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Impact Analysis of Changes in The Price of Water Resources in China and Beijing

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Abstract

This paper aims to analyze the impact of changes in resource prices on intra-region goods supply and on extra-region changes in prices, as well as possible impacts on the demand side, using China and Beijing as examples for analysis.

Results of the analysis with Input-Output model and CGE model demonstrate that changes in the price of water supply do not have as significant an impact as is the case with energy goods such as electrical power or oil and mining.

Also, another result with International IO model shows that an increase in the price of water resources in China would first induce changes in the prices of some domestic goods (education and research, chemical fertilizers, etc.); the effect on other countries would be relatively large in countries including Malaysia, Thailand, Singapore, and South Korea, and in the industries of flour milling, heavy electrical equipment, knitting, non-ferrous metals, and apparel. However, all of these impacts would be minimal.

Journal of Economic Literature classification codes: F18; O13; Q56.
Keywords: water resources; energy price rising effect; International Input-Output; CGE model.

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1. Introduction

This paper aims to analyze the impact of changes in resource prices on intra-region goods supply and on extra-region changes in prices, as well as possible impacts on the demand side.

The issue of the impact of resource prices has been seen, as one example, in the rise of oil prices from around $30 per barrel in the early 2000s to over $140 per barrel in July of 2008. In the September immediately after that, oil prices were affected by the economic downturn stemming from the American subprime mortgage problem and subsequent collapse of Lehman Brothers, and plummeted to the $30+ range in December of that year. Following this, oil prices trended upward again as gradual economic recovery proceeded, and at present in the first quarter of 2010, remain relatively stable in the mid-$80 range. However, this can be called a high level, compared with the situation in the early 2000s.

The rapid rise in oil prices in 2008 is considered to have been primarily brought about by the impact of speculative futures trading, with that impact seen as having been limited. Still, as a direct effect at the time, skyrocketing fuel surcharges at airports were in the news, and even in Japan an impact was felt in the form of increases in domestic gasoline prices.

As resources are treated as input elements in the same manner as capital and labor, changes in the price of resources naturally affect sales prices, and as a result cause some sort of change in demand behavior. In that sense, changes in resource prices are a real-world issue offering an ideal simulation topic, through analysis of changes in the behavior of economic systems.

What's more, resources are not a topic limited to the oil problems of the 21st century and later; rather, water, mineral resources, and a wide range of other goods can become inputs. For example, Banchongphanith (2010) considers through economics the increasingly serious problems of water resources in China, calculating on a per-industry basis the amount of water involved in goods production, and analyzing the impacts of increased costs of water pollution control.

Table 2-1

Breakdown of 42 Sectors

in the Input-Output Table

42sectors
Agriculture・Livestock
Forestry
Fishery
Coal mining and crude petroleum
Metallic ore
Non-metallic ore and quarrying
Food product
Beverage・Tobacco
Spinning
Wearing apparel・Other made-up textile products
Leather and leather products
Timber wooden products
Pulp and paper
Printing and publishing
chemical products
Drugs and Medicine
Refined petroleum and its products
Rubber product
Ceramics and Fire-clay
Iron and steel
Non-ferrous metal
Metal products
Machinery
Electronic machinery
Motor vehicles
Other transport equipment
Precision machines
Plastic products
Other manufacturing products
Electricity production and supply
Gas
Water production and supply
Scrap and waste
Construction
Wholesale and retail trade
Transportation
Telephone and telecommunication
Finance and insurance
Education and research
Other services
Public administration
Unclassified
sub total
Row item
Wages and salary
Operating surplus
Depreciation of fixed capital
Indirect taxes
less subsidies
Column item
private consumption
Government consumption
Gross domestic capital formation
Export
Outflow
Import
Inflow
Total Output

In this way, as economic activity is generally performed under resource constraints, it is obvious that the impacts from a change in the price of each resource need to be looked at in many ways.

This paper will consider the question of what impacts changes in the price of water resources and energy exert on economic systems, using China and Beijing as examples for analysis.

Section 2 will overview the magnitude of the impact of water supply prices in Beijing. Section 3 will consider the impact on the overall Beijing economic system. Section 4 will consider the possibility of effects of China's water resources on the entire Asian region. Finally, we will provide a brief summary.

2. The Influence of Water Supply Prices in Beijing

In this section, we will consider the price influences on industries in Beijing exerted by changes in water resource and energy prices, using an input-output table for Beijing.

The data used is an input-output table for mid-sized firms, with a 130-sector, input-output table for Beijing in 2002 condensed to 42 sectors. However, for water supply and electrical power we extract and use production amounts as they appear in the 130-sector table, while integrating 2 sectors for coal mining and oil into 1 sector.[3] The reason for using 42 sectors in the analysis is for ease of calculation and relative ease of interpreting the analysis.

The breakdown of the 42 sectors is per Table 2-1. The analytical model used is the equilibrium price model of equation (2 -1).

$$\mathbf{p} = \left[\mathbf{I} - (\mathbf{I} - \hat{\mathbf{M}})\mathbf{A}\right]^{-1'} \mathbf{V'e} \qquad (2\text{-}1)$$

Here p is an equilibrium price vector, and $\left[\mathbf{I} - (\mathbf{I} - \hat{\mathbf{M}})\mathbf{A}\right]^{-1'}$ is a Leontief inverse matrix (inverted) with self-sufficiency rate considered, $\mathbf{V}'$ is a value-added matrix (n × k), and e is a column vector with only 1 element (k × 1).

Typically, the equilibrium price model vertically aggregates the price table's input-output table and considers these as costs, and sets these as equilibrium prices on the assumption that market prices are marginal costs, assuming maximization of profits.

This model is one in which the aggregated added-value vector is given as an exogenous variable; thus, when value-added items such as indirect taxes change, usually it is the equation for analyzing what impact these changes exert on equilibrium prices in each industry. Thus, calculations of the impact of price changes in a particular industry on the prices of other goods cannot be performed directly from this model. This is because the relevant industries are endogenous variables in the model system. Therefore, it is necessary to pull the relevant industry prices out from the model system and calculate their impact exogenously. Here we performed calculations per Miyazawa (2002) of how the price of water resources and energy influence other goods. The equation used is the rightmost portion of the following.

