5	5.1	86.6	0.0	-15.4	-24.1	29.78
Other Raising	73.7	5.7	104.1	5.0	1.0	77.1	2.8	13.0	-3.8	2.87
Other Ag	7.8	5.2	57.2	5.1	0.1	19.4	0.0	4.6	3.6	-4.23
Fishing	4.2	1.0	9.0	1.3	0.6	55.8	2.3	6.1	2.3	-3.32
Coal Mining	-2.9	-1.2	-2.2	-0.3	0.1	4.5	-0.5	-4.3	7.0	-6.61
Crude Oil	-11.6	-4.8	-3.8	-2.9	2.2	4.9	-2.5	-10.0	8.0	-
Metal Mining	-2.5	-1.7	-1.1	-0.8	0.2	0.6	-0.2	-3.9	5.5	-
Quarrying	1.6	0.4	5.3	1.4	0.8	6.7	-0.4	-2.2	4.6	-6.00

Grain Oil	-18.7	-5.8	-13.3	-8.0	45.8	260	0.3	127	-21.7	10.77
Sugar	-1.7	-2.1	-1.5	-1.6	3.8	83.8	0.3	18.5	-0.6	-0.05
Food	74.8	5.3	31.6	5.9	8.5	16.1	24.2	31.7	-6.5	9.69
Textiles	390.1	25.5	282.5	23.6	158.5	85.7	183.1	63.8	-17.6	22.72
Clothing	522.3	74.0	261.0	52.3	6.3	124	491.6	214	-12.7	19.18
Leather & Fur	26.8	5.9	21.9	7.6	43.0	124	8.8	6.6	-9.1	14.46
Timber & Furniture	2.0	-0.6	2.1	0.6	1.3	5.6	-1.5	-2.1	3.2	-1.19
Paper	10.2	1.1	14.5	2.1	9.8	13.0	1.9	1.2	0.9	3.59
Power	-8.4	-1.4	-0.1	0.0	0.0	5.6	-0.4	-7.2	8.6	-7.98
Petroleum Refining	-16.7	-3.5	-3.1	-2.6	11.1	35.1	-1.6	-6.8	6.4	-4.58
Coking	-1.5	-1.6	-0.3	-1.2	0.0	1.7	-0.6	-4.3	6.6	-1.67
Chemical	95.0	3.8	58.9	4.2	92.5	26.8	32.7	14.4	-4.7	7.74
Building Materials	-11.3	-0.8	5.7	0.3	0.8	2.8	-4.0	-4.2	5.4	-8.67
Metal-lurgy	-28.9	-1.7	-4.2	-0.5	3.1	1.6	-5.2	-5.7	6.8	-9.82
Metal Product	-3.4	-0.4	4.9	0.9	2.9	8.0	-3.5	-3.8	5.7	-4.53
Machinery	-51.0	-3.1	-29.8	-2.2	49.3	10.2	-8.6	-4.4	4.5	-4.32
Auto-mobile	-81.2	-15.1	-49.8	-14.5	41.8	105	-0.9	-7.8	-0.1	0.29
Trans Equip	-0.6	-0.2	2.5	0.8	2.3	4.8	-1.6	-4.0	5.0	-5.22
Electrical Machine	-28.6	-3.2	-9.7	-1.8	11.1	12.0	-5.6	-4.9	5.2	-1.82
Electronic Instrument	-43.8	-4.7	-10.9	-3.3	12.9	5.2	-13.4	-5.2	4.8	-2.89
Repairing	1.0	0.9	2.4	1.5	0.0	0.0	0.0	0.0	4.8	-
Other Industry	1.0	1.2	9.7	2.2	4.5	60.2	0.1	1.7	0.5	-1.44
Construction	33.1	1.2	92.8	2.2	0.5	3.6	0.0	-0.3	6.0	-
Infrastructure	2.8	0.2	41.6	1.1	2.1	3.4	-1.7	-1.3	7.0	-6.61
Commerce	45.4	1.8	261.5	3.3	3.3	4.0	-0.3	-0.8	5.7	-3.55
Other Service	-3.5	-0.1	4.9	0.1	4.9	3.8	-2.1	-2.0	7.1	-5.72

Note: columns indicated by 'consumption' and 'price' give 2010 data; others show 2005.

