Economic Relation ships of Shanghai with the Rest of China and the World: A CGE Analysis

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Abstract

The purpose of this paper is to examine the linkages of the Shanghai economy with the rest of China (ROC) and the rest of the world (ROW) using a Dynamic Computable General Equilibrium (DCGE) model based on the input-output tables of 1997 and 2002. The model distinguishes 14 sectors and captures both demand and supply side linkages. Based on relationships observed during the sample period, the paper offers simulations for the 2002-2010 period. The results indicate that with respect to ROC, Shanghai is more of a supplier than a source of demand. With respect to ROW, however, Shanghai is both a supplier and a source of demand, reflecting a high degree of integration of Shanghai with the world market (globalization). Because of the two way integration with the world market and the large domestic demand that it caters to, Shanghai is more in a position to withstand adjustments in the exchange rate of Yuan.

Keywords: Shanghai Economy, ROC, World Market, Input-Output, CGE Model
JEL Classification: O

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1. Introduction

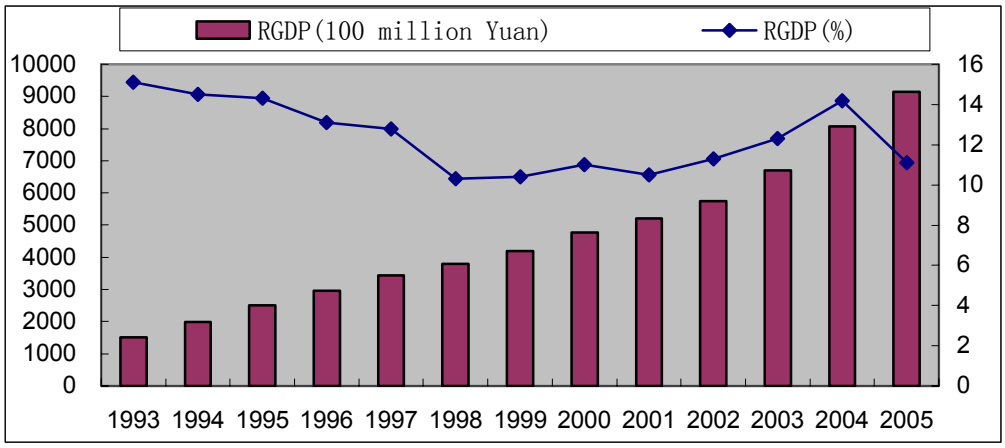
The Shanghai economy is a very important regional economy of China. At the beginning of 1990s, the Shanghai government took over *Pudong* (the area across the river *Pu*) and focused on it as the main developing area, at the same time speeding up economic reforms and embracing more openness. In order to adapt to changes in the domestic and international economy, Shanghai engaged twice in major upgrading of its economic structure. The first was in mid-1990s, when the Shanghai government selected automobile, information and communication technology (ICT), general electric equipment, petroleum and chemical, steel, and modern home appliance manufacturing as the key industries to be developed. However towards the end of the 1990s, the Shanghai government realized the importance of service industries and therefore modified the list of key industries to be promoted to include business and trade services, financial and insurance service, and the real estate industry. Through a combination of high tech manufacturing and advanced business services, Shanghai aimed at becoming a major international metropolis and emerging as the leader of the Yangtze River Delta Economic Region and in fact of the Chinese economy as a whole. These two waves of upgrading resulted in major changes in the structure of Shanghai's economy and altered its links with the domestic and the international economy.

Between 1993 and 2005, Shanghai's GDP growth rate averaged more than 10 percent per annum, and the GDP at constant 2000 price rose from 151.9 to 914.4 billion Yuan (Figure 1). At the same time, the relative importance of Shanghai's economic links with the rest of China (ROC) and the rest of the world (ROW) changed.[2] Between 1997 and 2002, the ratio of Shanghai's 'trade with ROC' to its GDP decreased from 107.1 to 96.7, whereas the ratio of Shanghai's trade with ROW to its GDP increased from 66.4 to 130.4 percent (Figure 2).

The purpose of this paper is to analyze the changes in Shanghai's external economic links in more detail and to use the results for future projections. For this purpose, the paper uses a dynamic computable general equilibrium model (DCGE) that is based on the input-output data for 1997 and 2002 and distinguishes fourteen sectors, capturing both demand and supply side linkages. Simulations are conducted for 2002 and 2010.

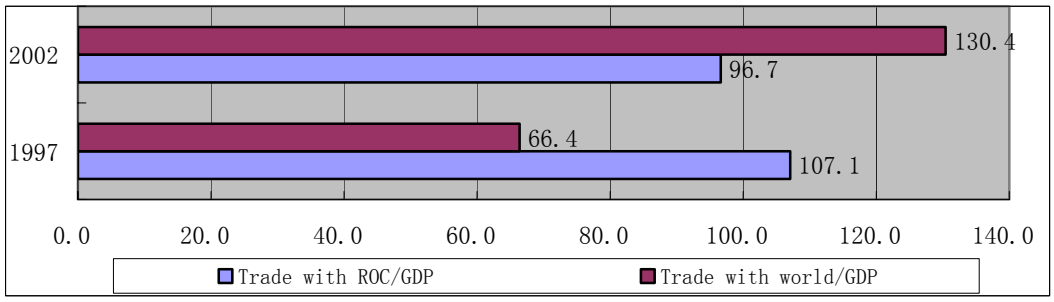
[2] 'Rest of China' (ROC) refers to the mainland China other than Shanghai, while 'rest of the world' (ROW) means economies outside of the mainland China.

Figure 1: Real GDP of Shanghai (Value and Growth Rate)



Data source: Shanghai Statistical Yearbook, 2006

Figure 2: Shanghai's trade dependence on ROC and ROW



Data source: Calculated by 1997 and 2002 Shanghai Input-Output Tables

The results indicate that with respect to ROC, Shanghai is more of a supplier than a source of demand. With respect to ROW, however, Shanghai is both a supplier and a source of demand, reflecting a high degree of integration of Shanghai with the world market (globalization). Because of the two way integration with the world market and the large domestic demand that it caters to, Shanghai is more in a position to withstand adjustments in the exchange rate of Yuan.

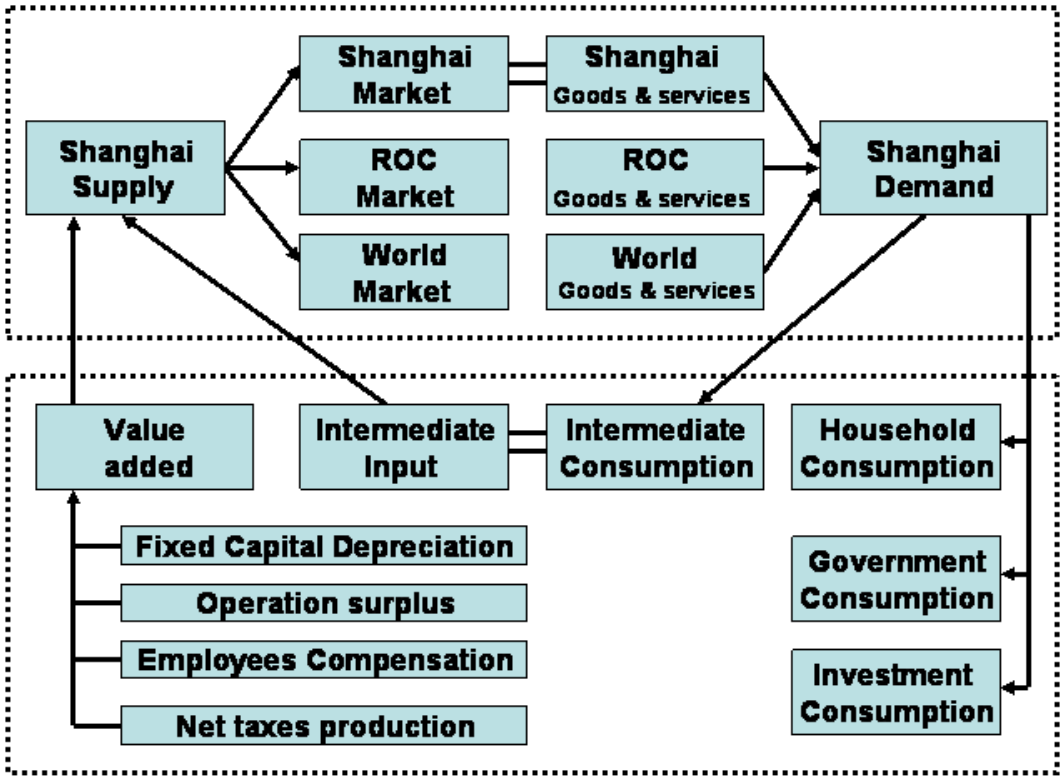
The paper is organized as follows. Section 2 describes the main changes in Shanghai's economic structure as revealed by the input-output tables of 1997 and 2002. Section 3 describes the Dynamic CGE model that is constructed and used for the analysis. Section 4 presents the results. Section 5 concludes.

2. Shanghai's economic relationships with ROC and ROW

In analyzing the economy of a region within a country, it is necessary to take into

account its links with both the rest of the country and the world market. These links span trade, factor flows, government transfers, etc.[3] Input-output tables provide good information regarding trade linkages and changes in them over time. Figure 3 presents a scheme that conceptualizes Shanghai's economic links with ROC and ROW.

Figure3: The Framework of I-O Analysis of Shanghai Economy



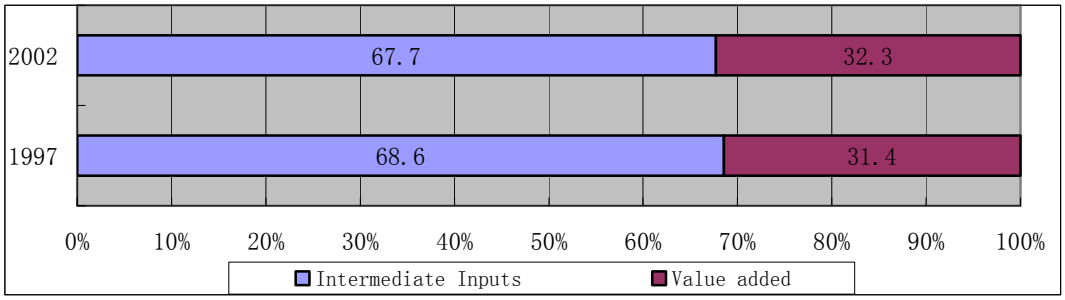
2.1 Changes in Shanghai's economic structure

On the production/supply side, Figure 4 shows that between 1997 and 2002 the share of value added in Shanghai's gross output has increased only slightly from 31.4 to 32.3, indicating that the intermediate input intensity of Shanghai's economy has not changed that much during this period. However, there have been notable changes in the composition of the value added itself, with the share of 'fixed capital depreciation' increasing from 12.1 to 14.7 percent, and the share of 'employee compensation' remaining almost constant (changing from 34.4 to 35.0 percent over the period). Capital accumulation rather than employment expansion has therefore played a more important

[3] The analysis of this paper focuses on the real economy, so that attention is paid to export, import of products and services between Shanghai on the one hand and ROC and ROW, on the other. Issues of factor flows and transfers between the regional and central governments are left for future studies.

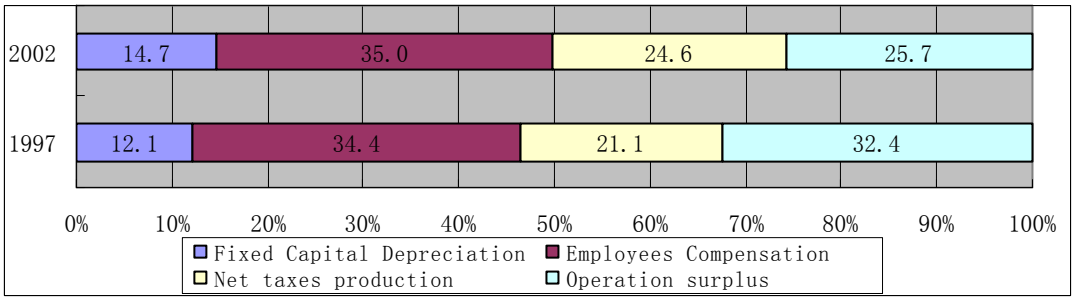
role in Shanghai's recent growth. Also, more of the surplus is now captured by the government in the form of taxes, leading to an increase of share of 'net taxes' in the value added from 21.1 to 24.6 percent during the period. The increases in the shares in value added of depreciation, labor, and taxes, have taken place at the expense of the share of capital, as reflected in the marked decline in the share of 'operation surplus' in the value added from 32.4 to 25.7 percent during the same period (Figure 5).