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[3] The reason for integrating coal mining and oil is because oil production is effectively non-existent in the Beijing table.

$$\begin{pmatrix} \Delta p_1 \\ \vdots \\ \Delta p_{n-1} \end{pmatrix} = \left[\begin{pmatrix} 1-a_{11} & \cdots & -a_{1,n-1} \\ \vdots & \ddots & \\ -a_{n-1,1} & \cdots & 1-a_{n-1,n-1} \end{pmatrix}^{-1} \right]' \begin{pmatrix} a_{n1} \\ \vdots \\ a_{n-1,1} \end{pmatrix} \Delta p_n \qquad (2\text{-}2)$$

where $\left[\quad b_{ij} \quad \right] = \left[\mathbf{I} - (\mathbf{I} - \hat{\mathbf{M}})\mathbf{A} \right]^{-1}$

In this equation, when a specified good rises only ⊿ pn, the amount by which this pulls up the prices of the remaining (n-1) sectors' goods is calculated.

Based on the equation, we calculated the impact when prices changed in the 32nd sector "Water production and supply", the 30th sector "Electricity production and supply", and the 4th sector "Coal mining and crude petroleum". When the price ripple effect is calculated for a rise of 100% in each price (in other words, a doubling of price), the results are per Table 2-2. The results shown on the table are the 20 sectors with the largest price ripple effect.

A feature of Beijing seen from this table is that the impact of price changes in the water supply is not so great. By contrast, electrical power exerts a strong influence on a large number of industries, with the result of about a 2% impact up until #20. Also, the price of coal has a significant impact mainly on the oil and coal refining industries, but a relatively minor impact on other industries. However, it is evident that the impact is larger than that of water supply price changes.

Electrical power price increases exerted relatively large impacts, especially price increase effects of over 8% on water supply, 6% on metallic ore mining, and about 4% on ceramics and fired clay and on on gas. Meanwhile, the impact of oil price was an 11% impact on oil and coal, 4% on electrical power, and 3% on chemicals.

By contrast, water supply price had impacts on education and research, fisheries, and forestry, but the scale of all of the impacts is small.

Looking at causes behind these results, the first is that the total value of water supply in Beijing is small relative to electrical power and coal. In the 2002 table, electrical power has 3.83 times the value of water supply, and coal mining and oil has 2.12 times the value.

Second, compared with electrical power, the amount of water supply used as a raw material for intermediate input is not so large; rather, the percentage consumed as a final consumption good is large. Thus, the price of water supply, more than price rises of goods in other industries, can be considered an impact directly affecting consumers.

The third cause lies within the peculiarities of water supply. The supply of water resources is normally under public sector management, with prices themselves tending to be regulated as industrial water, agricultural water, tap water, etc., but water is also a good that can be procured on one's own from wells, rivers, ponds, etc. For this reason, the amount of water itself traded on the market may be only a portion of the total water demand.

Table 2-2 Comparison of Ripple Effects When Prices are Doubled for Water, Electrical Power, and Coal Mining (Top 20 Sectors)

	Water production and supply			Electricity production and supply			Coal mining and crude petroleum	
1	Water production and supply	100.00%	1	Electricity production and supply	100.00%	1	Coal mining and crude petroleum	100.00%
2	Unclassified	2.93%	2	Water production and supply	8.28%	2	Refined petroleum and its products	11.70%
3	Education and research	0.78%	3	Metallic ore	6.41%	3	Electricity production and supply	3.86%
4	Fishery	0.75%	4	Ceramics and Fire-clay	4.18%	4	chemical products	3.29%
5	Forestry	0.73%	5	Gas	3.74%	5	Gas	2.87%
6	Agriculture・Livestock	0.66%	6	chemical products	3.55%	6	Iron and steel	2.31%
7	Spinning	0.63%	7	Iron and steel	3.53%	7	Ceramics and Fire-clay	2.11%
8	chemical products	0.63%	8	Timber wooden products	2.82%	8	Non-ferrous metal	1.49%
9	Electricity production and supply	0.62%	9	Plastic products	2.77%	9	Transportation	1.40%
10	Ceramics and Fire-clay	0.40%	10	Spinning	2.71%	10	Plastic products	1.21%
11	Public administration	0.38%	11	Education and research	2.68%	11	Unclassified	1.19%
12	Rubber product	0.37%	12	Rubber product	2.67%	12	Rubber product	1.18%
13	Other transport equipment	0.36%	13	Public administration	2.54%	13	Water production and supply	0.92%
14	Gas	0.36%	14	Fishery	2.39%	14	Other manufacturing products	0.80%
15	Plastic products	0.35%	15	Non-metallic ore and quarrying	2.13%	15	Public administration	0.80%
16	Iron and steel	0.34%	16	Agriculture・Livestock	2.04%	16	Education and research	0.79%
17	Other services	0.31%	17	Other transport equipment	2.00%	17	Construction	0.74%
18	Drugs and Medicine	0.31%	18	Other services	1.94%	18	Agriculture・Livestock	0.69%
19	Refined petroleum and its products	0.31%	19	Non-ferrous metal	1.88%	19	Metal products	0.64%
20	Metallic ore	0.29%	20	Metal products	1.85%	20	Spinning	0.63%

For the reasons given above, industries in Beijing can be interpreted as having a structure by which water resources cannot easily exert the same impact as electrical power resources.

3. Simulation via CGE Model

In this section, we will analyze, via a CGE model, the question of what sort of impact changes in energy prices in Beijing can exert on the overall Beijing economy, especially demand structure.

3.1 SAM and CGE Model for Beijing

Here we will look at the structure of a SAM built on input-output tables for Beijing. The basis for the data is, as in the previous section, a 130-sector input-output table for Beijing in 2002, aggregated into 5 sectors for use in a CGE model. In addition, to complete the table in SAM format, we take Beijing fiscal revenue from the 2003 Beijing Statistical Yearbook, and use it as supplementary information[4] to balance the totals among columns and rows.