Table 6. Output and Energy Intensity of Output of China in 1997

Industry/Item	Output (Billion yuan)	Energy (10 ⁴ Tce)	E/output (kg-c/100 yuan)	E/output * (kg/100 yuan)
Agriculture	24677.38	5905.4	0.239	0.191
Mining and quarrying	6828.39	10965.38	1.606	1.285
Foodstuffs	13792.59	3843.08	0.279	0.223
Textiles, Clothing, and leather	15366.56	3516.89	0.229	0.183

Other manufacturing	9884.89	2699.96	0.273	0.219
Power and steam	3908.71	11060.96	2.830	2.264
Coking and petroleum refining	3237.69	7388.5	2.282	1.826
Chemical industry	15212.23	19280.29	1.267	1.014
Building Materials and Non-metal Minerals	8807.40	12317.45	1.399	1.119
Metal products	12758.30	22493.26	1.763	1.410
Machinery	25546.61	6514.57	0.255	0.204
Construction	17385.50	1178.99	0.068	0.054
Transportation and communication	7025.19	7543.13	1.074	0.859
Other services	35412.77	7097.21	0.200	0.160
Residential	-	16368.01	-	

Source: China Statistical Yearbook, 1999

Note: the last column indicates the energy intensity of output in the year 2005.

Table 7. Energy Consumption Change due to Output Change with Access to the WTO in the Year 2005

Industry/Item	Output Change (Billion yuan)	E/output (kg-c/100 yuan)	Energy Change (Tce)
Agriculture	62.1	0.191	11888.6
Mining and quarrying	-15.4	1.285	-19784.1
Foodstuffs	54.4	0.223	12126.1
Textiles, Clothing, and leather	939.2	0.183	171961.1
Other manufacturing	12.2	0.219	2665.8
Power and steam	-8.4		-19016.4
Coking and petroleum refining	-18.2	1.826	-33226.3
Chemical industry	95	1.014	96323.9
Building Materials and Non-metal Minerals	-11.3	1.119	-12642.7
Metal products	-32.3	1.410	-45556.7
Machinery	-207.7	0.204	-42372.0
Construction	33.1	0.054	1795.7
Transportation and communication	2.8	0.859	2405.1
Other services	41.9	0.160	6717.9
Total	947.4		133286.1

Source: Author calculation

4. Residential Energy Consumption

Breaking down the whole effect of China's entry into the WTO helps us understand the individual parts of this trade policy adjustment easily. The relative shortage of arable lands, population growth, and industrialization will result in great demand for agricultural products. Meanwhile, taking limitations on the import of agricultural products into account, it can be

imagined that the liberalization of agricultural product trade is the critical and essential component of China's access to the WTO. Actually, based on the model simulation, the deletion of import quotas on agricultural products will bring about RMB 130,600 million yuan (in 1995 price) in the year 2005, which makes up for nearly 2/3 of the total gains due to access to the WTO. In this context, the rural households are definitely losers, but the town and city households will get a 4.2% increase in their income. The other two aspects of entry into the WTO, namely, cancellation of the MFA and tariff rate reductions and tariff exemptions and cancellation of NTBs, do not have so much positive effect on GDP. Under these two circumstances, the real GDP will rise by RMB 25 billion yuan and RMB 19.6 billion yuan (in 1995 price). But the welfare gain will be less than the GDP increase considering the adverse effect on trade conditions. In contrast to the agricultural trade liberalization, the effects of the tariff rate reductions and tariff exemptions and cancellation of NTBs on the income distribution are the opposite. It can be explained by the fact that the tariff rate reductions and tariff exemptions and cancellation of NTBs take place in industry sectors, of which a large share of textile and clothing exports are from town and village enterprises. Taking the above mentioned three aspects together, the income of the city and town residents will increase by 4.6 percent but that of the rural residents will decrease by 2.1 percent compared with base case when China becomes a member of the WTO.