Figure 4: Decomposition of Shanghai's gross output



Data source: Calculated by 1997 and 2002 Shanghai Input-Output Table

Figure 5: Decomposition of the value added

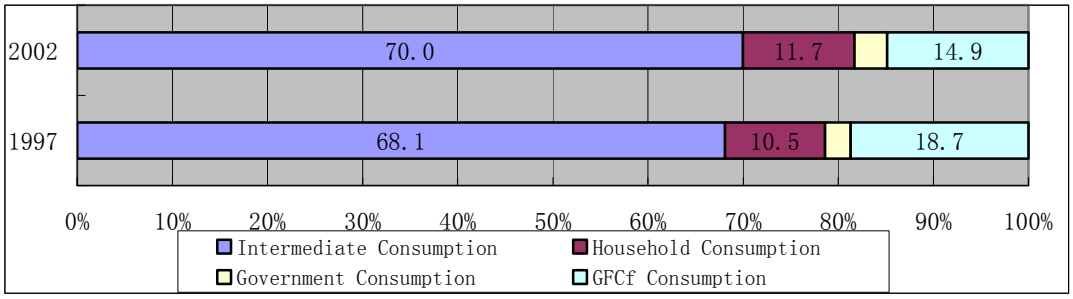


Data source: Calculated by 1997 and 2002 Shanghai Input-Output Table

On the disposal/demand side, Figure 6 shows that the shares of 'intermediate consumption,' 'household consumption,' and 'government consumption' in Shanghai's own output have increased from 68.1, 10.5, and 2.7 percent to 70.0, 11.7, and 3.4 percent, respectively, between 1997 and 2002. The share of 'gross fixed capital formation (GFCf),' on the other hand, has decreased from 18.7 to 14.9 percent (Figure 6). However, GFCf and 'intermediate consumption' together account for 85 percent of absorption of Shanghai's output in 2002, leaving only about 15 percent for 'household' and 'government consumption.' This indicates that most of Shanghai's production is geared toward production of intermediate and capital goods and not toward

consumption goods.

Figure 6: Use of Shanghai's output



Data source: Calculated by 1997 and 2002 Shanghai Input-Output Table

2.2 Shanghai's economic relationships with ROC and ROW

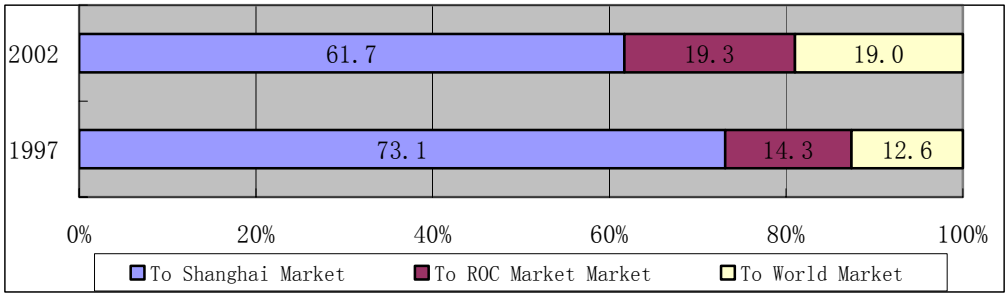
Changes in Shanghai's economic structure were obviously associated with changes in Shanghai's external economic relationships, in particular with changes in the relative importance of Shanghai's own market, ROC, and ROW as sources of demand and supply for Shanghai. First of all, there has been a significant shrinkage of the role of Shanghai's domestic market as a destination of Shanghai's output. The share of Shanghai's output absorbed by Shanghai domestic market decreased from 73.1 percent in 1997 to 61.7 percent in 2002 (Figure 7). Analogous shares of ROC and ROW increased from 14.3 and 12.6 percent to 19.3 and 19.0 percent, respectively, during the same period. In other words, about forty percent of Shanghai's output is now marketed outside of Shanghai, of which half is absorbed by the world market.

Second, related shifts have occurred on the demand side too. The share of Shanghai's demand met by Shanghai's own output declined from 72.6 percent in 1997 to 63.8 percent in 2002 (Figure 8). Interestingly, the share of ROC in meeting Shanghai's demand has also declined, from 19.2 to 12.3 percent over the same period. By contrast, there has been a large increase, from 8.2 to 19.2 percent, in the role of foreign market in meeting Shanghai's demand. Thus, while ROC absorbs relatively more (in 2002 compared to in 1997) of Shanghai's output, Shanghai itself is absorbing relatively more from the international market and relatively less from ROC.[4] In other words, ROC is more a market for sale of Shanghai products rather than a source of its own supply. For

[4] In this paper, we highlight the total amount level of the relation between Shanghai, ROC and world market, not discuss in industries level in detail.

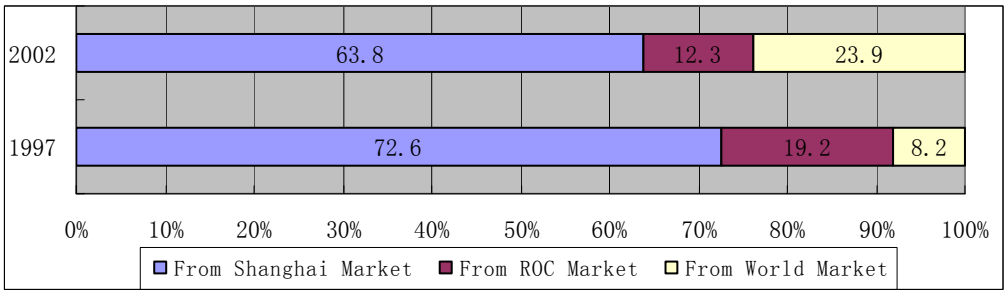
the latter, Shanghai is now more dependent on the world market.

Figure7: Changes in the destination of Shanghai output



Data source: Calculated by 1997 and 2002 Shanghai Input-Output Table

Figure8: Changes in the sources meeting Shanghai demand



Data source: Calculated by 1997 and 2002 Shanghai Input-Output Table

3. A dynamic regional CGE model for the Shanghai economy

In order to study the future impact of the changes in Shanghai's external economic linkages, this paper uses a dynamic regional computable general equilibrium (CGE) model. Before describing this model, it is useful to have a brief review of previous regional CGE models used elsewhere and in China.

3.1 Regional CGE models

CGE models designed to study development issues received considerable impetus from the work by Dervis, de Melo, and Robinson (1982). These models were later extended to study regional economies within or in relation with other economies. Thus, Madden (1990) developed a dynamic regional CGE model (FEDERAL-F model, as it is called) with Tasmania and rest of Australia as two regions of an economy. Similarly, Islam and Jenkins (1996) developed a CGE model to study the relationship between Puerto Rico and the mainland USA. Over time, regional CGE models have become a

popular tool to study regional economies and related policy issues (see Partridge and Richman (1998) for a survey).

In China, Li (2000) and Zheng (1999) developed the national CGE model, and applied it to study policy issues, such as issues of trade liberalization and of reducing emission by carbon taxes in China.[5] Ezaki and Sun (2000) used a CGE model to study the impact of trade liberalization on the Chinese economy. Li (2004) developed a regional CGE model with Guangdong province and ROC as two regions. The model was also adapted to have Shanxi province and ROC as the two regions. Sun (2004) developed a regional model with Sichuan province and ROC as the two regions to study the effect of investment. The model developed and used in this paper is a further extension of these regional CGE models.

3.2 Regional CGE model for Shanghai

Unlike national CGE models, regional CGE models have a more complex structure allowing for cross-region flows of products, factors, and funds. These cross-region flows can be endogenous, exogenous, or both (in part), depending on the model construction, which in turn depends on the purpose of the model.[6] The Shanghai regional CGE model presented in this paper distinguishes 14 industries, two types of households (rural and urban), two types labor (skilled and unskilled), and two types of government (central and regional).[7] The basic structure and features of the model are presented in Figure 9.[8]

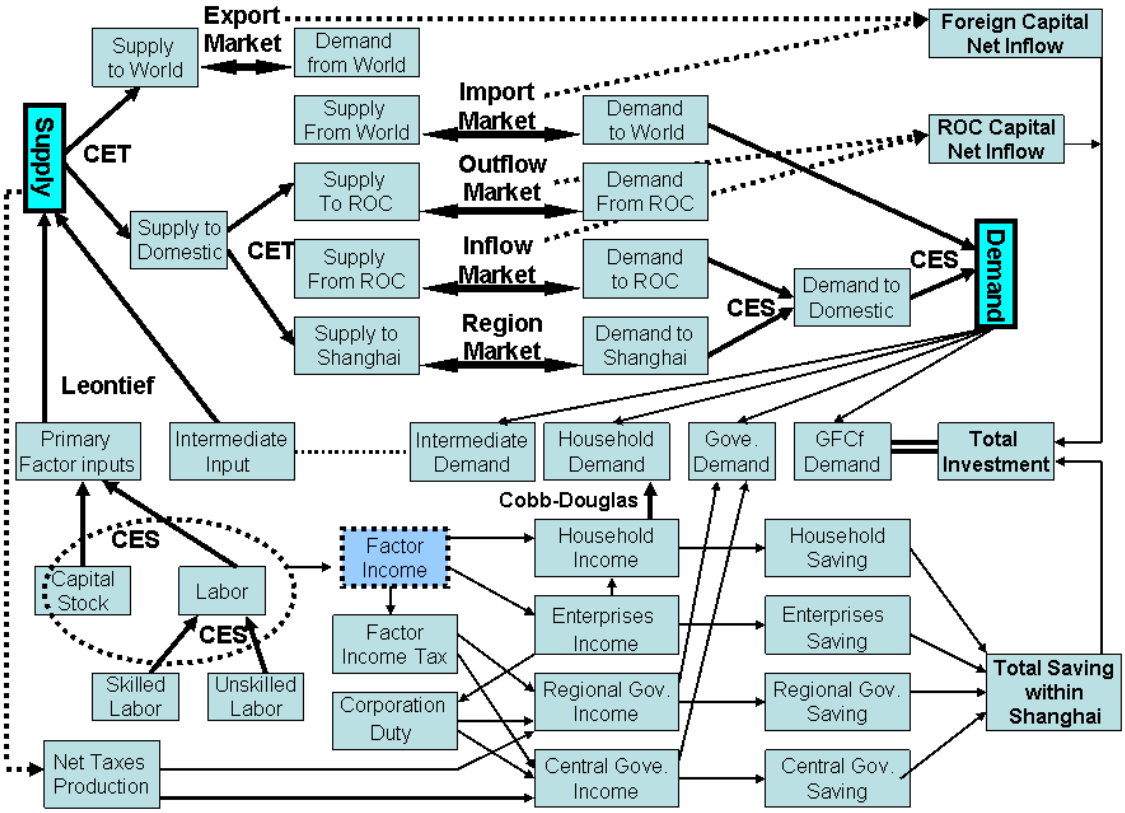
[5] Li (2000) is based on work done at Development Research Center (DRC) of the State Council, China, and Zheng (1999) is based on work done at Institute of Quantitative and Technical Economics of the Chinese Academy of Social Sciences (CASS).

[6] In Shanghai economy and ROC two regional link model that will be built in future, some flows in Shanghai and ROC, such as the labor force and the goods and services can be endogenous, and the total savings and the total investment should be balance. The detail explain can see the Shichuan and ROC two-region China CGE model (Sun, 2004).

[7] Fourteen industries include Shanghai' six new key industries, namely equipment industry, automobile industry, information technology product and service, wholesale and retail trade, finance and insurance, and real estate industry.

[8] The lower left corner of Figure 9 represents enterprises, where labor and capital combine to produce value added, which in turn gets distributed into factor incomes, on the one hand, and combines with intermediate inputs to produce gross output, on the other.

Figure 9 Structure of Shanghai Economic CGE Model



Highlights of the model specification

On the production side, all industries are assumed to operate under constant returns to the scale and observe the cost minimization rule. Production processes are assumed to follow CES (Constant Elasticity of Substitution) functions operating at two levels. At the first level, the CES specification is used to aggregate skilled and unskilled labor into a combined labor input. At the second level, the CES specification is used again to combine labor and capital to produce the value added. The intermediate input requirement is determined through the use of Leontief type fixed coefficients applied to the gross output.

On the supply side, the constant elasticity of transformation (CET) functions are used to allow for substitution possibilities at two levels. At the initial level, the CET specification is used to allow substitution between exports and the domestically disposed part of the output. The latter is disaggregated at the next level using the CET specification between the part that is marketed within Shanghai and the part that is

marketed in ROC.

On the demand side, CES specifications are used to conduct a similar two-level disaggregation with substitution possibilities. At the first level, the CES specification is used to aggregate the demand for Shanghai-produced output and the demand for ROC-produced output into a combined demand for domestically produced output. At the second level, the CES specification is used again to aggregate the demand for domestic output and the demand for import, following the Armington assumption.

So far as prices of exports and imports are concerned, Shanghai is assumed to a small-economy vis-à-vis both ROC and ROW, making these prices exogenous to the Shanghai economy.[9]

Utility functions of the Cobb-Douglas type are used to model the consumption demand of urban and rural residents and of regional and central governments. On the other hand, investment demand of the private sector and regional and central governments and the demand for intermediate output are all determined by fixed coefficients determined on the basis of the input-output table.

Income of the private sector is determined by factor income less taxes imposed on factor income (in the form of personal and property taxes), and it is distributed between rural and urban households.[10] Income of the central government consists of indirect taxes, tariffs, personal income tax, enterprise income tax, less by transfers to the regional government. Income of the regional government consists of its share in the indirect taxes, personal income tax, enterprise income tax, and transfers from the central government. Households, the central government, and the local government each splits up its income into consumption and savings. Savings of these three actors add up to form the total saving, which is spent on investment.

Equilibrium Conditions and the Law of Walras

For overall equilibrium of the model, equilibrium has to be reached in eight different

[9] If the model is Chinese two regions (Shanghai and ROC) link model, we can assume high influence of Chinese exports or imports to the world market, and setting high price elasticity of some industries, such as the agricultural or petroleum products imports, resulting some significant changes of agricultural or petroleum products prices in the world market.

[10] This distribution is carried out using the proportion of 2002 (the benchmark year) as the base and making adjustments in the light of the migration from rural areas to urban areas.

kinds of markets, namely (i) markets for Shanghai's own product inside Shanghai, (ii) markets for Shanghai's export to ROC, (iii) markets for Shanghai's export to ROW, (iv) markets in Shanghai for imports from ROC, (v) markets in Shanghai for imports from ROW, (vi) the market for skilled labor, (vii) the market for unskilled labor, and finally (viii) the market for capital. Note that so far as product markets are concerned (i.e. the first five of the above list), fourteen separate markets need to be distinguished, each for the fourteen different industries.