The sectors used are the 5 sectors agriculture, forestry & fisheries; energy-related; energy-intensive industry; manufacturing-related; and service-related, with specific details shown in Table 3-1.

The reason for choosing this small number of intensive sectors is that the behavior of the overall model becomes unstable with many sectors, making convergence to an equilibrium solution difficult. The instability of equilibrium analysis seen in CGE analysis, and the optimal number of sectors, are issues to be addressed in the future.

The Beijing SAM created and used in this paper is as shown in Table 3-2. Regarding the composition of the sectors, service-related and manufacturing-related comprise a large portion. Energy-related is only

[4] Specifically, this is used as a direct tax from the household sector.

about 4 percent.

Table 3-1 Breakdown of the 5 Sectors Used

10 Sectors	5 Sectors
1: Agriculture, forestry & fisheries	1: Agriculture, forestry & fisheries
2: Mining	2: Energy-related
3: Oil and coal products	2: Energy-related
4: Electrical power, gas, and heating supply	2: Energy-related
5: Chemical products	3: Energy-intensive industry
6: Steel	3: Energy-intensive industry
7: Transport	3: Energy-intensive industry
8: Manufacturing-related	4: Manufacturing-related
9: Construction	5: Service-related
10: Service-related	5: Service-related

The CGE model used in this paper is a modified version of that used by Hosoe et al (2004).[5]

The models for each block are as follows:

Domestic Production Block:

$$Y_j = b_j \Pi F_{h,j}^{\beta_{h,j}}, \forall j \tag{3-1}$$

$$F_{h,j} = \frac{\beta_{h,j} p_j^y}{p_j^f} Y_j, \forall h, j \tag{3-2}$$

$$X_{i,j} = ax_{i,j} Z_j, \forall i, j \tag{3-3}$$

$$Y_j = ay_j Z_j, \forall j \tag{3-4}$$

$$p_j^z = ay_j p_j^y + \sum_i ax_{i,j} p_i^q, \forall j \tag{3-5}$$

Symbols are defined as follows:

Y_j : Domestic value added (composite commodity) of the jth sector

$F_{h,j}$: Value-added items treated as the hth production element. In this model, these are of three types: employee income, operating surplus, and depreciation of fixed capital.

$X_{i,j}$: ith amount of intermediate inputs in the h,jth sector.

5 GAMS22.9, Model Library STDCGE model.

Z_j : Amount of supply in the jth sector.

$ax_{i,j}$: ith intermediate input coefficient in the jth sector.

$ay_{i,j}$: ith production factor input coefficient in the jth sector.

p^y : Value-added composite good price in each sector.

p^f : Factor price in each sector.

p^q : Armington (see below) composite good price in each sector.

p^z : Price (z) of supplied goods in each sector.

Equation (1) is a (Cobb-Douglas-type) domestic value-added production function, which, if optimized under profit maximization, leads to Equation (2). Using a Leontief-type production function and assuming that domestic supplied goods are produced as intermediate goods and composite value-added goods, Equations (3) and (4) can be derived from the definition of input coefficients. Under the condition of complete distribution of domestic supply (zero profit condition), deriving the price of supplied goods leads to Equation (5).

Government Block:

$$T^d = \tau^d \sum_h p_h^f FF_{h,1} + \sum_k p_k^f FF_{k,2} \tag{3-6}$$

$$T_j^z = \tau_j^z p_j^z Z_j, \forall j \tag{3-7}$$

$$X_i^g = \frac{\mu_i}{p_j^q}(T^d + \sum_j T_j^z - S_g), \forall i \tag{3-8}$$

T^d : Total direct taxes.

T^z : Indirect taxes and subsidies in the jth sector.

τ^d : Direct tax rate (exogenous).

τ^z : Indirect tax rate (exogenous) in the jth sector.

$FF_{h,1}$: Household stockpile of hth production factor (exogenous).

$FF_{h,2}$: Corporate stockpile of hth production factor (exogenous).

X_i^g : Government consumption of ith good.

μ_i : Percentage of consumption of ith good in total government consumption. ($\Sigma\mu i = 1$)

Table 3-2　5 Sectors of SAM for Beijing in 2002

Unit:1000RMB	AGR	ENE	ECS	MAN	SER	WAG	SUR	DFC	TAX	CON	GIV	INV	OFL	EXP	TX
AGR	7404349	286	145244	4938012	1299864					6523302	2038664	8831939	248928	2703030	34133618
ENE	545431	22952332	13226723	4909002	6677464					458820	0	1314885	10596311	452120	61133088
ECS	1704748	1703063	15073031	19026561	31555231					8838235	0	7306137	44988030	5472129	135667165
MAN	3172938	2594134	20414702	151138725	121383594					72691912	0	54496160	117478670	42913491	586284326
SER	1742764	4550544	15787655	45939816	178803659					60610586	74030094	134022487	145990749	30286293	691764647
WAG	6115948	1880295	13611173	28994480	140732776										191334672
SUR	3223401	2323524	1	23953850	82009591										111510367
DFC	697549	563069	12934347	10958547	36145026										61298538
TAX	48562	1024221	3236343	11001522	31801425										47112073
CON						191334672	111510367								302845039
GIV									47112073	16456470		12500215			76068758
INV								61298538		137265714			19741549	166022	218471823
IFL	8251002	23327496	38993660	221870853	46601226										339044237
IMP	1226926	214124	2244286	63552958	14754791										81993085
TX	34133618	61133088	135667165	586284326	691764647	191334672	111510367	61298538	47112073	302845039	76068758	218471823	339044237	81993085	

Note: Created from 2002 Beijing input-output table. The unit used in the table is 1,000 yuan. Symbols are as follows: AGR: agriculture, forestry & fisheries; ENE: energy-related industry; ECS: energy-intensive industry; MAN: manufacturing; SER: service Industry; WAG: employee income; SUR: operating surplus; DFC: depreciation of fixed capital; TAX: indirect taxes and subsidies; CON: consumption sector; GOV: government sectors; INV: investment sectors; OFL: outflows; EXP: exports; IFL: inflows; IMP: imports; XT: total production.