Two forces drive the final residential energy use demands. One is the price of energy products, and the other is the dispensable income of the households. Based on the aforementioned, the city and town residents will have gains in their income, but the rural residents will suffer net losses. Considering the difference in their saving propensity, the residents in the cities and towns will be more inclined to deposit their money, and thereby cause the increase of their investments. We herein can only analyze the income effect and price effect together. Based on the model simulation and forecast of the energy demand in the year 2005, and supposing the residential energy use accounts for 13% of the total 1770 million tons of coal equivalent and that it keeps its composition during the period 1995 to 2005, we can easily get the change in the residential energy consumption, which reaches around 15 Mtce. The energy demand of the city residents can not increase a lot due to income gains after entry into the WTO, except for energy use in private automobiles, considering the fact that they have already had freedom of access to most household appliances with lower prices relative to international markets. But the price rise of oil and electricity depresses the energy demand of city and town households. The rural residents, 70% of whose energy demand is met by biomass, will compress their demands because of both the price rise of energy products and the decrease of their income with accession to the WTO. So the total effect of entry into the WTO on residential energy demand is dominated by the price effect, and hence the energy demand of households will be lowered relative to China before accession to the WTO.

Table 8. Residential Energy Use Composition in 1995

		Share of Energy Use (%)	Energy Use (Mtce)
Town & City	Heating	38	25.36
	Hot Water and Cooking	50	33.37

	Lighting, Appliances, and Air Conditioning	12	8.01
	Total	100	66.73
Rural Areas	Heating	27	15.85
	Cooking	68	39.92
	Lighting and Appliances	5	2.94
	Total	100	58.70

Source: Zhou & Zhou (1999)

The energy use of industry as a whole made up 73.3% of the total 1311.76 Mtce of energy consumption in 1995, of which that of the energy-intensive heavy industries including mining and manufacturing accounted for over 60%. Agriculture consumed only 4.2 percent of the total, construction 1.0 percent, transportation and communications 4.4 percent, and residential consumption 12 percent; the energy consumption structure can not change much in the near term. Based on one optimistic forecast, the energy consumption mix will be changed up to 50:20:30 by the industry, transportation and communications and commercial, and residential use by the year 2020 to 2030.

Considering that the intermediate energy consumption will not vary a lot after entry into the WTO based on section 3, the energy demand of China will be kept under net export and residential use's thumb. From Table 5, the net exports of most energy types will decline due to higher prices plus the decrease of residential energy consumption. As a consequence, the total energy demand of China after being a member of the WTO will decline.

5. Impacts of China's Access to the WTO on Energy Production Enterprises

Along with the open door policy deepening, the energy production structure and consumption structure has been changing a lot. In the years 1980 through 1990, the share of coal in the production structure increased from 69.4 % to 74.3%, and the share of oil decreased from 23.8 % to 19.0% in the same period, while the share of oil in the consumption mix declined from 20.7% to 16.6%. But during the eighth five-year plan period (1991-1995), the share of oil in production shrank from 19.0% to 16.7%. However, the proportion of oil in consumption rose from 16.6% to 17.3%. The energy system of China had changed from the independent, closed system into an open one, and it began to use both the domestic energy market and international markets to meet its demand. In 1993, China changed from a net-exporter to a net-importer, and net imports hit 98.9 million tons of oil in this year. Up to 1996, it had stood on the deficit side of the foreign trade balance of crude oil. There are five provisions of the WTO to close with: China energy sectors, that is, (1). the most-favored-nation clause; (2) the universal-favored clause and special considerations for developing countries; (3) tariff rate reductions; (4) deletion of export subsidies; and (5) gradual cancellation of NTBs. Consequently, the world market opens further to China, and, in return, China has to open further its domestic market to the world. Its energy enterprises will compete with foreign enterprises in the domestic market and international markets at the same time. In the following sections we will discuss the effect of access to the WTO on China's energy industry in detail.