Equilibrium in each of the markets can be attained through adjustment of prices and/or quantities, depending on the assumptions. In the domestic product markets for Shanghai's own output, prices and output are jointly (endogenously) determined. However, given that prices in the markets for exports to and imports from both ROC and ROW are taken to be exogenous (following the small economy assumption), equilibrium in these markets is attained through adjustment of quantities only.

In the skilled labor market, the nominal wage adjusts to yield equilibrium between the total supply and the total demand generated by the non-agricultural industries.[11] To the extent that the nominal wage of unskilled labor is treated as exogenous, the demand for this type of labor in each industry adjusts to bring into equality the marginal value product in that industry with the wage. The agricultural employment (of unskilled labor) is determined as the residual, i.e. by the amount of unskilled labor left after its employment by non- agricultural industries.

The total supply of capital is given by the accumulation (investment) in each year added to previous year's capital stock and less by the depreciation. The rental rate adjusts to establish equality between the supply and the total demand for capital arising from the industries. Given the assumption of mobility of capital across industries, each industry employs capital up to the point where the marginal value product of capital of the industry equals the equilibrium rental rate.

A well specified model should satisfy Walras Law, according to which in an n-variable system, the equilibrium in n-1 markets should ensure the equilibrium in the n-th market. There are several popular ways to check whether Walras Law is satisfied in a CGE model. The model in this paper uses for this purpose the aggregate

[11] The agriculture sector is assumed to use no skilled labor.

savings-investment equation, namely $S+F+FO-I^n = 0$, in nominal terms, where S denotes savings generated within Shanghai, and F and FO denote savings flowing in from ROC and ROW, respectively. I^n, on the other hand, denotes the total investment that Shanghai carries out either inside Shanghai or in ROC and ROW. Leaving out this equation also makes price of savings as the *numeraire*. Tables 1 and 2 illustrate the theoretical and computational checks on whether or not Walras Law is satisfied.

Table 1: Equations checking Walras Law[12]

$W_U \cdot \left(L_U - \overline{L}_U^S\right)$	(Unskilled Labor Market)
$+ W_W \cdot \left(L_W - \overline{L}_W^S\right)$	(Skilled Labor Market)
$+ R \cdot \left(\sum K_i - \overline{K^S}\right)$	(Capital Stock Market)
$+ \sum PDS_i \cdot \left(DSD_i - DS_i^S\right)$	(Product Market inside Region)
$+ \sum PMOD_i \cdot \left(MOD_i - MO_i^{S*}\right)$	(Product Inflow Market)
$+ \sum PEO\$_i \cdot \left(EOD_i^* - EO_i^S\right)$	(Product Outflow Market)
$+ ER \sum PM\$_i \cdot \left(M_i - M_i^{S*}\right)$	(Product Import Market)
$+ ER \sum PE\$_i \cdot \left(E_i^* - E_i^S\right)$	(Product Export Market)
$+ \left(S + F + FO - I^n\right)$	(Savings-Investment Balance)

[12] The Appendix on equations and notations explains the symbols used.

Table 2: Numerical solutions checking Walras Law

YEAR	NIT	EPS	Region Inside Market	Outflow Market	Inflow Market	Export Market	Import Market	Skilled Labor Market	Unskilled Labor Market	Capital Stock Market	I-S Balance	WALARS
2002	2	1E-10	0	0	0	0	0	0	0	0	0	0
2003	162	1E-10	0	0	0	0	(0)	0	1	0	(0)	(2)
2004	162	1E-10	0	0	0	0	(0)	0	1	0	(0)	(2)
2005	159	1E-10	0	0	0	0	0	0	1	0	0	(3)
2006	158	1E-10	0	0	0	0	(0)	0	1	0	(0)	(3)
2007	159	1E-10	0	0	0	0	(0)	0	1	0	(0)	(3)
2008	167	1E-10	0	0	0	0	0	0	1	0	0	(3)
2009	225	1E-10	0	0	0	0	(0)	0	0	0	(0)	(1)
2010	186	1E-10	0	0	0	0	0	0	1	0	0	(2)

Note: "Year" is the calculating period, "EPS" is the calculating accuracy, and "NIT" is the number of iterations necessary to attain equilibrium in the respective markets.

The model used in the paper is a dynamic recursive model, so that it is solved for each year separately with updating equations connecting the model for one period with the one for the next period. The updating equations furnish the values (mostly through extrapolation) of the exogenous variables, such as the supply of skilled and unskilled labor, nominal wage of unskilled labor, real investment by the private sector and by regional and central government, capital stock, and also the values of the parameters such as the total factor productivity of each industry, scale factors of exports and imports to or from ROC and ROW. Extrapolations are made on the basis of specific growth rates and changes assumed for the pertinent variables and parameters. As already mentioned, total capital stock is obtained by adding investment to the previous period's capital stock and subtracting the depreciation. The predetermined capital stock is then allocated among industries in accordance to the rate of return to capital prevailing in them.[13].

Dataset and Baseline

The baseline information is summarized in the form of the Social Accounting Matrix (SAM) presented in Table 3. The parameters of the model are calibrated on the basis of

[13] See equation (94) below for the details.

the information contained in this SAM. It shows the balance between demand and supply in the output market, the balance between aggregate savings and investment, the budgetary balance of various actors, and the balance in the transactions with ROC and ROW. The SAM presented in Table 3 is based on Shanghai's input-output table of 2003 and other macroeconomic and sectoral information pertaining to that year obtained from various other publications.

The model uses six kinds of elasticity pertaining to CES and CET functions. GTAP data is used to obtain the elasticity of substitution between labor and capital and between imports and domestic goods. Evidence available in other studies is used to obtain the elasticity of substitution between skilled and unskilled labor and the elasticity of transformation between domestically disposed output and export, and between export to ROC and ROW.

In order to gauge the impact of alternative assumptions regarding parameter values, the paper presents extensive sensitivity tests with respect to all the six kinds of elasticity. The results indicate that changes in the assumed values of elasticity have only very small influences on the results of the model, except in the case of the elasticity of substitution between labor and capital.[14]

The first task in using the CGE model is to establish the baseline scenario (for 2002-2010) against which the simulated scenarios can be compared. The baseline needs to be reasonable, reflecting what would have happened if the recent trends by and large continued, and parameter values did not change too much. To construct such a baseline, it is assumed that during 2002-2010 labor (both skilled and unskilled), nominal wage of unskilled labor, real investment, and TFP of each industry would grow at 2, 5, 10, and 3 percent per annum, respectively. These values accord well with the recent experience.[15] Scale parameter of exports in each industry is extrapolated based on the growth

[14] GTAP uses common elasticity of substitution between labor and capital for all countries included in its world model. Elasticity adopted by GTAP seems to be high in general compared with several other country studies, but no data are available yet on China except for relying on GTAP. Elasticity of substitution between domestic and imported goods is similar. We have done sensitivity test concerning these 6 kinds of elasticity, which shows that change in elasticity has only very small influences on the results of the model, except for the elasticity of substitution between labor and capital(refer to Ezaki and Sun (2000)).

[15] The assumed growth rates for labor, nominal wage of unskilled labor, and real investment are based on actual pre 2005. The assumed growth of TFP is based on Ezaki and Sun (1999), which found the economy-wide TFP growth rate from 1981 to 1995 to be 3.8 percent per annum.

performance of exports in the past. Exchange rate is fixed at the 2002 level, and the coefficients of intermediate inputs are assumed to remain the same as in the 2002 input-output table.

Table 4 presents the baseline scenario in terms of average growth rates of key macroeconomic variables and gross value added by industry during 2002-2010. As we can see, under the baseline scenario, Shanghai's real GDP is to grow at an annual average rate of 10.2 percent. Shanghai's real import from ROW is to grow at a faster rate of 12.8 percent per annum, while real import from ROC is to grow at a slower rate of 8.2 percent per annum. On the other hand, Shanghai's export to ROC is to grow at an annual average rate of 11.7 percent, which is higher than 10 percent, the rate at which Shanghai's export to ROW is to grow. The baseline scenario therefore reflects the current trend of increasing dependence of Shanghai on ROW as a source of consumption and ROC as a source of demand for her output.

Table 3: Shanghai Social Accounting Matrix (SAM),2002 in 10 Million Yuan

Receipts		Expenditures																
		Activities	Commodities	Factors				Institutions					Savings-Investment			Trade		Total
				Fixed Capital	Operation surplus	Un-skilled Labor	Skilled Labor	Enterprises	Rural House.	Urban House.	Central Gove.	Regional Gove.	Private Investment.	Central Investment.	Regional Investment	ROC	World	
Activities			16749															16749
Commodities		11340							242	1660	22	532	1758	344	307	3233	3191	22629
Factors	Fixed Capital Deprei.	793																793
	Operation surplus	1388																1388
	Un-skilled Labor	436																436
	Skilled Labor	1459																1459
Institutions	Enterprises			793	1388													2181
	Rural Households					114		141										255
	Urban Households					322	1325	965										2612
	Central Government	854					67	150										1071
	Regional Government	478					67	133			161							839
Savings-Investment	Private Savings							793	13	951						-1227	684	1758
	Central Gove. Savings										888							888
	Regional Gove. Savings											307						307
Trade	ROC		2005															2005
	World		3874															3874
Total		16749	22629	793	1388	436	1459	2181	255	2612	1071	839	1758	344	307	2005	3874	16205

Table 4:The Baseline Scenario of CGE Model (2002-2010) in 100 Million Yuan

	growth rate	2002	2003	2004	2005	2006	2007	2008	2009	2010
Real GDP	10.2%	5409	5940	6529	7185	7915	8727	9630	10633	11745
Real rural house. consumption	13.3%	242	274	311	353	400	453	513	582	658
Real urban house. consumption	11.6%	1660	1846	2055	2289	2554	2851	3188	3568	3999
Real central gov. consumption	7.3%	22	23	24	26	28	30	32	35	38
Real regional gov. consumption	9.9%	532	584	641	705	775	852	937	1031	1136
Real private investment	10.0%	1758	1934	2127	2340	2574	2831	3114	3426	3768
Real central gov. investment.	10.0%	344	378	416	458	504	554	609	670	737
Real regional gov. investment.	10.0%	307	338	372	409	450	495	545	599	659
Real total import from World	12.8%	3874	4358	4906	5527	6230	7028	7933	8960	10128
Real total export to World	10.0%	3191	3496	3834	4211	4630	5097	5615	6191	6830
Real total import from ROC	8.2%	2005	2166	2340	2530	2737	2962	3208	3477	3771
Real total export to ROC	11.7%	3233	3590	3994	4451	4969	5554	6217	6968	7817
Nominal GDP	12.9%	5409	6091	6863	7737	8728	9854	11136	12597	14265
Nominal savings	12.9%	2953	3325	3747	4225	4768	5385	6088	6891	7808
Nominal investment	11.0%	2409	2680	2979	3310	3676	4080	4527	5022	5571
Nominal rural House. income	14.7%	255	293	337	387	444	509	583	667	764
Nominal urban House. income	12.8%	2612	2939	3311	3731	4207	4748	5363	6065	6867
Nominal private savings	12.5%	965	1083	1216	1367	1537	1729	1948	2197	2480
Nominal private investment	11.0%	1758	1955	2174	2415	2682	2977	3303	3665	4065
transfer intra-government	10.0%	161	178	195	215	236	260	286	315	346
Central gov. income	12.7%	1071	1202	1352	1522	1715	1934	2184	2469	2794
Central gov. consumption	8.7%	22	23	25	27	29	32	35	38	42
Central gov. savings	13.3%	888	1002	1132	1280	1449	1642	1863	2116	2406
Central gov. investment	11.0%	344	383	425	473	525	583	646	717	795
Regional gov. income	11.7%	839	936	1044	1165	1301	1454	1626	1819	2037
Regional gov. consumption	11.4%	532	591	657	731	814	907	1011	1127	1258
Regional gov. savings	12.3%	307	345	386	434	487	547	615	692	779
Regional gov. investment	11.0%	307	342	380	422	469	521	578	641	711
GDP deflator	2.5%	1.00	1.03	1.05	1.08	1.10	1.13	1.16	1.18	1.21
Agriculture GDP(real)	4.0%	92	96	101	105	109	114	118	122	126
Energy industry GDP	9.6%	230	250	272	298	326	358	394	434	480
Light industry GDP	8.7%	565	612	664	722	785	854	929	1011	1101
Chemical industry GDP	8.2%	333	358	386	417	451	488	530	575	625
Construction material GDP	10.7%	141	155	171	189	210	232	257	286	317
Iron and steel industry GDP	10.6%	181	199	220	243	268	297	329	365	405
Equipment industry GDP	10.8%	334	369	408	452	501	556	617	685	761
Automobile industry GDP	15.5%	297	342	395	456	526	608	704	815	944
Information technology GDP	12.5%	419	470	527	593	667	751	847	955	1078
Construction GDP	10.0%	252	277	304	335	368	405	446	490	540
Sales, retail trade GDP	10.3%	529	580	638	702	774	854	944	1044	1155
Finance and insurance GDP	10.3%	585	641	704	775	855	945	1045	1158	1284
Real estate GDP	10.4%	374	411	452	498	550	607	671	742	822
Other services GDP	9.7%	1077	1177	1289	1412	1549	1700	1868	2053	2257

4. The Simulations and their results

4.1 Simulations

In order to analyze the linkages of the Shanghai economy with ROC and ROW, simulations are designed to study the relationships from two sides. Looking from the Shanghai side, simulations are designed to study the influence of Shanghai economy's growth on exports and imports to or from ROC and ROW. These simulations belong to category 1, so to speak. Next, approaching from the side of ROC and ROW, simulations are conducted to examine the influence on the Shanghai economy of changes in exports and imports to or from ROC and ROW. These simulations belong to category 2. Finally, simulations are conducted to investigate the impact on Shanghai economy of changes in the exchange rate of Yuan. These simulations belong to category 3.