S_g : Government savings.[6]

Savings and Investment Block:

$$X_i^v = \frac{\lambda_i}{p_i^q}(S_p + S_g + S_r + S_{f1} + \varepsilon S_{f2}), \forall i \tag{3-9}$$

$$S_p = ss^p \sum_h p_h^f FF_{h,1} \tag{3-10}$$

$$S_r = ss^r IT \tag{3-11}$$

X_i^v : Amount of corporate investment in ith good

λ_i : Percentage of investment in ith good within total investment. ($\Sigma\lambda_i = 1$)

S_p : Private savings.

S_r : Total depreciation reserve.

S_{f1} : Amount of in-shipment and out-shipment deficit (domestic extra-regional savings, exogenous).

S_{f2} : Foreign currency-denominated current account deficit (foreign savings, exogenous).

ε : Exchange rate (yen / dollar).

ss^p : Private sector average savings rate.

ss^r : Average rate of fixed capital depreciation.

IT : Total investment.

Household Block:

$$X_i^c = \frac{\alpha_i}{p_i^q}(\sum_j X_j^c + \sum_h p_h^f FF_{h,1} - S_p - T^d), \forall i \tag{3-12}$$

X_i^c : Household consumption of ith good.

α_i : Percentage of consumption of ith good in total household consumption. ($\Sigma\alpha_i = 1$)

6 However, in the data used in this paper, the amount is 0.

In-Shipment and Out-Shipment Block:

$$OF_i = OFL_i^0, \forall i$$
$$IF_i = IFL_i^0, \forall i \qquad (3\text{-}13)$$

OF_i : Out-shipment value of ith good.

IF_i : In-shipment value of ith good.

OFL_i^0 : Initial out-shipment value of ith good (exogenous).

IFL_i^0 : Initial in-shipment value of ith good (exogenous).

Trade Block:

1) Import-export prices

$$p_i^e = \varepsilon \overline{p}_i^{We}, \forall i \qquad (3\text{-}14)$$

$$p_i^m = \varepsilon \overline{p}_i^{Wm}, \forall i \qquad (3\text{-}15)$$

$$\sum_i p_i^{We} E_i + S_f^2 = \sum_i p_i^{Wm} M_i \qquad (3\text{-}16)$$

p_i^e : Local currency-denominated export price of ith good

p_i^{We} : Foreign currency-denominated export price of ith good (exogenous)

p_i^m : Local currency-denominated import price of ith good

p_i^{Wm} : Foreign currency-denominated import price of ith good (exogenous)

E_i : Export volume of ith good.

M_i : Import volume of ith good.

Here we assume a small-country model, with import and export prices linked to international import-export prices through exchange rates.

2) Armington composite goods

We use the Armington hypothesis to assume imperfect substitutability of domestic goods and imported goods, and derive the Armington (Cobb-Douglas-type) composite goods production function, and the production and import volume of each good, as follows:

$$Q_i = tfp_{i,1}(M_i + IF_i)^{am_i} D_i^{ad_i}, \forall i \quad (3\text{-}17)$$

$$M_i = ms_i \frac{p_i^q Q_i}{p_i^m} - IF_i, \forall i \quad (3\text{-}18)$$

$$D_i = ds_{i,1} \frac{p_i^q Q_i}{p_i^d}, \forall i \quad (3\text{-}19)$$

Q_i : Production volume of ith Armington composite good.

D_i : Input volume of ith domestic supply-demand good.

$tfp_{i,1}$: Solow residual of the Armington composite goods production function.

am_i : Elasticity parameter of imported goods.

ad_i : Elasticity parameter of domestic supply-demand goods.

ms_i : Percentage of in-shipments and imports in production volume of Armington composite goods.

$ds_{i,1}$: Percentage of domestic supply-demand in production volume of Armington composite goods.

3) Transformation function

As with the Armington hypothesis, we assume that domestic goods and export goods are also apportioned according to the following transformation function:

$$Z_i = tfp_{i,2}(E_i + OF_i)^{be_i} D_i^{bd_i}, \forall i \quad (3\text{-}20)$$

$$E_i = es_i \frac{p_i^z Z_i}{p_i^e} - OF_i, \forall i \quad (3\text{-}21)$$

$$D_i = ds_{i,2} \frac{p_i^z Z_i}{p_i^2}, \forall i \quad (3\text{-}22)$$

$tfp_{i,1}$: Solow residual of production function of supplied goods.

be_i : Elasticity parameter of out-shipment and export goods.

bd_i : Elasticity parameter of domestic supply-demand goods.

es_i : Percentage of out-shipments and exports in total supply.

$ds_{i,1}$: Percentage of domestic supply-demand in total supply.

Market Clearance Condition:

$$Q_i = X_i^c + X_i^g + X_i^v + \sum_j X_{i,j}, \forall i \quad (3\text{-}23)$$

$$\sum_j F_{ihj} = FF_{h,1} + FF_{h,2} \quad (3\text{-}24)$$

Utility maximization problem:

Here utility maximization is given as maximization of the following Cobb-Douglas-type social utility function:

$$U = \prod_i^n X_i^{c\,\alpha_i} \quad (3\text{-}25)$$

Endogenous variables:

$$Y_j, X_{i,j}, F_{h,j}, Z_j, X_i^c, X_i^v, X_i^g, E_i, M_j, Q_i, D_i, OF_i, IF_j, p_h^f, p_j^y, p_j^z, p_i^q,$$
$$p_i^e, p_j^m, p_i^d, \varepsilon, S_p, S_r, T^d, T_j^d, U$$

Exogenous variables:

$$FF_{h,1}, FF_{h,2}, S_{f1}, S_{f2}, p_i^{We}, p_i^{Wm}, \tau^d, \tau_j^z, OFL_i^0, IFL_j^0$$

In the above simultaneous systems, there are 138 endogenous variables with an equal number of equations. The number of exogenous variables is 34. In addition, we used the price (p^f) of employee compensation (wages) as the numéraire.

We derived a standard equilibrium solution for the above model using nonlinear programming, and conducted simulations making changes to several assumptions.[7]

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7 Using the MINOS GAMS 22.9 solver.