5.1 Coal Industry

Coal is the fossil fuel with the largest reserves and is also distributed most widely. Based on the estimates of the World Energy Council, the world exploitable reserves of coal can reach 4,840 billion Tce, making up 66.8% of the total fossil fuel exploitable reserves (Fan, 1998). In the energy resource market, coal has the competitiveness in price. At present, the ratio of thermal value to the price of coal is only half that of natural gas, and one-third of petroleum in the international markets. In China, taking the Beijing fuel market for instance, the price of natural gas in Beijing from Northern Shan'xi is RMB 2.00 yuan/m³ in terms of cost pricing, while the market price of coal is RMB 250 yuan/ton, and therefore, if we suppose 2 kg of coal is equivalent to 1 m³ of gas, the gas price is 4 times that of coal. Hence, coal can be thought of as the first choice in terms of price (Li, and Huang, 1999).

In the year 1998, the world's coal output declined by 2.4% due to the 6.0% output decrease of the biggest producer – China. And accordingly, global coal consumption also decreased by 2.1% due to the demand declines of China and Europe for Coal (Ding and Li, 2000). As a matter of fact, in the past three years, the coal industry of China has been in its downturn, which can be summed in the four aspects. (1) The oversupply of coal. Total coal production increased sharply from 1097 Mtce in the year 1990 to 1374 Mtce in the year 1996 because the central government deployed a shortsighted policy to encourage small coal mines' development. Up to the end of May 1999, the social inventory of coal had reached around 200 Mtce (Li and Huang, 1999). (2) The disordered competition of the coal market. Some enterprises dumped coal, resulting in a price slump. (3) The outstanding payment of users. Based on the statistics, by the end of May 1999, the payments in arrears in the 94 key state-owned coal enterprises accounted to RMB 32,733 million yuan, which exceeded the revenues of the half year. (4) Redundant employees and exhausted mines in operation.

Access to the WTO is the two faces of the coin to the coal industry in China. On the one hand, it leads to a positive effect on the coal industry in three aspects: (1) the intermediate circulation costs can be reduced to raise the export competitiveness of coal in the international markets. Currently, based on the statistics, the "free on board" (FOB) of China power coal is a little less than that of Australia. But taking the export to Japan for example, the cost insurance and freight (CIF) of China power coal is higher than that of Russia or Canada, but a little less than that of South Africa, Australia, and the USA. The FOB of the power coal of China is not reasonably formed (Fan, 1998; Li and Huang, 1999; Gao, 1999; Wang, 2000). Take the Da Tong coal for instance: the current FOB (under the long-term contract) is 2.76 US\$/ton, equivalent to RMB 271 yuan/ton, of which the intermediate cost per ton including miscellaneous delivery costs, miscellaneous port charges, agent costs, waste, export tax, and other charges hits a high of RMB 161 yuan, accounting for 59.4% of the total FOB. The left - producer price is only RMB 110 yuan. Actually, the current spot FOB is only 25 US\$/ton, and therefore, the factory price can not exceed 46 RMB yuan/ton, which is much lower than the production cost. Not to mention the current production cost of China does not consider the resource tax, infrastructure cost, and environmental protection charges. So access to the WTO

forces China to deepen its energy export policy to reduce the intermediate charges so as to increase the coal export competitiveness. (2) It will smooth the coal market of China. The operation of small coal mines and mines with exhaustive reserves is not in accordance with the market competition. As a matter of fact, it is their existence which raises the production costs of the coal industry and increases the industry loss. The plants are under a burden which should be shouldered by the central or local governments at all levels. The provisions of the WTO require its members to clear subsidies to enterprises which run under the margin. So China's access to the WTO will promote the scale economy of its coal industry. (3) It will diversify the export system. Currently, the export rights are not completely out of control. The export volume of the China Coal Corporation accounts for 80% of total exports, and it monopolizes coal exports, roughly speaking.