Six simulations are conducted under category 1. The first of these focuses on possible increases in Shanghai's consumption propensity. In particular, this simulation allows Shanghai's real consumption to increase by reducing the household savings rate by 0.5 percentage point (the averaged saving rate is 36.4 percent in 2002) every year. The second simulation of this category considers the impact of changes in the opposite direction, namely increase in Shanghai's propensity to invest. In particular, this simulation allows the growth rate of real investment to increase from baseline's 10 percent to 11 percent in every year. The third simulation of this category examines the impact of productivity increase in Shanghai's economy. In particular, the simulation allows the total factor productivity (TFP) to increase from baseline's 3 percent to 4 percent in all sectors in every year. The remaining simulations of this category examine the impact of productivity increase in selected industries. Accordingly, the fourth simulation considers the impact of productivity increase (allows the TFP of the sector increase to increase from baseline's 3 to 4 percent in every year) in the automobile sector, a domestic market-focused industry. The fifth and sixth simulations allow analogous productivity increase in the information technology industry, a strongly outward/export-oriented industry, and the equipment industry that depends on ROW for input supply and ROC for market.

Simulations under category 2 number four, and these allow one percent increase in Shanghai's import from ROC and ROW and in Shanghai's export to ROC and ROW,

one at a time. The two simulations under category 3 allow Yuan to appreciate or depreciate, as the case may be, by 20 percent.

4.2 Simulation Results

The detailed results of the simulations are presented in Appendix Tables 2.1 through 2.4. Table 5 presents the highlights of the results in normalized form in order to make the comparison easier.[16] Looking at the results of the simulations under category 1, we see that an increase in Shanghai's real consumption (simulation 1) (by reducing the household savings rate) leads to relatively larger increase in the import from ROW than from ROC (0.34 percent compared to 0.18 percent in 2010). The reduction in savings leads to a reduction in investment, causing less capital accumulation and slower expansion in the production capacity, resulting in a reduction in Shanghai's export to both ROC and ROW. In fact, the process leads to a drop in Shanghai's real GDP (relative to the baseline).

The increase in Shanghai's investment by one percent (simulation 2) has a similar impact (as is the case with simulation 1), increasing Shanghai's import from ROW by much more than import from ROC (0.39 percent compared to 0.15 percent in 2010). However, higher investment increases the production capacity and leads to an increase in Shanghai's export to ROC and ROW (in 2010) and in her real GDP.

Increase in the across-the-board productivity by one percent (simulation 3) enlarges Shanghai's productive capacity, increasing her exports to ROC and ROW to a similar extent (by 0.90 and 0.86 percent, respectively, by 2010). The process however leads to opposite effects on Shanghai's import. While the import from ROW increases, the import from ROC decreases. These results indicate that Shanghai is primarily a supplier to the ROC and less a source of demand. With respect to ROW however Shanghai is both a supplier and a source of demand.

[16] In table 5, the numerical values those are divided by the reference term are calculated based on Appendix table 4, that mean how many unit changes have happed refer to 1 unit change of shock variable. Through this conversion, we can compare these data in the same mean.

Table 5: The Simulation Results of Shanghai Economic CGE model (%)

	Real Investment Quantity 1 % Raise		Real House. Consump. Quantity 1 % Raise		Real GDP Quantity 1 % Raise		Automobile Industry Quantity 1 % Raise		IT Industry Quantity 1 % Raise		Equipment Industry Quantity 1 % Raise	
	2005	2010	2005	2010	2005	2010	2005	2010	2005	2010	2005	2010
Real GDP	0.05	0.16	-0.01	-0.03	1.00	1.00	0.11	0.14	0.14	0.16	0.18	0.18
Nominal GDP	0.24	0.14	0.17	0.16	-0.60	-0.50	-0.11	-0.13	-0.14	-0.14	-0.16	-0.14
Total Supply	0.06	0.18	-0.02	-0.02	0.97	0.93	0.12	0.15	0.15	0.16	0.20	0.20
Demand by Shanghai	0.13	0.26	0.00	0.01	1.01	0.97	0.09	0.11	0.11	0.12	0.20	0.20
Demand by ROC	-0.04	0.08	-0.05	-0.05	0.93	0.90	0.28	0.33	0.17	0.18	0.22	0.21
Demand by World	-0.06	0.06	-0.08	-0.07	0.90	0.86	0.05	0.06	0.25	0.28	0.20	0.19
Total Demand	0.21	0.28	0.10	0.12	0.65	0.62	0.07	0.09	0.09	0.09	0.13	0.12
Supply by Shanghai	0.13	0.26	0.00	0.01	1.01	0.97	0.09	0.11	0.11	0.12	0.20	0.20
Supply by ROC	0.17	0.15	0.16	0.18	-0.09	-0.10	0.01	0.01	0.01	0.01	-0.00	-0.01
Supply by World	0.40	0.39	0.31	0.34	0.12	0.13	0.05	0.06	0.07	0.07	0.01	0.02

	Import Quantity from ROC 1 % Raise		Export Quantity to ROC 1 % Raise		Import Quantity from World 1 % Raise		Export Quantity to World 1 % Raise		Yuan Appreciation +20%		Yuan Depreciation +20%	
	2005	2010	2005	2010	2005	2010	2005	2010	2005	2010	2005	2010
Real GDP	0.01	0.03	-0.01	-0.24	-0.03	-0.10	-0.01	-0.10	-1.09	-1.88	0.05	0.66
Nominal GDP	0.03	0.02	3.13	3.25	0.38	0.34	2.04	1.69	-5.71	-4.65	5.91	4.73
Total Supply	0.01	0.01	0.06	0.04	0.01	0.00	0.08	0.08	-0.33	-0.45	0.20	0.32
Demand by Shanghai	-0.02	-0.02	-0.11	-0.14	-0.08	-0.09	-0.12	-0.10	-0.53	-0.73	0.38	0.32
Demand by ROC	0.04	0.03	1.00	1.00	0.13	0.12	-0.20	-0.20	3.37	3.26	-2.87	-2.77
Demand by World	0.05	0.05	-0.40	-0.47	0.16	0.16	1.00	1.00	-3.59	-3.82	2.84	3.10
Total Demand	0.03	0.02	0.38	0.45	0.16	0.19	0.27	0.27	1.40	1.81	-0.74	-1.04
Supply by Shanghai	-0.02	-0.02	-0.11	-0.14	-0.08	-0.09	-0.12	-0.10	-0.53	-0.73	0.38	0.56
Supply by ROC	1.00	1.00	0.83	1.00	-0.39	-0.38	0.64	0.64	-10.3	-10.2	9.46	9.38
Supply by World	-0.28	-0.25	1.36	1.50	1.00	1.00	1.06	0.94	11.49	11.72	-8.13	-8.31

Note: Except the Yuan App or depreciation, the datum means that how many % quantitative change of the item in column by 1% quantitative change of that in row.

Looking at the effects of industry-specific productivity increases, it may be seen that the TFP increase in the automobile sector (simulation 4) leads to a robust increase in Shanghai's export to ROC. A similar TFP increase in ICT industry (simulation 5) on the other hand leads to a much larger increase in Shanghai's export to ROW than to ROC. Finally, the TFP increase in the equipment industry (simulation 6) leads to an increase in Shanghai's export to both ROC and ROW roughly to the same degree. However, the simulation depresses Shanghai's import from ROC, confirming again Shanghai's lesser role as a source of demand for ROC output.

Turning to the simulations of category 2, it may be noticed that the increase in Shanghai's import from ROC (simulation 7) has a positive effect on her real GDP. An increase in Shanghai's export to ROC (simulation 8) leads to an almost proportionate increase in Shanghai's import from ROC. However, the process leads to a greater (more than proportionate increase) in Shanghai's import from ROW. The increase in Shanghai's import from ROW (simulation 9) leads to a decline in Shanghai's import from ROC. The increase in Shanghai's export to ROW (simulation 10) leads to a decrease in Shanghai's export to ROC, at the same time increasing Shanghai's import from both ROC and ROW.

Simulations with respect to the exchange rate show that appreciation of Yuan has a larger impact than depreciation of Yuan. Appreciation of Yuan by 20 percent (simulation 11) leads to large increase in Shanghai's import from ROW and an almost equivalent decrease in her import from ROC. Shanghai's exports to ROW decline (though less dramatically than the increase in her import from ROW), accompanied by an almost offsetting increase in her exports to ROC. Shanghai's GDP suffers, in both nominal and real terms. Depreciation of Yuan by 20 percent (simulation 12) has almost mirror opposite effects, though less pronounced in degree. It increases Shanghai's exports to ROW and decreases her imports from ROW. On the other hand, the depreciation increases Shanghai's exports to ROC and increases her imports from ROC. However, on the whole, the depreciation increases Shanghai's GDP in both nominal and real terms. The increase is however insignificant in terms of its magnitude, particularly in comparison with the associated increase in inflation.

5. Conclusions

This paper examines the changes that have taken place in recent years in Shanghai's economic structure and its linkages with ROC and ROW and the implication of these changes for the future. For this purpose, the paper makes use of a dynamic CGE model constructed on the basis of the input-output tables of 1997 and 2002. The model distinguishes fourteen industries and captures both demand and supply side linkages. After constructing a baseline scenario for 2002-2010 based on recent trends, the paper presents twelve simulations assessing the impact of possible changes on the side of Shanghai's own economy and on the side of ROC and ROW. Two of these simulations address directly the issue of possible impact of changes in the exchange rate of Yuan.

A comparison of the input-output tables of 1997 and 2002 shows that Shanghai's economy over this period has become integrated more with the ROW than with ROC. Shanghai's economy is now firmly connected with ROW through both supply and demand linkages, whereas its connection with ROC runs mostly along supply linkages and not so much along demand linkages. Shanghai economy's integration with ROW is a direct result of the raging globalization, whereby Shanghai has become a workshop for the entire world absorbing capital goods and intermediate inputs and exporting back finished manufacturing products. An accompanying feature of this process has been greater reliance of the Shanghai economy on capital accumulation and less on labor absorption for its expansion. Increased importance of intermediate input in the process also finds reflection in the decline of the share of value added in gross output. (To what extent the latter decline is also a manifestation of a decline in the efficiency of utilization of capital and labor is an important question that demands further investigation.)

Results from simulations focusing on changes in Shanghai economy show that an expansion of the Shanghai economy (through an increase in TFP in all sectors) leads to an increase in export to ROC and ROW to a similar extent. However, the same expansion decreases Shanghai's import from ROC while increasing the import from ROW. Similarly, an increase in Shanghai's consumption propensity (through a reduction in the savings ratio) leads to increases in her import from both ROC and ROW. However, the extent of increase in import from ROW proves to be almost two times

higher than that for import from ROC. These results point to strong demand linkages of Shanghai economy with ROW and weakening of these linkages with ROC.

Results from simulations focusing on changes in ROC and ROW show that only an increase in import from ROC leads to an increase in Shanghai's GDP in both nominal and real terms. On the other hand, an increase in export to both ROC and ROW leads to increases in import from both these sources, with the extent of the increase much higher for import from ROW than for import from ROC. However, such increases in export leads to a decrease in Shanghai's GDP, in both nominal and real terms. The substitution effect between import from ROC and ROW is larger than the substitution effect between the export to ROC and ROW.

Simulations with respect to the exchange rate show that appreciation of Yuan has a greater impact than depreciation of Yuan. Appreciation of Yuan brings about a steep increase in Shanghai's import from ROW, and by dint of the substitution effect, causes sharp decline in the import from ROC. The appreciation decreases Shanghai's export to ROW, but this decline is offset by large increase (through substitution effect) in Shanghai's export to ROC, so that the real GDP of Shanghai does not suffer that much. Depreciation of Yuan leads to an increase in Shanghai's export to ROW and decreases her import from ROW, via the substitution effect. It has opposite effects on Shanghai's export to and import from ROC. On the whole, the depreciation leads to an increase in Shanghai's GDP in both nominal and real terms, though the increased GDP comes in return for a significant rise in prices (high level of inflation). Overall the effect of exchange rate adjustments remains mild because of simultaneous demand and supply side linkages of the Shanghai economy with ROW. The two-way linkages with ROW and the presence of a large domestic market in ROC make Shanghai's economy resilient to foreign exchange fluctuations.

Shanghai's economic relationship with the ROC is not limited to demand and supply of output. Other important linkages lie along factor flows, public transfers, etc. Study of these relationships require the development of two-region China link CGE model of Shanghai-ROC and use of such a model to do conduct pertinent simulations.