3.2 Results of the Simulation

Here we conducted a simulation of changes in the price of energy goods in Beijing. The simulation looks at the impact of raising the indirect tax on energy goods from the current 2.7% to 10%, as well as the impact of a 10% rise in the price of energy goods.

Here we will extract only the main results and discuss their characteristics.

First, Table 3-3 displays the key results when only the indirect tax τ^{z}_{ENE} on domestic energy goods is raised from its current rate to 10% through some form of government policy.

Table 3-3 Simulation Results 1

10% Rise in Indirect Taxes on Energy Goods
(currently 2.73% from SAM)

Percentage change in amount of supply (Zj)	
Agriculture, forestry & fisheries	−1.76
Energy-related	−0.95
Energy-intensive industry	−0.63
Manufacturing-related	−0.37
Service-related	0.26

Percentage change in amount of consumption (Xcj)	
Agriculture, forestry & fisheries	−3.15
Energy-related	−2.42
Energy-intensive industry	−1.84
Manufacturing-related	−1.08
Service-related	−0.57

Percentage change in amount of government consumption (Xgj)	
Agriculture, forestry & fisheries	0.81
Energy-related	0
Energy-intensive industry	0
Manufacturing-related	0
Service-related	3.51

Percentage change in export volume (Ej)	
Agriculture, forestry & fisheries	0.58
Energy-related	9.68
Energy-intensive industry	−3.45
Manufacturing-related	−0.4
Service-related	0.85

Percentage change in import volume (Mj)	
Agriculture, forestry & fisheries	4.12
Energy-related	−17.85
Energy-intensive industry	1.3
Manufacturing-related	−0.33
Service-related	0.82

Percentage change in price of supplied goods (pzj)	
Agriculture, forestry & fisheries	2.74
Energy-related	1.73
Energy-intensive industry	0.9
Manufacturing-related	0.92
Service-related	0.52

Percentage change in price of domestic goods (pdj)	
Agriculture, forestry & fisheries	4.2
Energy-related	3.34
Energy-intensive industry	0.84
Manufacturing-related	1.13
Service-related	0.46

Table 3-4 Simulation Results 2

10% Rise in Price of Energy Goods	
Percentage change in amount of supply (Zj)	
Agriculture, forestry & fisheries	−0.00005
Energy-related	0
Energy-intensive industry	0.00002
Manufacturing-related	−0.00003
Service-related	−0.00001

Percentage change in amount of consumption (Xcj)	
Agriculture, forestry & fisheries	−4.3
Energy-related	−11.89
Energy-intensive industry	−4.2
Manufacturing-related	1.81
Service-related	−1.14

Percentage change in amount of government consumption (Xgj)	
Agriculture, forestry & fisheries	−3.31
Energy-related	0
Energy-intensive industry	0
Manufacturing-related	0
Service-related	−0.15

Percentage change in export volume (Ej)	
Agriculture, forestry & fisheries	−0.002
Energy-related	−0.016
Energy-intensive industry	−0.012
Manufacturing-related	−0.005
Service-related	−0.009

Percentage change in import volume (Mj)	
Agriculture, forestry & fisheries	−3.52
Energy-related	20.05
Energy-intensive industry	−0.023
Manufacturing-related	−0.0064
Service-related	−0.0063

Percentage change in price of supplied goods (pzj)	
Agriculture, forestry & fisheries	2.24
Energy-related	10
Energy-intensive industry	2.42
Manufacturing-related	1.92
Service-related	1.14

Percentage change in price of domestic goods (pdj)	
Agriculture, forestry & fisheries	1.97
Energy-related	9.09
Energy-intensive industry	3.41
Manufacturing-related	2.42
Service-related	0.69

Notable points include, first, that regardless of the supply or consumption volumes of goods, both mostly decline as a result of the impact of indirect taxes, but results show a more serious impact on agricultural goods than on energy goods. This suggests that demand for energy goods is inelastic with respect to changes in taxes, while demand for agricultural goods is relatively elastic.

Second, results show that the indirect tax increase on energy goods has a negative impact on import of energy goods, but a positive one on exports. Here indirect taxes include customs taxes on imports; when these rise, it is natural that imports decline. The increase in exports is more difficult to interpret, but this may be a case of a reaction by which decline in domestic consumption is compensated for by increasing exports.

Third, results show an overall increase in the price of supplied goods overall and the price of domestic goods. This is due to the increase in indirect taxes on energy goods pushing up the prices of other goods.

Next, Table 3-4 shows the key results when the supply price of energy goods p^{z}_{ENE} increases 10%.

First, as in the case of an indirect tax increase, the volume of supply and of consumption of goods mainly decreases, but while the volume of supply itself decreases only slightly, consumption itself displays a relatively large decline. In particular, the decline in consumption itself of energy goods is over 11%. This suggests that price increases exert a more serious impact on consumer behavior than do taxes. The reason may be that in the case of a tax increase, the government in the end pays subsidies and support funds from the increased taxes, leading to expectations of the possibility of support for consumption, or to consumers incorporating this into their behavior. In fact, in the case of indirect tax increases, volume of government consumption increases for agriculture and services. By contrast, in the case of price increases, results show government consumption itself decreasing.

Second, a rise in the price of energy goods has the effect of increasing the import of energy goods and decreasing export. This result is opposite from the impact of indirect tax increases, but can be interpreted as the manifestation of the effect of trying to substitute energy goods from overseas as the price of domestic energy rises. In addition, the decrease in exports is viewed as the direct impact of the rise in energy prices.

Third, as in the case of indirect tax increases, when the price of energy goods supply increases, an increase overall in the price of supply goods and domestic goods takes place. This is an expected result, but the magnitude of the increase is greater than that of an increase in indirect taxes. Price increases in specific goods may be more directly pulling up the prices of other goods.

From the above, as a feature of Beijing's economic structure, we can discern the very interesting finding that the impact on demand and supply differ for an increase in indirect taxes versus an increase in prices. This can be considered to occur through the mutual cross-impacting of structural characteristics of the economic system as a whole, such as the economic routes through which effects spread and the elasticity of the supposed taxes and prices.