On the other hand, we can not be optimistic with regard to the prospects for China's coal industry after WTO accession. It has its own disadvantages as follows: (1) the high supply cost due to the low production efficiency (Wang, 2000; Li, 1999). In April 1999, the coal FOB of Indonesia and South Africa decreased to 20 US\$/ton in the international market, but the product cost of China's coal industry has been gradually increasing. At present, the production cost of old mines reaches a high of 140 to 150 RMB yuan/ton, that of new mines 70 to 80 RMB yuan/ton. There are several factors to explain the high cost of production; the main reasons include the low mechanized exploitation rate of 41% in 1997 and the small share of open-cast mining. (2) The unstable quality of coal. There exist many factors to cause the unstable quality of coal: from production to delivery to port storage, some materials such as metals, bamboo scraps, and explosives are mixed in. In addition, China does not adopt the international standard to control its coal quality. For instance, the processes of most coal selection plants are designed according to the domestic demand; that is, ash share is less than 12%, water share is less than 13%, which are exceed the international standard (the former is 8%, the latter is 8%). (3) Low level of infrastructure. The development of China's transportation and communication systems can not keep pace with that of the coal industry, especially the slow railway development. Moreover the low level of port construction and its management constrains the large-scale export of coal. (4) The limited users of export. Coal export from China relies highly on the Asian market, which accounts for 80% of its total export annually, of which the largest share flows to East Asia. The limited diversity of purchasers of Chinese coal causes Chinese coal exports to be highly affected by market fluctuations. The financial crisis of Southeast Asia affected 90% of users of Chinese coal, resulting in a great decline of export demand for China's coal industry.

Of course, there are other external factors affecting coal exports: coal oversupply in the international markets, environmental protection pressures, fierce competition between the main coal producing countries, and the like. With entry into the WTO, China can use licensing to control the foreign enterprises that enter its domestic coal industry according to WTO rules, but it can not control the foreign coal enterprises that compete with its enterprises in the international coal markets. So we can say that there is little impact on the coal industry after WTO accession if we only keep our eyes on the domestic market, but it should sharpen its edges if it would increase the competitiveness of coal industry in the world market.

5.2 Petroleum and Natural Gas Industry

In the year 1998, China restructured its petroleum industry system. Consequently, four large group corporations, namely, China National Petroleum Corporation (CNPC), China Petrochemical Corporation (SINOPEC), China National Offshore Oil Corporation (CNOOC), and China New Star Corporation (CNSC) control the petroleum industry. Table 9 outlines the economic indicators of the four corporations in 1998. After this reformation, CNPC and SINOPEC realized the integration of up-reach and down-reach and integration of domestic trade and international trade. The two corporations take advantage of their respective characteristics and predominance to cooperate with and compete against each other in the markets. CNPC will focus on the exploitation and development of crude oil and natural gas, but will do petrochemicals at the same time; on the contrary, SINOPEC attaches its attention to petrochemical operation, but is engaged in exploitation of crude oil and natural gas at the same time.

Table 9 The Economic Indicators of the Four Corporations in 1998

Item	Unit	CNPC	SINOPEC	CNOOC	Total
Oil Reserve	billion ton	55.8	9.9	28.3	94.0
Natural Gas Reserve	10 ¹² m ³	25.6	0.95	11.5	38.10
Crude Oil Output	million ton	107.38	35.32	16.32	16.26
Gas Output	billion m ³	14.97	2.324	3.90	22.297
Crude Oil Process	million ton	68.95	80.60	16.15	165.70

Source: Dong 2000.