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Appendix Table 1-1: Output and value added in Shanghai industries

Term / Industry	Share in total value added (%)		Rate of value added (%)		Change of value added constitute (%)							
					Depreciation		Operation surplus		Employees income		Net taxes production	
	status	change	status	change	status	change	status	change	status	change	status	Change
Agriculture	1.7	-0.5	37.0	-0.1	4.8	1.3	15.7	-1.5	73.2	-2.2	6.3	2.3
Mining	0.4	0.4	70.2	44.8	21.4	12.0	44.7	44.5	20.4	-60.8	13.5	4.3
Food industry	3.4	0.7	30.6	7.9	10.0	-1.6	20.5	8.9	22.8	-9.6	46.7	2.4
Textile goods	1.3	-1.1	19.9	-2.7	17.5	5.9	17.2	-7.5	53.6	4.5	11.7	-2.9
Wearing products	1.7	-0.3	19.6	-3.1	2.4	-7.5	29.9	-3.3	48.0	9.8	19.8	0.9
Sawmills and furniture	0.4	-0.1	14.1	-2.9	14.7	-1.2	19.6	3.6	52.9	-4.3	12.7	1.9
Paper, printing and toys	1.5	-0.5	21.3	-5.3	14.2	3.6	21.5	-13.8	41.2	4.7	23.1	5.5
Petroleum products	1.0	0.2	21.6	2.1	25.6	4.8	24.4	-1.2	16.0	-2.3	34.0	-1.4
Chemicals industry	6.2	-2.0	24.8	-1.6	15.7	-0.2	31.3	-1.2	27.3	-2.3	25.7	3.8
Non-Metal products	1.2	-0.2	25.4	-1.6	17.8	0.4	29.3	4.8	37.3	-7.0	15.6	1.8
Iron and steel industry	3.4	-1.3	22.6	3.1	26.0	2.4	22.8	-2.0	21.0	-12.6	30.2	12.1
Metal products	1.4	-0.4	17.1	-4.6	16.9	3.9	35.6	5.4	29.2	-13.6	18.3	4.3
Machinery and equip.	3.7	-0.8	22.9	-3.2	13.9	1.9	24.4	5.6	44.4	-6.4	17.2	-1.2
Transport machinery	6.3	1.2	26.6	5.1	17.3	7.9	20.4	-21.2	19.4	-12.3	42.9	25.5
Electric equipment	2.3	-0.8	18.5	-5.2	11.5	0.4	24.8	-0.5	42.5	-3.4	21.2	3.6
Electronic and telecom	4.3	1.6	20.3	-1.5	23.6	7.2	30.7	5.8	29.6	-15.5	16.0	2.4
Precision machinery	0.7	-0.1	23.2	0.6	12.2	2.2	33.4	6.7	42.4	-7.7	12.0	-1.2
Other manufacture	0.9	-0.7	46.8	3.2	5.4	-3.9	78.2	17.5	11.1	-13.2	5.3	-0.5
Electricity, gas, water	2.8	-0.1	43.7	7.6	37.7	14.0	19.8	4.9	17.0	-9.4	25.5	-9.5
Construction	4.7	-0.5	21.8	0.8	8.5	3.1	12.8	-6.3	62.8	3.9	15.9	-0.7
Transport	5.1	1.0	26.7	-13.0	21.0	-9.5	17.1	-8.1	48.0	9.6	13.9	8.0
Post and telecom	3.8	1.1	52.1	-29.8	29.3	-4.7	35.8	-7.3	25.7	12.0	9.1	0.0
Wholesale, retail trade	9.8	-0.6	54.4	2.0	4.1	1.1	17.5	-17.4	23.0	-7.4	55.3	23.7
Eating and drinking	2.6	1.6	37.7	7.5	13.7	8.0	8.8	-2.2	51.8	-12.1	25.7	6.3
Finance and insurance	10.8	-2.9	60.0	5.0	5.7	3.7	56.3	-1.8	15.3	10.1	22.8	-12.0
Real estate	6.9	2.5	67.8	13.7	30.3	1.6	24.2	-9.5	23.9	5.9	21.7	2.0
Social services	2.7	-0.9	35.9	-1.8	13.6	1.1	14.8	-14.4	48.9	11.3	22.7	2.0
Education, Public	9.3	3.5	50.1	5.4	6.5	-0.9	12.0	-11.6	72.6	9.4	9.0	3.0
Total manufacture	39.5	-4.6	23.1	-0.5	7.5	2.3	13.0	-2.2	73.6	-7.4	10.0	7.2
Total services	50.9	5.3	48.3	-1.2	8.5	2.2	14.0	-12.6	74.6	9.2	11.0	1.2
Total	100	0.0	32.3	0.9	14.7	2.5	25.7	-6.7	35.0	0.7	24.6	3.5

Note: Status is 2002 data, change is 2002 -1997; The function of demand market means the capacities of Shanghai market consume the goods & services; The function of supply market means the capacities of Shanghai market supply goods & services.

Appendix Table 1-2:Demand and supply of Shanghai industries

Term / Industry	Change of Shanghai consume function (%)						Change of Shanghai supply function (%)					
	from Shanghai		from ROC		from World		to Shanghai		to ROC		to World	
	status	change	status	change	status	change	status	change	status	change	status	change
Agriculture	57.4	1.4	30.4	-6.8	12. 2	5.4	96.4	8.0	1.1	-3.8	2.5	-4.2
Mining	6.7	6.8	55.5	-41.5	37.8	34.7	92.0	92.0	4.0	-89.7	4.1	-41.5
Food industry	57.1	1.0	33.4	-6.4	9.5	5.3	63.7	3.7	27.4	0.4	8.8	-4.2
Textile goods	1.1	-61.6	42.8	19.8	56.2	41.8	1.1	-49.2	1.5	-5.0	97.4	54.2
Wearing products	64.7	-6.7	21.9	3.3	13.4	3.4	23.5	-9.4	3.0	-3.8	73.5	13.2
Sawmills and furniture	53.4	-10.2	20.4	-4.3	26.2	14.4	60.7	-11.4	3.4	-2.3	35.9	13.7
Paper, printing and toys	65.1	-2.0	7.5	-8.8	27.5	10.8	66.9	-8.5	8.5	1.3	24.6	7.2
Petroleum products	72.6	1.3	10.1	-2.8	17.3	1.5	92.0	13.4	1.1	-14.5	6.9	1.1
Chemicals industry	52.4	-16.5	5.7	-7.5	42.0	24.0	52.1	-7.6	25.8	9.1	22.2	-1.5
Non-Metal products	55.8	-1.8	36.4	1.3	7.8	0.5	92.4	4.6	1.0	-5.0	6.5	0.4
Iron and steel industry	60.9	-8.4	19.7	-2.5	19.4	10.9	88.2	-1.5	4.6	-1.1	7.2	2.6
Metal products	70.2	-20.2	0.5	-3.5	29.3	23.7	63.1	-15.5	2.4	0.5	34.5	15.0
Machinery and equip.	52.8	-1.6	5.7	-22.2	41.4	23.8	57.7	-15.1	24.1	12.3	18.2	2.8
Transport machinery	69.3	-18.5	1.9	-4.3	28.8	22.8	34.4	-19.9	58.2	19.5	7.4	0.4
Electric equipment	27.6	-54.7	27.6	20.9	44.7	33.8	23.7	-36.3	45.5	16.3	30.8	19.9
Electronic and telecom	16.6	-44.6	5.0	-11.1	78.5	55.7	13.8	-51.9	30.5	17.9	55.7	34.0
Precision machinery	40.0	-29.8	1.7	-7.5	58.2	37.3	41.6	-26.5	24.3	10.4	34.1	16.2
Other manufacture	15.0	-48.6	42.6	15.6	42.4	33.0	17.7	-49.3	38.3	24.6	44.0	24.7
Electricity, gas, water	81.6	2.0	16.8	-3.6	1.6	1.6	99.8	0.9	0.2	-0.9	0.0	0.0
Construction	98.4	5.8	0.6	-6.8	1.0	1.0	98.3	-1.2	0.3	-0.2	1.5	1.5
Transport	56.9	-4.0	14.1	-14.5	29.0	18.5	41.9	-20.4	32.5	7.7	25.5	12.6
Post and telecom	93.9	9.7	1.5	-13.2	4.6	3.4	75.1	-16.8	14.8	11.6	10.1	5.2
Wholesale, retail trade	94.3	-1.6	5.6	1.5	0.1	0.1	91.9	7.1	7.9	-2.5	0.3	-4.7
Eating and drinking	79.2	-14.0	13.8	8.2	7.0	5.8	46.7	-18.2	29.2	6.6	23.4	11.6
Finance and insurance	96.8	1.0	0.9	-1.6	2.3	0.6	76.6	2.7	21.2	0.1	2.2	-2.8
Real estate	100	0.7	0.0	-0.7	0.0	0.0	100	12.5	0.0	-9.8	0.0	-2.7
Social services	57.0	-24.6	6.1	-10.2	36.9	34.7	59.5	-1.2	18.6	-5.6	21.9	6.8
Education, Public	93.4	3.4	1.2	-4.6	5.5	1.3	91.6	0.1	5.3	-0.7	3.1	0.6
Total manufacture	94.4	-18.5	2.2	-4.7	6.5	23.2	92.6	-19.0	6.3	8.7	4.1	10.3
Total services	95.4	-3.2	3.2	-3.7	7.5	6.9	93.6	-3.0	7.3	0.2	5.1	2.8
Total	63.8	-8.8	12.3	-6.9	23.9	15.7	61.7	-11.4	19.3	5.0	19.0	6.4

Note: Status is 2002 data, change is 2002 -1997; The function of demand market means the capacities of Shanghai market consume the goods & services; The function of supply market means the capacities of Shanghai market supply goods & services.

Appendix Table 2-1: Impact of changes in consumption, investment, and TFP

	Investment growth rate 1 % Raise		Household C Raise by -0.005% Savings		Real GDP growth by TFP Raise 1%	
	2005	2010	2005	2010	2005	2010
Real GDP	0.15	1.27	-0.01	-0.10	2.93	8.17
Real rural house. consumption	0.21	0.28	2.09	5.49	-0.76	-1.71
Real urban house. consumption	0.15	0.15	2.11	5.61	-0.66	-1.78
Real central gov. consumption	4.47	10.61	2.66	7.06	-0.93	-1.57
Real regional gov. consumption	0.12	0.67	-0.21	-0.52	1.49	3.89
Real private investment	2.75	7.51	0.00	0.00	0.00	0.00
Real central gov. investment.	2.75	7.51	0.00	0.00	0.00	0.00
Real regional gov. investment.	2.75	7.51	0.00	0.00	0.00	0.00
Real total import from World	1.11	2.96	0.64	1.77	0.38	1.14
Real total export to World	-0.16	0.45	-0.16	-0.39	2.65	7.18
Real total import from ROC	0.46	1.10	0.34	0.96	-0.27	-0.81
Real total export to ROC	-0.12	0.60	-0.11	-0.28	2.76	7.56
Nominal GDP	0.66	1.09	0.35	0.89	-1.80	-4.39
Nominal savings	0.61	1.03	-1.14	-3.11	-1.54	-3.79
Nominal investment	3.57	9.09	0.26	0.71	-1.73	-4.45
Nominal rural House. income	1.08	1.83	0.92	1.87	-3.29	-5.96
Nominal urban House. income	0.64	0.85	0.29	0.74	-2.36	-5.92
Nominal private savings	0.65	0.86	-4.24	-11.66	-2.37	-5.92
Nominal private investment	3.57	9.09	0.26	0.71	-1.73	-4.45
transfer intra-government	0.00	0.00	0.00	0.00	0.00	0.00
Central gov. income	0.56	1.25	0.36	0.93	-0.34	-0.75
Central gov. consumption	5.04	11.48	3.22	8.58	-3.09	-6.92
Central gov. savings	0.56	1.25	0.36	0.93	-0.34	-0.75
Central gov. investment	3.57	9.09	0.26	0.71	-1.73	-4.45
Regional gov. income	0.66	1.47	0.34	0.90	-0.71	-1.76
Regional gov. consumption	0.66	1.47	0.34	0.90	-0.71	-1.76
Regional gov. savings	0.66	1.47	0.34	0.90	-0.71	-1.76
Regional gov. investment	3.57	9.09	0.26	0.71	-1.73	-4.45
GDP deflator	0.51	-0.18	0.36	0.98	-4.59	-11.61
Agriculture GDP(real)	-1.54	-3.70	-0.60	-2.36	8.18	26.42
Energy industry GDP	-0.01	1.75	-0.03	-0.02	4.78	13.06
Light industry GDP	-0.29	0.07	-0.13	-0.31	2.80	7.51
Chemical industry GDP	-0.21	0.59	-0.21	-0.53	3.25	8.76
Construction material GDP	0.67	2.64	-0.14	-0.34	2.93	7.97
Iron and steel industry GDP	0.25	2.11	-0.28	-0.74	4.23	11.69
Equipment industry GDP	0.22	1.29	-0.19	-0.47	2.45	6.56
Automobile industry GDP	-0.21	0.45	-0.15	-0.39	2.54	7.42
Information technology GDP	-0.16	0.63	-0.14	-0.37	2.85	7.86
Construction GDP	2.36	6.58	0.02	0.05	0.46	1.26
Sales, retail trade GDP	0.29	1.70	0.13	0.36	2.75	7.57
Finance and insurance GDP	0.16	1.57	0.16	0.46	3.01	8.14
Real estate GDP	1.16	3.68	0.38	1.03	1.62	4.57
Other services GDP	-0.09	0.63	0.15	0.46	3.12	8.50