4. Impact of the Price of Water Resources in China on the Asian Economy

In a departure from the previous two sections, in this section we will overview the situation of dependence upon water resources in Asian countries by analyzing what sort of impact water resources in China may have on the Asian economic region.

The data used for analysis is from 76 sectors in Asia input-output tables from 2000, published by the Asian Institute of Economic Research.

The Asian table is composed of 10 countries, with the United States added to 9 countries from Indonesia to Japan, in the format of a non-competitive import-type (Isard-type) inter-regional table. Therefore, as the import component is deducted in this table from the intermediate demand table, from the start there is no need to consider self-sufficiency ratios when creating the Leontief inverse matrix, which makes the table relatively easy to work with.

The breakdown of the 10 countries is Indonesia, Malaysia, the Philippines, Singapore, Thailand, China, Taiwan, South Korea, Japan, and the United States. As the table has 76 sectors for 10 countries, overall it is a relatively large table at 760 × 760 sectors. If this input-output table is presented schematically, it appears as shown in Figure 4-1.

The analysis here is of the equilibrium price models (2-1) used in Section 2, and the equation (2-2), which is the calculation method between them.

The premise of the simulation is a calculation of the impact of doubled water resource prices in China. The main results are shown in Table 4-2.

In the results of Table 4-2, when the increase in the price of China's water resources is 100%, the greatest result is the impact on education and research, but at 1.34% the rate of increase is not significant. Below that, chemical fertilizers, hotels, and basic chemicals follow in the size of impacts, yet the impact of price rises is faint for all of these.

Figure 4-1 Asian Input-Output Table for 2000

	code	Intermediate Demand (A)										Final Demand (F)										Export (L)					
		Indonesia (AI)	Malaysia (AM)	Philippines (AP)	Singapore (AS)	Thailand (AT)	China (AC)	Taiwan (AN)	Korea (AK)	Japan (AJ)	U.S.A. (AU)	Indonesia (FI)	Malaysia (FM)	Philippines (FP)	Singapore (FS)	Thailand (FT)	China (FC)	Taiwan (FN)	Korea (FK)	Japan (FJ)	U.S.A. (FU)	Export to Hong Kong (LH)	Export to EU (LO)	Export to R.O.W. (LW)	Statistical Discrepancy (QX)	Total Outputs (XX)	
Indonesia	(AI)	A^{II}	A^{IM}	A^{IP}	A^{IS}	A^{IT}	A^{IC}	A^{IN}	A^{IK}	A^{IJ}	A^{IU}	F^{II}	F^{IM}	F^{IP}	F^{IS}	F^{IT}	F^{IC}	F^{IN}	F^{IK}	F^{IJ}	F^{IU}	L^{IH}	L^{IO}	L^{IW}	Q^{I}	X^{I}	Valued at producer's price
Malaysia	(AM)	A^{MI}	A^{MM}	A^{MP}	A^{MS}	A^{MT}	A^{MC}	A^{MN}	A^{MK}	A^{MJ}	A^{MU}	F^{MI}	F^{MM}	F^{MP}	F^{MS}	F^{MT}	F^{MC}	F^{MN}	F^{MK}	F^{MJ}	F^{MU}	L^{MH}	L^{MO}	L^{MW}	Q^{M}	X^{M}	
Philippines	(AP)	A^{PI}	A^{PM}	A^{PP}	A^{PS}	A^{PT}	A^{PC}	A^{PN}	A^{PK}	A^{PJ}	A^{PU}	F^{PI}	F^{PM}	F^{PP}	F^{PS}	F^{PT}	F^{PC}	F^{PN}	F^{PK}	F^{PJ}	F^{PU}	L^{PH}	L^{PO}	L^{PW}	Q^{P}	X^{P}	
Singapore	(AS)	A^{SI}	A^{SM}	A^{SP}	A^{SS}	A^{ST}	A^{SC}	A^{SN}	A^{SK}	A^{SJ}	A^{SU}	F^{SI}	F^{SM}	F^{SP}	F^{SS}	F^{ST}	F^{SC}	F^{SN}	F^{SK}	F^{SJ}	F^{SU}	L^{SH}	L^{SO}	L^{SW}	Q^{S}	X^{S}	
Thailand	(AT)	A^{TI}	A^{TM}	A^{TP}	A^{TS}	A^{TT}	A^{TC}	A^{TN}	A^{TK}	A^{TJ}	A^{TU}	F^{TI}	F^{TM}	F^{TP}	F^{TS}	F^{TT}	F^{TC}	F^{TN}	F^{TK}	F^{TJ}	F^{TU}	L^{TH}	L^{TO}	L^{TW}	Q^{T}	X^{T}	
China	(AC)	A^{CI}	A^{CM}	A^{CP}	A^{CS}	A^{CT}	A^{CC}	A^{CN}	A^{CK}	A^{CJ}	A^{CU}	F^{CI}	F^{CM}	F^{CP}	F^{CS}	F^{CT}	F^{CC}	F^{CN}	F^{CK}	F^{CJ}	F^{CU}	L^{CH}	L^{CO}	L^{CW}	Q^{C}	X^{C}	
Taiwan	(AN)	A^{NI}	A^{NM}	A^{NP}	A^{NS}	A^{NT}	A^{NC}	A^{NN}	A^{NK}	A^{NJ}	A^{NU}	F^{NI}	F^{NM}	F^{NP}	F^{NS}	F^{NT}	F^{NC}	F^{NN}	F^{NK}	F^{NJ}	F^{NU}	L^{NH}	L^{NO}	L^{NW}	Q^{N}	X^{N}	
Korea	(AK)	A^{KI}	A^{KM}	A^{KP}	A^{KS}	A^{KT}	A^{KC}	A^{KN}	A^{KK}	A^{KJ}	A^{KU}	F^{KI}	F^{KM}	F^{KP}	F^{KS}	F^{KT}	F^{KC}	F^{KN}	F^{KK}	F^{KJ}	F^{KU}	L^{KH}	L^{KO}	L^{KW}	Q^{K}	X^{K}	
Japan	(AJ)	A^{JI}	A^{JM}	A^{JP}	A^{JS}	A^{JT}	A^{JC}	A^{JN}	A^{JK}	A^{JJ}	A^{JU}	F^{JI}	F^{JM}	F^{JP}	F^{JS}	F^{JT}	F^{JC}	F^{JN}	F^{JK}	F^{JJ}	F^{JU}	L^{JH}	L^{JO}	L^{JW}	Q^{J}	X^{J}	
U.S.A.	(AU)	A^{UI}	A^{UM}	A^{UP}	A^{US}	A^{UT}	A^{UC}	A^{UN}	A^{UK}	A^{UJ}	A^{UU}	F^{UI}	F^{UM}	F^{UP}	F^{US}	F^{UT}	F^{UC}	F^{UN}	F^{UK}	F^{UJ}	F^{UU}	L^{UH}	L^{UO}	L^{UW}	Q^{U}	X^{U}	
Freight and Insurance	(BF)	BA^{I}	BA^{M}	BA^{P}	BA^{S}	BA^{T}	BA^{C}	BA^{N}	BA^{K}	BA^{J}	BA^{U}	BF^{I}	BF^{M}	BF^{P}	BF^{S}	BF^{T}	BF^{C}	BF^{N}	BF^{K}	BF^{J}	BF^{U}	← International freight and insurance on the trade between member countries (A**, F**).					
Import from Hong Kong	(CH)	A^{HI}	A^{HM}	A^{HP}	A^{HS}	A^{HT}	A^{HC}	A^{HN}	A^{HK}	A^{HJ}	A^{HU}	F^{HI}	F^{HM}	F^{HP}	F^{HS}	F^{HT}	F^{HC}	F^{HN}	F^{HK}	F^{HJ}	F^{HU}	Valued at C.I.F.					
Import from EU	(CO)	A^{OI}	A^{OM}	A^{OP}	A^{OS}	A^{OT}	A^{OC}	A^{ON}	A^{OK}	A^{OJ}	A^{OU}	F^{OI}	F^{OM}	F^{OP}	F^{OS}	F^{OT}	F^{OC}	F^{ON}	F^{OK}	F^{OJ}	F^{OU}						
Import from the R.O.W.	(CW)	A^{WI}	A^{WM}	A^{WP}	A^{WS}	A^{WT}	A^{WC}	A^{WN}	A^{WK}	A^{WJ}	A^{WU}	F^{WI}	F^{WM}	F^{WP}	F^{WS}	F^{WT}	F^{WC}	F^{WN}	F^{WK}	F^{WJ}	F^{WU}						
Duties and Import Commodity Taxes	(DT)	DA^{I}	DA^{M}	DA^{P}	DA^{S}	DA^{T}	DA^{C}	DA^{N}	DA^{K}	DA^{J}	DA^{U}	DF^{I}	DF^{M}	DF^{P}	DF^{S}	DF^{T}	DF^{C}	DF^{N}	DF^{K}	DF^{J}	DF^{U}	← Import duties and import commodity taxes levied on all trade.					
Value Added	(VV)	V^{I}	V^{M}	V^{P}	V^{S}	V^{T}	V^{C}	V^{N}	V^{K}	V^{J}	V^{U}																
Total Inputs	(XX)	X^{I}	X^{M}	X^{P}	X^{S}	X^{T}	X^{C}	X^{N}	X^{K}	X^{J}	X^{U}																