In accordance with the China-US agreement, China promises that it will levy a zero tariff rate on crude oil and natural gas imports, reduce its tariff rate on oil products and fuel to 6% in one or two years, and gradually reduce the tariff rate on plastic and plastic products after China enters into the WTO. The NTBs on the import of crude oil and oil products will be cancelled step by step, and the oil product sales market will be opened gradually. Obviously, China's access to the WTO brings about many challenges to its petroleum and gas industry. On the whole, the impacts on the down-reach enterprises will be larger than that on the up-reach enterprises: reconnaissance and exploitation. It can be explained by the intrinsic weakness of China's petroleum enterprises. (1) The production costs of Chinese petroleum products are comparably higher than those of the main large petroleum corporations in the world. Based on the statistics of the Energy Information Agency of the US DOE, crude oil production costs average 3.86 US\$/barrel for the main large petroleum corporations in the world, and discovery costs average 5.54 US\$/barrel, and hence, the full supply cost averages 9.4 US\$/barrel. But the current comprehensive production cost of China has already reached 12.3 US\$/barrel. In addition, the process cost per ton of crude oil of large foreign corporations averages 155 RMB yuan equivalently, but that of SINOPEC and that of CNPC highly hit 206 yuan/ton and 231 yuan/ton, respectively. (2) The technological level of the petroleum industry of China largely lags behind the developed countries. Currently, the lower process technology of the crude oil

in China leads to the high share (20%) of heavy oil output. Consequently, large quantities of petrochemicals are burned as raw materials. (3) The product mix can not adapt to the market demand. There are high contents of sulfur and benzene in gasoline in China. Developed countries have several thousands of petrochemicals, but China only has 1800 types; the domestic produced superior lubricants only account for 10% of the total output, and furthermore, the quality and kinds are 2-3 classes lower than that of foreign countries. The low-grade gasoline still accounts for 10% of the total, and the high-quality lead-free gasoline only makes up 20%. In addition, the production of superior asphalt can not meet the domestic demand, so the import of this kind of asphalt has accounted for 80% of the actual use in China. (4) The capacity of the refining industry is smaller than those of foreign countries. Table 10 illustrates the comparison of refining industry scale of major countries. (5) The ratio of reserves to development is much lower than that of the world average level. The average oil ratio of the world's top 50 petroleum corporations is 49.2:1, and the natural gas ratio is 76.3:1. Accordingly, the oil ratio of CNPC is 15.7:1, and that of SINOPEC is 6.1: 1; the gas ratio of the former is 35.7:1, and that of the latter is 17.4:1.

Table 10. The Average Scale of the Refining Industry (10^4 ton/a)

Country/region	Number of Refining Enterprises	Average Scale
Singapore	4	1465
Korea	6	2116.5
Japan	38	665.7
USA	161	510
UK	14	662
France	14	695
Italy	17	719
Germany	17	661
China	67	334
China (>500* 10^4 t/a)	25	636
China Taiwan	3	1283

Source: Yao 1999.

The effect of access to the WTO on China's petroleum and gas industry can be demonstrated in the following regards:

(1) WTO access has few impacts on the reconnoitering and development of petroleum and natural gas. First of all, the up-reach market has been opened in the domestic and foreign cooperation manner. China can limit the share of foreign capital in the joint ventures to restrain foreign enterprises from holding in accordance with WTO rules. In addition, in mining industry, the resource development licensing does not belong to NTBs, and therefore, China can deploy control on opening development areas and development licensing to limit the volume and scope of foreign capital. Under these conditions, the entry of foreign capital can bring about advanced technologies and management skills beneficial to China. Finally, the domestic crude oil price has been in the same track with the international markets since 1998. At present, The tariff rate of crude oil import is only 16 RMB yuan/ton, equivalent to 1.8%. If we call the CIF of imported crude oil plus import tariff, value added tax, consumption tax, and other import charges, minus tax deduction as the critical cost of the CNPC and SINOPEC, it was 722.62 yuan/ton in the year 1998, but the real cost averaged 687.89 yuan/ton. Despite the

CIF of crude oil decrease to 12.5 US\$/ton, the critical cost was still higher than the real cost in the year 1998.