Appendix Table 2-2: Impact of sectoral productivity improvements

	Equipment growth by TFP 1 % Raise		IT Industry growth by TFP 1 % Raise		Automobile growth by TFP 1 % Raise	
	2005	2010	2005	2010	2005	2010
Real GDP	0.19	0.52	0.27	0.81	0.18	0.68
Real rural house. consumption	-0.20	-0.47	-0.29	-0.83	-0.20	-0.73
Real urban house. consumption	-0.20	-0.52	-0.32	-0.92	-0.21	-0.79
Real central gov. consumption	0.20	0.43	0.11	0.31	0.34	1.25
Real regional gov. consumption	0.07	0.17	0.03	0.07	0.02	0.06
Real private investment	0.00	0.00	0.00	0.00	0.00	0.00
Real central gov. investment.	0.00	0.00	0.00	0.00	0.00	0.00
Real regional gov. investment.	0.00	0.00	0.00	0.00	0.00	0.00
Real total import from World	0.02	0.05	0.13	0.36	0.08	0.31
Real total export to World	0.21	0.55	0.47	1.46	0.08	0.29
Real total import from ROC	0.00	-0.03	0.02	0.04	0.02	0.06
Real total export to ROC	0.23	0.61	0.32	0.95	0.44	1.62
Nominal GDP	-0.17	-0.41	-0.26	-0.74	-0.18	-0.64
Nominal savings	-0.13	-0.31	-0.24	-0.68	-0.16	-0.56
Nominal investment	-0.15	-0.39	-0.05	-0.14	-0.02	-0.08
Nominal rural House. income	-0.27	-0.36	-0.17	-0.46	-0.19	-0.56
Nominal urban House. income	-0.28	-0.69	-0.37	-1.08	-0.25	-0.93
Nominal private savings	-0.28	-0.68	-0.37	-1.08	-0.25	-0.93
Nominal private investment	-0.15	-0.39	-0.05	-0.14	-0.02	-0.08
transfer intra-government	0.00	0.00	0.00	0.00	0.00	0.00
Central gov. income	0.03	0.09	0.00	0.01	0.03	0.11
Central gov. consumption	0.10	0.18	0.01	0.02	0.27	0.99
Central gov. savings	0.03	0.09	0.00	0.01	0.03	0.11
Central gov. investment	-0.15	-0.39	-0.05	-0.14	-0.02	-0.08
Regional gov. income	-0.04	-0.08	-0.07	-0.21	-0.05	-0.20
Regional gov. consumption	-0.04	-0.08	-0.07	-0.21	-0.05	-0.20
Regional gov. savings	-0.04	-0.08	-0.07	-0.21	-0.05	-0.20
Regional gov. investment	-0.15	-0.39	-0.05	-0.14	-0.02	-0.08
GDP deflator	-0.36	-0.92	-0.52	-1.55	-0.35	-1.31
Agriculture GDP(real)	0.60	2.65	-0.10	-0.60	-0.02	-0.10
Energy industry GDP	0.17	0.43	0.16	0.47	0.12	0.43
Light industry GDP	0.09	0.25	0.06	0.15	0.04	0.14
Chemical industry GDP	0.11	0.28	0.13	0.36	0.09	0.34
Construction material GDP	0.14	0.34	0.15	0.44	0.08	0.30
Iron and steel industry GDP	0.36	0.92	0.18	0.54	0.19	0.71
Equipment industry GDP	1.06	2.85	0.10	0.28	0.07	0.27
Automobile industry GDP	0.08	0.23	0.08	0.29	1.59	4.86
Information technology GDP	0.09	0.23	1.87	5.25	0.06	0.26
Construction GDP	0.02	0.06	0.03	0.09	0.02	0.06
Sales, retail trade GDP	0.17	0.45	0.20	0.60	0.15	0.58
Finance and insurance GDP	0.11	0.28	0.16	0.49	0.09	0.32
Real estate GDP	0.03	0.08	0.05	0.15	0.02	0.08
Other services GDP	0.14	0.36	0.14	0.41	0.09	0.36

Appendix Table 2-3: Impact of changes in export and import

	Import growth rate from ROC 1 % Raise		Export growth rate to ROC 1 % Raise		Import growth rate from World 1 % Raise		Export growth rate to World 1 % Raise	
	2005	2010	2005	2010	2005	2010	2005	2010
Real GDP	0.02	0.15	-0.01	-0.35	-0.01	-0.05	-0.01	-0.22
Real rural house. consumption	0.15	0.01	1.85	2.09	0.34	0.67	2.03	2.05
Real urban house. consumption	0.45	1.12	1.18	3.43	0.19	0.53	0.90	2.31
Real central gov. consumption	-0.12	0.11	3.95	5.23	0.05	0.17	2.85	2.86
Real regional gov. consumption	0.16	0.44	0.34	1.02	0.08	0.22	0.19	0.63
Real private investment	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Real central gov. investment.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Real regional gov. investment.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Real total import from World	-0.51	-1.23	0.78	2.23	0.20	0.51	0.80	1.99
Real total export to World	0.09	0.22	-0.23	-0.70	0.03	0.08	0.76	2.10
Real total import from ROC	1.80	4.91	0.48	1.49	-0.08	-0.20	0.48	1.35
Real total export to ROC	0.07	0.15	0.57	1.49	0.03	0.06	-0.15	-0.42
Nominal GDP	0.06	0.12	1.79	4.85	0.07	0.18	1.55	3.55
Nominal savings	0.05	0.11	1.69	4.72	0.06	0.14	1.41	3.34
Nominal investment	-0.27	-0.63	0.54	1.54	-0.12	-0.33	0.49	1.19
Nominal rural House. income	-0.13	-0.69	2.66	4.22	0.26	0.41	2.87	3.91
Nominal urban House. income	0.15	0.37	1.93	5.43	0.10	0.25	1.66	4.02
Nominal private savings	0.15	0.36	1.94	5.43	0.10	0.25	1.68	4.02
Nominal private investment	-0.27	-0.63	0.54	1.54	-0.12	-0.33	0.49	1.19
transfer intra-government	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Central gov. income	-0.09	-0.22	1.36	3.86	-0.01	-0.02	1.06	2.46
Central gov. consumption	-0.33	-0.44	4.80	7.65	-0.02	-0.05	3.72	4.87
Central gov. savings	-0.09	-0.22	1.36	3.86	-0.01	-0.02	1.06	2.46
Central gov. investment	-0.27	-0.63	0.54	1.54	-0.12	-0.33	0.49	1.19
Regional gov. income	-0.05	-0.12	1.16	3.34	0.01	0.01	1.04	2.60
Regional gov. consumption	-0.05	-0.12	1.16	3.34	0.01	0.01	1.04	2.60
Regional gov. savings	-0.05	-0.12	1.16	3.34	0.01	0.01	1.04	2.60
Regional gov. investment	-0.27	-0.63	0.54	1.54	-0.12	-0.33	0.49	1.19
GDP deflator	0.04	-0.03	1.80	5.22	0.08	0.23	1.56	3.78
Agriculture GDP(real)	-0.29	-1.04	-3.76	-17.69	-0.23	-0.96	-4.28	-18.23
Energy industry GDP	-0.32	-0.83	-0.46	-1.25	-0.06	-0.16	-0.36	-0.81
Light industry GDP	0.11	0.32	-0.17	-0.64	0.02	0.05	0.62	1.64
Chemical industry GDP	0.12	0.34	0.18	0.63	-0.01	-0.03	0.04	0.07
Construction material GDP	-0.17	-0.36	-0.32	-0.89	-0.02	-0.04	0.29	1.07
Iron and steel industry GDP	-0.16	-0.33	-0.40	-1.09	-0.08	-0.22	-0.29	-0.60
Equipment industry GDP	0.10	0.23	0.30	1.05	0.01	0.05	0.12	0.33
Automobile industry GDP	0.08	0.14	0.99	2.36	0.05	0.10	-0.43	-1.17
Information technology GDP	0.03	0.06	-0.02	-0.18	0.03	0.07	0.39	1.18
Construction GDP	0.00	0.00	0.00	-0.03	0.00	-0.01	0.01	0.01
Sales, retail trade GDP	-0.08	-0.23	0.12	0.27	0.02	0.04	0.12	0.29
Finance and insurance GDP	-0.01	-0.03	0.08	0.15	0.00	-0.01	-0.03	-0.06
Real estate GDP	0.00	-0.02	0.13	0.27	0.02	0.04	0.12	0.24
Other services GDP	0.02	0.03	0.13	0.16	0.00	-0.01	0.06	0.16

Appendix Table 2-4: Impact of changes in Yuan exchange rate

	Yuan Appreciating +20%		Yuan Depreciating +20%	
	2005	2010	2005	2010
Real GDP	-1.0	-1.8	0.05	0.67
Real rural house. consumption	10.1	11.2	-6.76	-7.63
Real urban house. consumption	10.6	11.7	-7.20	-7.98
Real central gov. consumption	-70.3	-64.5	54.48	50.17
Real regional gov. consumption	6.1	6.0	-4.36	-4.29
Real private investment	0.0	0.0	0.00	0.00
Real central gov. investment.	0.0	0.0	0.00	0.00
Real regional gov. investment.	0.0	0.0	0.00	0.00
Real total import from World	11.4	11.5	-8.07	-8.12
Real total export to World	-3.6	-3.8	2.85	3.12
Real total import from ROC	-10.4	-10.2	9.46	9.37
Real total export to ROC	3.4	3.3	-2.87	-2.79
Nominal GDP	-5.7	-4.8	5.96	4.95
Nominal savings	-5.7	-4.9	5.90	5.00
Nominal investment	-13.5	-13.3	12.95	12.76
Nominal rural House. income	-7.1	-5.9	8.30	6.26
Nominal urban House. income	-4.2	-3.3	4.63	3.58
Nominal private savings	-4.3	-3.3	4.68	3.62
Nominal private investment	-13.5	-13.3	12.95	12.76
transfer intra-government	0.0	0.0	0.00	0.00
Central gov. income	-8.3	-7.5	8.12	7.29
Central gov. consumption	-74.0	-68.7	72.75	67.08
Central gov. savings	-8.3	-7.5	8.12	7.29
Central gov. investment	-13.5	-13.3	12.95	12.76
Regional gov. income	-7.0	-6.6	6.95	6.49
Regional gov. consumption	-7.0	-6.6	6.95	6.49
Regional gov. savings	-7.0	-6.6	6.95	6.49
Regional gov. investment	-13.5	-13.3	12.95	12.76
GDP deflator	-4.8	-3.0	5.90	4.24
Agriculture GDP(real)	11.3	13.7	-11.74	-14.07
Energy industry GDP	-2.5	-2.8	1.58	1.92
Light industry GDP	-2.7	-3.0	2.17	2.43
Chemical industry GDP	-0.9	-0.7	0.90	0.80
Construction material GDP	-4.1	-4.9	3.07	3.84
Iron and steel industry GDP	-4.3	-5.2	3.27	4.11
Equipment industry GDP	0.4	0.9	-0.12	-0.44
Automobile industry GDP	7.5	6.5	-6.38	-5.67
Information technology GDP	-1.0	-1.6	0.87	1.40
Construction GDP	-0.2	-0.3	0.15	0.18
Sales, retail trade GDP	0.3	0.1	-0.28	-0.16
Finance and insurance GDP	0.1	-0.1	-0.13	0.00
Real estate GDP	0.2	0.2	-0.14	-0.14
Other services GDP	-0.5	-0.8	0.37	0.62

Appendix: Equations System of Shanghai Economic CGE Model

Price Identities:

(1) $PM_i = PM\$_i \cdot (1 + \overline{tm}_i + \overline{tn}_i) \cdot ER$

(2) $PES_i = PE\$_i \cdot ER \cdot (1 + \overline{te}_i)$

(3) $PDS_i = (PDSS_i \cdot DS^S{}_i + PEOS_i \cdot EO^S{}_i) / D^S{}_i$

(4) $PX_i = (PDS_i \cdot D^S{}_i + PES_i \cdot E^S{}_i) / X^S{}_i$

(5) $PN_i = PX_i - \sum P_j \cdot \overline{a}_{ji} - PX_i \cdot \overline{td}_i$

Supply for Shanghai, ROC and World Markets:

(6) $D_i^S = \overline{A}_{Ti}{}^{\sigma_{Ti}\rho_{Ti}} \cdot (\alpha_{DSi} \cdot PX_i / PDS_i)^{\sigma_{Ti}} \cdot X_i^S$

(7) $DS_i^S = \overline{A}_{TDi}{}^{\sigma_{DTi}\rho_{DTi}} \cdot (\alpha_{DSSi} \cdot PDS_i / PDSS_i)^{\sigma_{DTi}} \cdot D_i^S$

(8) $EO_i^S = \overline{A}_{TDi}{}^{\sigma_{DTi}\rho_{DTi}} \cdot (\alpha_{EOSi} \cdot PDS_i / PEOS_i)^{\sigma_{TDi}} \cdot D_i^S$

$$where \quad D_i^S = \overline{A_{TDi}} \cdot \left(\alpha_{EOSi} \cdot (EO_i^S)^{\rho_{TD_i}} + \alpha_{DSSi} \cdot (DS_i^S)^{\rho_{TD_i}}\right)^{1/\rho_{DT_i}}$$

$$\sigma_{TDi} = 1/(1-\rho_{TDi}), \quad \rho_{TDi} > 1$$

(9) $E_i^S = \overline{A}_{Ti}{}^{\sigma_{Ti}\rho_{Ti}} \cdot (\alpha_{ESi} \cdot PX_i / PES_i)^{\sigma_{Ti}} \cdot X_i^S$

$$where \quad X_i^S = \overline{A_{Ti}} \cdot \left(\alpha_{ESi} \cdot (E_i^S)^{\rho_{T_i}} + \alpha_{DSi} \cdot (D_i^S)^{\rho_{T_i}}\right)^{1/\rho_{T_i}}$$

$$\sigma_{Ti} = 1/(1-\rho_{Ti}), \quad \rho_{Ti} > 1$$

Production Function:

(10) $X_i^S = \overline{A}_{Xi} \cdot \left(\alpha_{Ki} \cdot K_{Ki}^{\rho_{Xi}} + \alpha_{Li} \cdot L_i^{\rho_{Xi}}\right)^{1/\rho_{X_i}}$

$$where \quad \alpha_{Ki} + \alpha_{Li} = 1 \qquad \sigma_{Xi} = 1/(1-\rho_{Xi}), \quad \rho_{Xi} < 1$$

Demand for Labor:

(11) $L_1 = L_{U1}$

(12) $L_i = \overline{A}_{Xi}{}^{\rho_{X_i}} \cdot (\alpha_{Li} \cdot PN_i / W_i)^{\sigma_{X_i}} \cdot X_i \qquad (i \neq 1)$

(13) $W_1 = \overline{A}_{X1}{}^{\rho_{X1}} \cdot \alpha_{L1} \cdot PN_1 \cdot (X_1 / L_1)^{(1-\rho_{X1})}$

(14) $W_i = \overline{A}_{Li}^{-1} \cdot \left(\alpha_{Ui}^{\sigma_{Li}} \cdot W_{Ui}{}^{-\rho_{Li}\sigma_{Li}} + \alpha_{Wi}^{\sigma_{Li}} \cdot (W_{Wi})^{-\rho_{Li}\sigma_{Li}}\right)^{-1/\rho_{Li}\sigma_{Li}}$

$$where \quad L_i = \overline{A}_{Li} \cdot (\alpha_{Ui} \cdot L_{Ui}^{\rho_{Li}} + \alpha_{Wi} \cdot L_{Wi}^{\rho_{Li}})^{1/\rho_{L_i}} \qquad (i \neq 1)$$

$$\alpha_{Ui} + \alpha_{Wi} = 1 \quad \sigma_{Li} = 1/(1-\rho_{Li}), \quad \rho_{Li} < 1$$

Unskilled Labor Market:

(15) $L_{Ui} = \overline{A}_{Li}{}^{\rho_{Li}\sigma_{Li}} \cdot (\alpha_{Ui} \cdot W_i / W_{Ui})^{\sigma_{Li}} \cdot L_i \qquad and \quad W_{Ui} = \overline{W}_{Ui} \qquad (i = 2...14)$

(16) $L_{U1} = \overline{L}_U^S - \sum_{i=2}^{14} L_{Ui}$

(17) $W_{U1} = W_1$

(18) $W_U = \sum W_{Ui} L_{Ui} / \overline{L}_U^S$

Skilled Labor Market:

(19) $L_{W1} = 0$

(20) $L_{Wi} = \overline{A}_{Li}^{\rho_{L_i}\sigma_{L_i}} \cdot \left(\alpha_{Wi} \cdot W_i / W_{Wi}\right)^{\sigma_{L_i}} \cdot L_i \qquad (i \neq 1)$

(21) $W_{Wi} = \lambda_{Wi} \cdot W_W \qquad (i \neq 1)$

(22) $L^*_{Wi} = \lambda_{Wi} \cdot L_{Wi} \qquad (i \neq 1)$

(23) $L_W = \sum L_{Wi} \quad (L_W = \overline{L}^S_W) \quad and \quad W_W = W^e_W \ (W^e: equilibrium\ wage) \quad (i \neq 1)$

(24) $L^*_W = \sum L^*_{Wi} \qquad (i \neq 1)$

(25) $\lambda_W = L_W^* / L^S_W \quad (\lambda_{W0} = 1.0,\ L^S_W = L^*_W,\ \sum W_{Wi} L^*_{Wi} = W_W L^*_W \ \ for\ 2002)$

Capital Stocks by Industry:

(26) $K_i = \overline{K}_i$

(27) $R_i = \overline{A}_{Xi}^{\rho_{X_i}} \cdot \alpha_{Ki} \cdot PN_i \cdot \left(X_i / K_i\right)^{1-\rho_{X_i}}$

(28) $R = \sum R_i \cdot K_i / \overline{K}^S \qquad \sum K_i = \overline{K}^S$

Income Distribution and Savings:

Capital income

(29) $YK_i = R_i \cdot K_i \qquad YK = \sum YK_i$

Labor Income

(30) $YL_{Ui} = W_{Ui} \cdot L_{Ui} \qquad YL_U = \sum YL_{Ui}$

(31) $YL_{Wi} = W_{Wi} \cdot L_{Wi} \qquad YL_W = \sum YL_{Wi}$

Skilled Labor Income Tax

(32) $TY_{LW}C = t_{YLWC} \cdot YL_W$

(33) $TY_{LW}S = t_{YLWS} \cdot YL_W$

Enterprise Income Tax

(34) $TYEC = t_{YEC} \cdot YKT$

(35) $TYES = t_{YES} \cdot YKT$

Rural Household Income

(36) $Y_{PA} = YL_{U1} + (YL_U - YL_{U1}) \cdot \psi_1 + YKT \cdot \psi_2$

Urban Household Income

(37) $Y_{PN} = (YL_U - YL_{U1}) \cdot (1 - \psi_1) + YL_W \cdot (1 - t_{YLWC} - t_{YLWS}) + YKT \cdot \psi_3$

Central Government Income

(38) $Y_{GC} = TYEC + TYL_{WC} + \sum t_{DCi} \cdot PX_i \cdot X_i + t_{mi} \cdot PM_i / (1 + t_{mi} + t_{ni}) \cdot M_i - t_{ei} \cdot PE_i / (1 + t_{ei} + t_{ni}) \cdot E_i$

Regional Government Income

(39) $Y_{GS} = TYES + TYL_{WS} + \sum t_{DSi} \cdot PX_i \cdot X_i + TGG$

Institute Savings

(40) $SE = \overline{s}_E \cdot YKT$

(41) $SPA = \overline{s}_{PA} \cdot YPA \quad SPN = \overline{s}_{PN} \cdot YPN$

(42) $SGS = \overline{s}_{GS} \cdot YGS \quad SGC = \overline{s}_{GC} \cdot YGC$

(43) $S = SE + SPA + SPN + SGC + SGS$

Real Consumption Expenditure by Rural Residents:

(44) $C_{Aj} = \gamma_{Aj} \cdot \left(1 - \bar{s}_{PA}\right) \cdot Y_{PA} / P_j$

(45) $C_A = \sum_{j=1}^{14} C_{Aj}$

(46) $PC_A = \left(1 - \bar{s}_{PA}\right) \cdot Y_{PA} / C_A \qquad (PC_A \cdot C_A \equiv \sum P_j \cdot C_{Aj})$

Real Consumption Expenditure by Urban Residents:

(47) $C_{Nj} = \gamma_{Nj} \cdot \left(1 - \bar{s}_{PN}\right) \cdot Y_{PN} / P_j$

(48) $C_N = \sum_{j=1}^{14} C_{Nj}$

(49) $PC_N = \left(1 - \bar{s}_{PN}\right) \cdot Y_{PN} / C_N \qquad (PC_N \cdot C_N \equiv \sum P_j \cdot C_{Nj})$

Real Consumption Expenditure by Regional Government:

(50) $GS = \left(1 - \bar{s}_{GS}\right) \cdot Y_{GS} / PGS$

(51) $GS_j = \gamma_{GSj} \cdot GS \qquad (\sum \gamma_{GSj} = 1)$

(52) $PGS = \sum \gamma_{GSj} \cdot PGS_i \qquad (PGS \cdot GS = \sum PGS_j \cdot GS_j)$

Real Consumption Expenditure by Central Regional Government:

(53) $GC = \left(1 - \bar{s}_{GC}\right) \cdot Y_{GC} / PGC$

(54) $GC_j = \gamma_{GCj} \cdot GC \qquad (\sum \gamma_{GCj} = 1)$

(55) $PGC = \sum \gamma_{GCj} \cdot PGC_i \qquad (PGC \cdot GC = \sum PGC_j \cdot GC_j)$

Fixed Capital Formation:

(56) $I = IP + IGS + IGC$

(57) $I_i = \bar{b}_i \cdot I \qquad (\sum \bar{b}_I = 1.0) \qquad PI = \sum \bar{b}_i \cdot P_i \qquad IP^n = IP \cdot PIP$

(58) $IP_i = \bar{b}_{Pi} \cdot IP \qquad (\sum \bar{b}_{Ii} = 1.0) \qquad PIP = \sum \bar{b}_{Pi} \cdot P_i \qquad IP^n = IP \cdot PIP$

(59) $IGS_i = \bar{b}_{GSi} \cdot IGS \quad (\sum \bar{b}_{GSi} = 1.0) \quad PIGS = \sum \bar{b}_{GSi} \cdot P_i \qquad IGS^n = IGS \cdot PIGS$

(60) $IGC_i = \bar{b}_{GCi} \cdot IGC \; (\sum \bar{b}_{GCi} = 1.0) \quad PIGC = \sum \bar{b}_{GCi} \cdot P_i \qquad IGC^n = IGC \cdot PIGC$

Demand for Shanghai, ROC and World Goods:

(61) $Q_i = \sum \bar{a}_{ij} \cdot X_j^S + C_{Ai} + C_{Ni} + GS_i + GC_i + I_i$

(62) $P_i = \bar{A}_{Qi}^{-1} \cdot \left(\alpha_{Mi}^{\sigma_{Qi}} \cdot PM_i^{-\rho_{Qi}\sigma_{Qi}} + \alpha_{Di}^{\sigma_{Qii}} \cdot PD_i^{-\rho_{Qi}\sigma_{Qi}}\right)^{-1/\rho_{Qi}\sigma_{Qi}}$

(63) $D_i = \bar{A}_{Qi}^{\rho_{Qi}\sigma_{Qi}} \cdot \left(\alpha_{Di} \cdot P_i / PD_i\right)^{\sigma_{Qi}} \cdot Q_i$

(64) $PD_i = \bar{A}_{Di}^{-1} \cdot \left(\alpha_{MOi}^{\sigma_{Di}} \cdot PMO_i^{-\rho_{Di}\sigma_{Di}} + \alpha_{DSDi}^{\sigma_{Qii}} \cdot PDS_i^{-\rho_{Di}\sigma_{Di}}\right)^{-1/\rho_{Di}\sigma_{Di}}$

(65) $DSD_i = \bar{A}_{Di}^{\rho_{Di}\sigma_{Di}} \cdot \left(\alpha_{DSDi} \cdot PD_i / PDS_i\right)^{\sigma_{Di}} \cdot D_i$

(66) $MOD_i = \bar{A}_{Di}^{\rho_{Di}\sigma_{Di}} \cdot \left(\alpha_{DMOi} \cdot PD_i / PMOD_i\right)^{\sigma_{Di}} \cdot D_i$

(67) $M_i = \bar{A}_Q^{\rho_Q\sigma_Q} \cdot \left(\alpha_{Mi} \cdot P_i / PM_i\right)^{\sigma_{Qi}} \cdot Q_i$

where $\mathrm{D}_i = \overline{A_{Di}} \cdot \left(\alpha_{DMOi} \cdot MOD_i^{\rho_{Di}} + \alpha_{DSDi} \cdot DSD_i^{\rho_{Di}}\right)^{1/\rho_{Di}}$

$\sigma_{Di} = 1/(1 - \rho_{Di}) \;, \qquad \rho_{Di} < 1$

where $Q_i = \overline{A_{Qi}} \cdot \left(\alpha_{Mi} \cdot M_i^{\rho_{Qi}} + \alpha_{Di} \cdot D_i^{\rho_{Qi}}\right)^{1/\rho_{Qi}}$

$\sigma_{Qi} = 1/(1 - \rho_{Qi}) \;, \qquad \rho_{Qi} < 1$

Demand for Shanghai Exports by World:

(68) $E_i = \overline{E}_i^0 \cdot \left(\prod_{Ei} / PE\$_i\right)^{\eta_{Ei}}$

Demand for Shanghai Exports to ROC: by ROC:

(69) $EOD_i = \overline{EO}_i^0 \cdot \left(\prod_{EOi} / PEO_i\right)^{\eta_{EOi}}$

Supply for Shanghai Imports by World:

(70) $M_i^S = \overline{M}_i^0 \cdot \left(PM\$_i / \prod_{Mi}\right)^{\eta_{Mi}}$

Supply for Shanghai Imports from ROC:

(71) $MO_i^S = \overline{MO}_i^0 \cdot \left(PMO_i / \prod_{MOi}\right)^{\eta_{MOi}}$

Foreign Capital Inflow:

(72) $F = F\$ \cdot \overline{ER}$ or $F = \overline{F\$} \cdot ER$ and $ER = ER^e$ (*equilibrium rate*)

Equilibrium Conditions:

Shanghai Products Markets:

(73) $DSD_i = DSS_i^S$ *and* $PDSS_i = PDSS_i^e$ ($PDSS_i^e$: *equilibrium price*)

Shanghai Export to ROC Markets:

(74) $EOD_i = EO_i^S$ *and* $PEOS_i = PEOS_i^e$ ($PEOS_i^e$: *equilibrium price*)

Shanghai Import from ROC Markets:

(75) $MOD_i = MO_i^S$ *and* $PMOD_i = PMOD_i^e$ ($PMOD_i^e$: *equilibrium price*)

Shanghai Export to World Markets:

(76) $E_i = E_i^S$ *and* $PE\$_i = PE\$_i^e$ ($PE\$_i^e$: *equilibrium price*)

Shanghai Import from World Markets:

(77) $M_i = M_i^S$ *and* $PM\$_i = PM\$_i^e$ ($PM\$_i^e$: *equilibrium price*)

Foreign Exchange market:

(78) $F\$ = \sum PM\$_i \cdot M_i - \sum PE\$_i \cdot E_i$ *and* $ER = \overline{ER}$

(exogenous in regional model)

GDP Identity:

(79) $E = \sum E_i$

(80) $EO = \sum EO_i$

(81) $PE = \sum \left(PES_i / (1 + \overline{te}_i)\right) \cdot E_i / E$

(82) $M = \sum M_i$

(83) $MO = \sum MO_i$

(84) $PM = \sum \left(PM_i / (1 + \overline{tm}_i + \overline{tn}_i)\right) \cdot M_i / M$

(85) $GDP^n = Y_p + Y_G$

$$= PC_A \cdot C_A + PC_N \cdot C_N + PGS \cdot GS + PGC \cdot GC + PI \cdot I + PE \cdot E - PM \cdot M + PEO \cdot EO - PMO \cdot MO$$

$$= \sum \left(PX_i - \sum P_j \cdot \overline{a}_{ji}\right) \cdot X_i^S + \sum \overline{tm}_i \cdot PM\$_i \cdot M_i \cdot ER + \sum \overline{te}_i \cdot PE\$_i \cdot ER \cdot E + \sum MOD_i \cdot PMOD_i + \sum EOD_i \cdot PEOS_i$$

(86) $GDP = C_A + C_N + GS + GC + I + E - M + EO - MO$

(87) $GDP_i^n = (PX_i - \sum P_j \cdot \bar{a}_{ji}) \cdot X_i^S$

(88) $GDP_i = \left(1 - \sum \bar{a}_{ji}\right) \cdot X_i^S$

(89) $PGDP = GDP^n / GDP$

Social Welfare:

(90) $U = \left(\prod_{i \neq 2,3,4,5,6} C_i^{\gamma_i} \right) \cdot C_E^{\gamma_E}$

(91) $EV = C \cdot (U^* - U)/U$ $\qquad (U^* = U \text{ of } \textit{alternative senario})$

Law of Walras:

(92) $$\begin{aligned} & W_{LU} \cdot \left(L_U - \bar{L}_U^S\right) + W_W \cdot \left(L_W - \bar{L}_W^S\right) + R \cdot \left(\sum K_i - \bar{K}^S\right) + \sum PDS_i \cdot \left(DSD_i - DS_i^S\right) \\ & + \left[\sum PMOD_i \cdot \left(MOD_i - MO_i^S\right) + \sum PEOS_i \cdot \left(EOD_i - EO_i^S\right)\right] \\ & + \sum PE\$_i \cdot \left(E_i - E_i^S\right) + \sum PM\$_i \cdot \left(M_i - M_i^S\right) \\ & + \left(S + F + FO - I^n\right) \\ & + ER \cdot \left\{\sum PM\$_i \cdot M_i - \sum PE\$_i \cdot E_i - \overline{F\$}\right\} \equiv 0 \end{aligned}$$

Capital Stock Accumulation and Allocation for the Next Period:

(93) $K_{t+1}^S = K_t^S + I_t - \delta \cdot K_t^S$

(94) $K_{i,t+1} = \frac{K_{i,t}}{K_t} \cdot \left(1 + \mu \cdot \frac{R_i - R}{R}\right) \cdot K_{t+1}$ $\qquad (0 \le \mu \le 1)$

N.B. Law of Walras Extended to Include Money*:

(90)' $$\begin{aligned} & W_U \cdot \left(L_U - \bar{L}_U^S\right) + W_W \cdot \left(L_W - \bar{L}_W^S\right) + R \cdot \left(\sum K_i - \bar{K}^S\right) + \sum PDS_i \cdot \left(DSD_i - DS_i^S\right) \\ & + \left[\sum PMOD_i \cdot \left(MOD_i - MO_i^S\right) + \sum PEOS_i \cdot \left(EOD_i - EO_i^S\right)\right] \\ & + \sum PE\$_i \cdot \left(E_i - E_i^S\right) + \sum PM\$_i \cdot \left(M_i - M_i^S\right) \\ & + \left(M^D - M^S\right) + ER\left(\sum PM\$_i \cdot M_i - \sum PE\$_i \cdot E_i - \overline{F\$}\right) \equiv 0 \end{aligned}$$

where $S + F + FO - I^n = \Delta M^D - \Delta M^S = M^D - M^S$

$\Delta M^D = M_t^D - M_{t-1}^D \qquad \Delta M^S = M_t^S - M_{t-1}^S \qquad M_{t-1}^D \equiv M_{t-1}^S$

$M^D / PGDP = \bar{M}_O \cdot GDP^{\psi} \qquad M^S = \bar{M}^S$

* This formulation assumes that the balance between demand and supply for non-money financial assets such as loans, net foreign assets, etc. holds automatically by quantity adjustment, so that the balance equations for these assets are not equilibrium conditions but identities.

Appendix: Notations of Shanghai Economic CGE Model

Price Variables:

PX_i = Composite price of domestic and export goods of industry i
PDS_i = Composite price of domestic goods of industry i
$PDSS_i$ = Supply and demand price of region goods of industry i
$PEOS_i$ = Supply price of export to ROC of industry i
PES_i = Export price of industry i
$PE\$_i$ = Export price of industry i (US$)
P_i = Composite price of domestic and imported goods from world of industry i
PD_i = Demand price of domestic market of industry i
$PMOD_i$ = Demand price of import from ROC of industry i
PM_i = Import price of industry i in
$PM\$_i$ = Import price of industry i in (US$)
PN_i = Net price of industry i
W_i = Composite wage of skilled and unskilled employment in industry i.
W = Composite wage of skilled and unskilled employment for all industries
W_{Ui} = Wage of unskilled employment in industry i
W_U = Wage of unskilled employment averaged for all industries
W_{Wi} = Wage of skilled employment in industry i
W_W = Wage of skilled employment averaged for all industries
W_W^e = Equilibrium wage of skilled employment
R_i = Rental price of capital in industry i
R = Rental price of capital averaged for all industries
PC_A = Deflator of rural consumption
PC_N = Deflator of urban consumption
PG = Deflator of government consumption
PGC = Deflator of central government consumption
PGS = Deflator of regional government consumption
PI = Deflator of investment
PIP = Deflator of private investment
$PIGC$ = Deflator of central government investment
$PIGS$ = Deflator of regional government investment
PE = Deflator of exports of goods and services
PM = Deflator of imports of goods and services
PEO = Deflator of exports to ROC of goods and services
PMO = Deflator of import from ROC of goods and services
$PGDP$ = GDPdeflator
$\prod_{Ei}$ = World price in the export market of industry i (US$)
$\prod_{Mi}$ = World price in the import market of industry i (US$)
$\prod_{EOi}$ = ROC price in the export to ROC market of industry i
$\prod_{MOi}$ = ROC price in the import from market of industry i
ER = Exchange rate (Yuan/US$)

Quantity Variables:

X_i^S = Real domestic production of industry i
X_i = Total demand for production of industry i
$D^S{}_i$ = Supply of production for domestic markets by industry i
$DS^S{}_i$ = Supply of production for regional markets by industry i
$EO^S{}_i$ = Supply of production to ROC markets by industry i
EOD_i = Demand of production from ROC markets by industry i
$E^S{}_i$ = Supply of export markets by industry i
E_i = Demand of export market by industry i
Q_i = Total domestic demand for composite goods of industry i
D_i = Total domestic demand for production of industry i
DSD_i = Total regional demand for production of industry i
MOD_i = Total import demand from ROC for production of industry i

MO_i^s = Total import supply from ROC for production of industry i
M_i = Import demand of industry i
M_i^s = Supply import market of industry i

(Factors)

L_i = Composite labor input in industry i
L_{Ui} = Un-skilled employment in industry i
L_{Wi} = Skilled employment in industry i
L_{Wi}^* = Skilled employment in industry i (in efficiency units)
$\underline{L}_W^S$ = Total supply of skilled labor (in efficiency units)
$\underline{L}_U^S$ = Total supply of Un-skilled labor
L_W = Total supply of skilled labor
K_i = Capital stocks in industry i
$\underline{K}_i^S$ = Supply of capital stocks for industry i
K^S = Total supply of capital stocks

(Consumption)

C_A = Real consumption by rural households
C_N = Real consumption by urban households
G = Real consumption by government
GS = Real consumption by regional government
GC = Real consumption by central government
G_i = Government consumption demand for composite goods of industry i
GS_i = Central government consumption demand for composite goods of industry i
GC_i = Regional Government consumption demand for composite goods of industry i
I_i = Investment demand for composite goods of industry i
IP_i = Private investment demand for composite goods of industry i（$\bar{b}_{P_i}$ = rate）
IGS_i = Regional government investment demand for composite goods of I (b_{GS_i} = rate)
IGC_i = Central government investment demand for composite goods of I (b_{GC_i} = rate)
I = Real investment
$IP = IP^n$ = Private real and nominal investment
$IGC = IGC^n$ = Central government real and nominal investment
$IGS = IGS^n$ = Regional government real and nominal investment

Value Variables:

(Income and Allocation)

Y_{PA}, Y_{PN} = Nominal income of rural and urban households
Y_G = Nominal income of government
YL_U, YL_w = Skilled and Un-skilled labor income
YKT = Income of Capital stock
$TY_{LW}C, TY_{LW}S$ = Labor income taxes to central and regional government
$TYEC, TYES$ = Enterprise income of to central and regional government
Y_{GS} = Nominal income of regional income
Y_{GC} = Nominal income of central income
S = Gross national savings
I^n = Nominal investment
SP = Private savings (s_P = the rate of private savings）
SGC = Central government savings (s_{GC} = the rate of central government savings）
SGS = Regional government savings (s_{GS} = the rate of regional government savings）
FO = Net inflow of capital from ROC
F = Net inflow of foreign capital (Current Balance of Payment)
$F\$$ = Net inflow of foreign capital (in US$)

(GDP)

M = Real imports of goods and services
E = Real exports of goods and services
MO = Real import of goods and services from ROC
EO = Real exports of goods and services from ROC
GDP_i^n = Nominal GDP of industry i
GDP^n = Nominal GDP
GDP_i = Real GDP of industry i

GDP = Real GD
EV = Equivalent variation of rural and urban households
U = Utility level of rural and urban household s
M_S^D = Demand for money (M_2)
$\overline{M}$ = Supply of money (M_2)

Parameters:

$\overline{A}_{Ti}$ = Scale factor of CET (Domestic and world) transformation function for industry i
$\alpha_{ESi}, \alpha_{DSi}$ = Share parameters of CET transformation function for industry i
σ_{Ti} = Elasticity of transformation in CET transformation function for industry i
$\rho_{T_i} = (\sigma_{T_i} - 1)/\sigma_{T_i}$
$\overline{A}_{TDi}$ = Scale factor of CET (Regional and ROC) transformation function for industry i
$\alpha_{EOSi}, \alpha_{DSSi}$ = Share parameters of CET transformation function for industry i
σ_{TDi} = Elasticity of transformation in CET transformation function for industry i
$\rho_{TD_i} = (\sigma_{TD_i} - 1)/\sigma_{TD_i}$
A_{Qi} = Scale factor of CES (Domestic and world) composite goods function for industry i
α_{Mi}, α_{Di} = Share parameters of CES composite goods function for industry i
σ_{Qi} = Elasticity of composite goods in CES composite function for industry i
$\rho_{Q_i} = (\sigma_{Q_i} - 1)/\sigma_{Q_i}$
A_{Di} = Scale factor of CES (Region and ROC) composite goods function for industry i
$\alpha_{MOi}, \alpha_{DSDi}$ = Share parameters of CES composite goods function for industry i
σ_{Di} = Elasticity of composite goods in CES composite function for industry i
$\rho_{D_i} = (\sigma_{D_i} - 1)/\sigma_{D_i}$
a_{ij} = Intermediate input coefficient from industry i to industry j
A_{Li} = Scale factor of CES composite labor function for industry i
α_{Ui}, α_{Wi} = Share parameters of CES composite labor function for industry i
σ_{Li} = Elasticity of substitution between skilled and unskilled labor for industry i
$\rho_{L_i} = (\sigma_{L_i} - 1)/\sigma_{L_i}$
A_{Xi} = Scale factor of CES production function for industry i
α_{Li}, α_{Ki} = Share parameters of CES production function for industry i
σ_{Xi} = Elasticity of substitution between labor and capital for industry i
$\rho_{X_i} = (\sigma_{X_i} - 1)/\sigma_{X_i}$
M_i = Scale factor of import supply function for idustry i
η_{Mi} = Price elasticity of import supply function for industry i
MO_i = Scale factor of import fron ROC supply function for industry i
η_{MOi} = Price elasticity of import from ROC supply function for industry i
E_i = Scale factor of export demand function for industry i
η_{Ei} = Price elasticity of export demand function for industry i
EO_i = Scale factor of export to ROC demand function for idustry i
η_{EOi} = Price elasticity of export to ROC demand function for industry i
γ_{Ai}, γ_{Ni} = Share parameters of Cobb-Douglas utility function, rural and urban
M_0 = Scale factor of real demand function for money
ν = GGP elasticity of real demand for money
δ = Rate of depreciation for capital assets
λ_{Wi} = Efficiency parameters for skilled labor
μ = Adjustment speed of capital allocation between industries
ψ = Share of rural income in total private income

Tax and Subsidy:

tm_i = Import tariff rate of industry i
tn_i = Non-tariff barriers of industry i (tariff-equivalent rate)
te_i = Export subsidy rate of industry i
td_i = Indirect tax rate of industry i
tdc_i, tds_i = Central and regional indirect tax rate of industry i
$tylwc, tylws$ = Income tax rate of Central and regional government
$tyec_L, tyes_L$ = Property tax rate of central and regional government
$tyeha, tyehn$ = Income transfer rate of Enterprise to rural and urban households