* Each cell of A** and F** represents a matrix of 76 x 76 and 76 x 4 dimension, respectively.

Table 4-2: Impact (%) of Doubling the Price of Water Resources in China

1	China	Water supply	100%
2	China	Education and research	1.341%
3	China	Chemical fertilizers and pesticides	0.832%
4	China	Hotel	0.761%
5	China	Unclassified	0.698%
6	China	Basic industrial chemicals	0.688%
7	China	Electricity and gas	0.682%
8	China	Iron ore	0.669%
9	China	Other transport equipment	0.596%
10	China	Iron and steel	0.596%
11	China	Pulp and paper	0.595%
12	China	Medical and health service	0.588%
13	China	Telephone and telecommunication	0.583%
14	China	Cement and cement products	0.563%
15	China	Metal products	0.543%
16	China	Other service	0.539%
17	China	Drugs and medicine	0.521%
18	China	Glass and glass products	0.514%
19	China	Other construction	0.511%
20	China	Building construction	0.509%
21	China	Boilers, Engines and turbines	0.507%
22	China	Wooden furniture	0.504%
23	China	Other wooden products	0.484%
24	China	Other chemical products	0.479%
25	China	Lighting fixtures, batteries, wiring and others	0.479%
26	China	Non-ferrous metal	0.476%
27	China	Specialized machinery	0.471%
28	China	General machinery	0.467%
29	China	Shipbuilding	0.467%
30	China	Restaurants	0.461%

This result is similar to that of Section 2, in which increases in the price of water resources in Beijing exert only a faint impact.

The impact that water resources in China exert on other countries is shown in Table 4-3. While the impact is by no means large, a relatively strong dependency with China is seen in Malaysia, Thailand, Singapore, and Korea. The industries are flour milling, heavy electrical machinery, knitting, non-ferrous metals, and apparel.

In general, the extent to which water resources are used as intermediate inputs in other countries is difficult to know. However, in the Asian input-output table, as information on trading of water resources among nations is included, through an inverse Leontief matrix it becomes possible to grasp their degree of impact.

Next, at the end of this section, we attempt cross-comparison among all 10 of the countries on the Asian table.