(2) Currently, the import tariff rate on natural gas (including LNG) is 7.3%. The price before taxation of the imported LNG in Shanghai amounts to 1.6-1.7 yuan/m³ (based on CIF of Japan). In this case, domestic natural gas has price competitiveness given that the price of pipeline gas in Shanghai is 1.2 - 1.3 yuan/m³. It is estimated that the import of LNG and LPG by China will continuously increase in the future. The Chinese government decided that it would build an LNG import base in Dapeng Bay of Shenzhen, which indicated that China had taken real measures in preparing for LNG import. Although at present many foreign investors are building or planning to build 1-2 × 10⁴ ton low temperature tanks in the coastal areas of southeast China, they are mainly large low temperature vessels anchoring overseas. The Taiwan Plastic Group is planning to build several large low temperature LPG tanks in Mailiao as the distribution center to import LPG from the Middle East. It is estimated that, this center can supply 150 × 10⁴ tons of LPG after its construction, which accounts for 20% of the total imported LPG of China annually.

(3) Access to the WTO will strike the refining industry of China negatively. Of the total 220 refining plants, 166 with capacity under 100 × 10⁴ ton/a will disappear, and most of the refineries with 100 × 10⁴ ton/a capacity in the inner land and along the coastal areas will be seriously threatened. Getting the permission of market entry, large foreign petroleum enterprises will manage to set up single-venture factories in China to make use of the cheap labor resources and their own advanced technologies and managerial skills to localize their production. The domestic refining industry is in a weak position and will lose its market share and suffer more losses considering that the refining plants under the auspices of SINOPEC made losses high to 4.8 billion yuan in 1998 (in the context of the domestic refined oil price as two times that in international markets). What's more, foreign corporations will be reluctant to set up cooperative ventures or joint ventures because they want to be single-ventures. The 'trade market for technology' policy will lose attraction to foreign countries. China's refining industry will have to innovate its technologies by itself, which may slow the technological retrofitting pace of the petroleum industry.

(4) The refined oil sales system is the most vulnerable part of China's petroleum industry. This situation was formed under the past planned economy when the oil sales were under the strict control of the government and thus there was no sales network built by China's petroleum corporations. Even in the conditions where the domestic refined oil price was much higher than that of the world market, for example, the refining plants of SINOPEC suffered losses and 613 county-level petroleum sales corporations lost 5.6 million yuan last year, which accounted for 60% of the total sales corporations at the county level. If the domestic refined oil price is in accordance with the international markets, 40 to 50 percent of refining plants and sales enterprises will be in bankruptcy in two years when China enters into the WTO. In the circumstance where the refined oil sales are under the special operation by the CNPC and SINOPEC authorized by the central government and refined oil imports are under strict control, the two corporations only win a small share in the refined oil market. When the tariff rate is reduced and NTBs are deleted, the import of refined oil will increase sharply, and the foreign petroleum corporations will occupy the refined oil market, especially the south Chinese market. As a result, the domestic oil price will slump because of oversupply, and meanwhile, the

market share of China's petroleum industry will diminish gradually.

On the whole, China's access to the WTO will induce different impacts on different links. It has less negative effects on the up-reach industry, including reconnaissance and exploitation of crude oil and natural gas reserves, but raises more influences on the down-reach industry, including refining plants and the petroleum sales system.

5.3 Electric Power Industry

With the reform and opening policy, China's electric power industry has been speeding up since 1978. In the past 20+ years, the installed capacity grew by 10 GW annually, the annual average growth rate amounting to 7.68%; and the average growth rate of power production reached 7.48% annually. By the end of 1998, the installed capacity of China got to 277 GW, and meanwhile the power generation hit 1,157 TWh, forming a complete power industry system on a large scale. It established 5 regional power grids including Northeast China, North China, East China, Central China, and Northwest China; the interconnected grid of four southern provinces; the independent provincial grids of Shangdong, Fujian, Chongqing, and Sichuan; and realized the 5-level scheduling from central to regional to province to city, and to county. By the second half of 1996, China balanced its demand and supply of electric power and concluded the shortage of power sustaining more than 20 years. On the strength of China's economic prospects from 2000 to 2010, the power industry will keep an appropriate development speed to adapt to the demand of economic development. It is forecast that the total installed capacity of the whole country will be 290 GW in the year 2000 and will attain 500 GW in 2010 (Gao, 1999; Wang, 1999). The State Power Corporation (SPC) adopted a four-step market-oriented reform policy. The first step was from the establishment of the SPC to the year 1998, when the Ministry of Electric Power was withdrawn; the second step was from 1998 to 2000, when the power reformation was to propel the modern enterprise institution establishment in the SPC system and to strengthen the power grid development in city and rural areas set out the pilot separation of generation plants and the power grid, and bid for connection with the power grid. The third step is from 2001 to 2010 when the national interconnected power grid and uniform scheduling will be shaped. The fourth step is after 2010 when generation, delivery, and distribution are separated from each other, and a normalized power market is set up.

Joining the WTO will facilitate the power market development and expedite the opening of the power generation market. Under the conditions of the 'power grid controlled by government and generation plants built by enterprises' policy, the government will not deregulate its control over the power grid whether China enters into the WTO or not. It is close with economic and military security. Even though China will open its generation market to foreign investors, the opening process will be step by step considering that power is critical to the development of the country. And consequently, the market share of foreign capital is roughly limited. So, in the short run, the power enterprises of China will not be seriously affected by access to the WTO. In the long run, with the gradual opening of the power generation market, the polishing of the investment environment will attract foreign capital to cooperate with

Chinese enterprises to develop areas that are difficult to exploit. And foreign capital will be permitted to construct single power generation ventures. In that case, Chinese listed enterprises will compete at the same level with joint ventures or single ventures supported by foreigners. But China's power industry can have a gradual intermediate phase to promote its technological innovation and enhance managerial skills, thus intensifying its competitiveness compared with foreign enterprises.

6. Concluding Remarks

Based on the simulation using a CGE model, following China's entry into the WTO, real GDP and social welfare revenue in terms of Hicksian Equivalent Variations will increase by RMB195.5 billion yuan and 159.5 billion yuan (in 1995 price), respectively, and will account for 1.5% and 1.2% of the current GDP, in contrast to the situation before China's accession to the WTO. This large gain in GDP is due to the efficiency improvements resulting from the resource re-allocation brought about by the international comparative advantage. The abolishment of the Multi-Fiber Agreement (MFA) will promote the competitiveness of China's clothing and textile sectors, and consequently it will result in the export expansion in these sectors.

The efficiency improvements are unevenly distributed among sectors, and permission for foreign companies to enter the domestic markets will bring about a decrease in the output of the agricultural and automobile sectors, which were heavily protected before. Capital-intensive sectors such as electric machinery, electronics, and instruments will shrink because of lower competitiveness in the open market. And the output of all the energy sectors (including mining, refining, and secondary energy) will be reduced by 1.2 to 4.8 percent. In contrast, the low energy and labor-intensive sectors (including clothing, textiles, leather, and food production) will expand their output and export. Almost all the energy-intensive sectors called heavy sector except the chemical industry will shrink their output, exports will decrease, but imports increase. The consumption volume of capital-intensive sectors will also decline due to the price increases resulting from the increase in the user costs of capital. The calculation results tell us that the intermediate energy consumption of the economy will grow, although output declines take place in sectors with high energy intensities including mining and quarrying, electric power and steam production, metallurgy, and machinery (except the chemical industry), yet the energy-savings due to economic restructuring are much lower than the energy consumption increases because of output expansion in light industries including foodstuffs, textiles, garments, leather and fur processing, and the chemical industry. As a result, the comprehensive effect leads to an increase in the total intermediate energy use.

China's accession to the WTO will bring about less impact on coal and petroleum mining than on refining, because China has opened its reconnaissance and development market in the form of international cooperation, and it can also control resource development permits to restrict the overdue entrance of foreign companies in accordance with the rules of the WTO. The high production costs of the mining industry due to redundant employees and the low level of management lead domestic enterprises into a weak position relative to their international

counterparts. Especially for the down-reach side of the petroleum industry, it has not the capability to compete with multi-national companies because of high production costs and the lack of a complete retail system.

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