Table 4-3 Impact (%) of the Price of Water Resources on Other Countries

1	China	Water supply	1
77	Malaysia	Milled grain and flour	0.027%
78	Thailand	Heavy Electrical equipment	0.027%
79	Thailand	Knitting	0.024%
80	Singapore	Non-ferrous metal	0.024%
81	Korea	Wearing apparel	0.021%
82	Singapore	Heavy Electrical equipment	0.021%
83	Malaysia	Weaving and dyeing	0.020%
84	Thailand	Lighting fixtures, batteries, wiring and others	0.020%
85	Korea	Chemical fertilizers and pesticides	0.019%
86	Malaysia	Wearing apparel	0.019%
87	Taiwan	Other non-metallic mineral products	0.018%
88	Korea	Weaving and dyeing	0.018%
89	Singapore	Household electrical equipment	0.018%
90	Singapore	Wearing apparel	0.017%
91	Singapore	Motor cycles	0.017%
92	Thailand	Television sets, radios audios and communication equipment	0.017%
93	Thailand	Semiconductors and integrated circuits	0.017%
94	Thailand	Household electrical equipment	0.017%
95	Korea	Knitting	0.017%
96	Singapore	Other manufacturing products	0.017%
97	Singapore	Leather and leather products	0.016%
98	Taiwan	Iron and steel	0.016%
99	Korea	Iron and steel	0.015%
100	Taiwan	Lighting fixtures, batteries, wiring and others	0.015%
101	Taiwan	Heavy Electrical equipment	0.015%
102	Philippines	Basic industrial chemicals	0.015%
103	Philippines	Glass and glass products	0.015%
104	Malaysia	Chemical fertilizers and pesticides	0.015%
105	Taiwan	Non-ferrous metal	0.015%

When water supply price increases all at once in the 10 Asian countries, which country's impact is the largest? And on what industries in what countries is impact seen?

Table 4-4 displays the results. This table extracts the impacts other than the increased price of water supply in the 10 countries, for the top 11th through 36th place among the total 7600 sectors.

Results show that water resources in each country exert a large impact on that country, with the largest impacts seen in fisheries in Singapore, followed by the public sector in the United States, and hotels and restaurants in Japan.

The impact of water resources in China, as seen in Table 4-2, is not large in value, but compared to the 7600 sectors ranks at #18, making it by no means a small impact. Moreover, the impact on chemical fertilizers in China is a relatively high #36.

Table 4-4: Impact (%) of Increases in Price of Water Resources in 10 Asia Region Countries

rank	country	sector	increasing(%)	Source of water supply	
11	Singapore	Fishery	1.93803%	Singapore	Water supply
12	USA	Public administration	1.75594%	USA	Water supply
13	Japan	Hotel	1.45895%	Japan	Water supply
14	Japan	Restaurants	1.41188%	Japan	Water supply
15	Thailand	Chemical fertilizers and pesticides	1.40982%	Thailand	Water supply
16	Philippines	Beverage	1.38369%	Philippines	Water supply
17	Japan	Synthetic resins and fiber	1.36984%	Japan	Water supply
18	China	Education and research	1.34107%	China	Water supply
19	Philippines	Cement and cement products	1.25277%	Philippines	Water supply
20	Malaysia	Hotel	1.18988%	Malaysia	Water supply
21	USA	Food crops	1.14020%	USA	Water supply
22	USA	Other grain	1.11954%	USA	Water supply
23	Japan	Basic industrial chemicals	1.06095%	Japan	Water supply
24	Japan	Public administration	1.02701%	Japan	Water supply
25	Japan	Chemical fertilizers and pesticides	1.02576%	Japan	Water supply
26	Philippines	Hotel	0.98852%	Philippines	Water supply
27	Japan	Education and research	0.97990%	Japan	Water supply
28	Philippines	Other service	0.91795%	Philippines	Water supply
29	USA	Non-food crops	0.88953%	USA	Water supply
30	Malaysia	Medical and health service	0.87543%	Malaysia	Water supply
31	Philippines	Wholesales and retail trade	0.87384%	Philippines	Water supply
32	Malaysia	Restaurants	0.85667%	Malaysia	Water supply
33	Singapore	Knitting	0.83950%	Singapore	Water supply
34	Singapore	Weaving and dyeing	0.83949%	Singapore	Water supply
35	Singapore	Spinning	0.83852%	Singapore	Water supply
36	China	Chemical fertilizers and pesticides	0.83174%	China	Water supply

5. Concluding Notes

In this paper, we used three types of data to analyze the impact that changes in resource prices, especially in water supply prices, exert on intra-regional supply of goods and extra-regional price changes, as well as the possible impact of such on the demand side.

The first of these was analysis using an input-output table

(42-sector table) for Beijing in 2002.

Results of the analysis demonstrate that changes in the price of water supply do not have as significant an impact as is the case with energy goods such as electrical power or oil and mining. This result is a feasible one, given that trading volume itself in water resource markets is a mere fraction of the trading volume of electrical power and oil and mining, and given the possibility that water is used directly from rivers, lakes, etc.

The second was analysis conducted on the Beijing economic structure using a CGE model, in a general equilibrium framework.

Looking at indirect taxes of 10% on the purchase of energy goods, and a 10% increase in the price of energy goods, even with similar price increase policies, differences were seen in the effects. This can be interpreted as the possibility that the economy foresees and acts upon the increased taxes taken in by the government being fed back into the market as demand, or the possibility of differences in the substitution effect via trade.

The third was analysis of what sort of ripple effect on domestic and foreign prices would come about from changes in the price of water supply in China, based on Fig. 4-1.

It was evident that an increase in the price of water resources would not effect a significantly large increase in the prices of other goods. Looking at the extent of the effect, an increase in the price of water resources in China would first induce changes in the prices of other domestic goods (education and research, chemical fertilizers, etc.); the effect on other countries would be relatively large in countries including Malaysia, Thailand, Singapore, and South Korea, and in the industries of flour milling, heavy electrical equipment, knitting, non-ferrous metals, and apparel. However, all of these impacts would be minimal. This tendency is not one limited China and is common to the countries of Asia, but the strongest relative impacts of water prices would be borne by fisheries in Singapore, followed by the public sector in the United States, and hotels and restaurants in Japan.

The above comprise the main analyses of this paper, demonstrating that the impact of changes in water prices would not be so great. While some of this result can be attributed to the data used, some can also be attributed to the analysis models.

In particular, a framework for analysis of general equilibrium such as a CGE model faces the problem that as the number of industrial sectors becomes large, the behavior of the simulation quickly becomes unstable, and the model as a whole does not head toward a convergent solution. This is a problem with large-scale simultaneous measurement models that has been pointed out in the past, and is an issue in empirical research.

Consideration of simple, easily operable analytical methods that can withstand complicated real analysis remains as a topic for the future[8].

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