Economic Relationships of Shanghai with the Rest of China and the World: A CGE Model 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. The model distinguishes 14 sectors. Based on relationships observed during the sample period, the paper offers simulations for the 2017-2020 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, CGE Model

1. Introduction

The Shanghai economy is a very important regional economy of China. 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 2012 and distinguishes fourteen sectors, capturing both demand and supply side linkages. Simulations are conducted for 2017 to 2020. The paper is organized as follows. Section 2 describes the Dynamic CGE model that is constructed and used for the analysis. Section 3 presents the results. Section 4 concludes.

2. A dynamic regional CGE model for the Shanghai economy

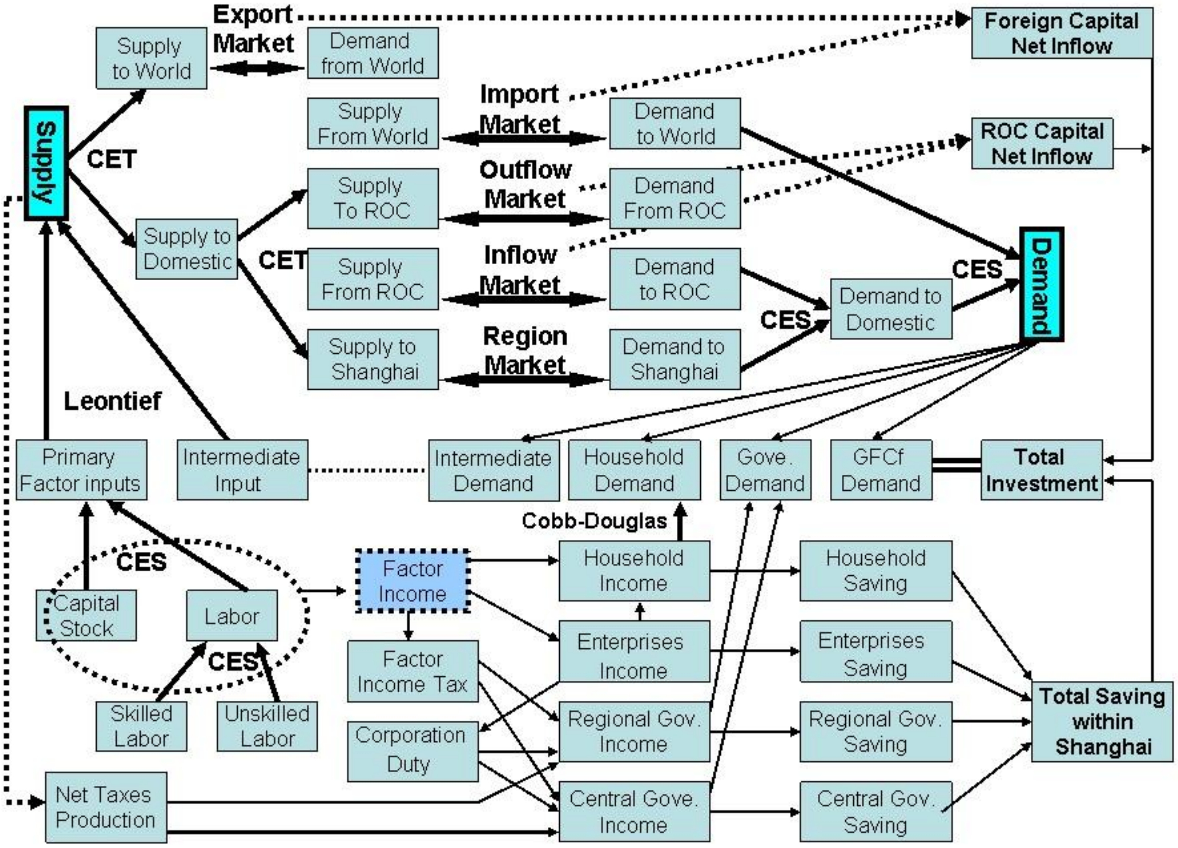
In order to study the future impact of the changes in Shanghai's external economic linkages, this paper uses a dynamic regional computable general equilibrium (CGE) model. Before describing this model, it is useful to have a brief review of previous regional CGE models used elsewhere and in China.

2.1 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. 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 (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 (2005, 2011, and 2017) also developed a single region model of Shanghai to study the effect of Yuan exchange rate, value-add tax reform and energy price. The model used in this paper is a further application to Shanghai economy.

2.2 Regional CGE model for Shanghai

Figure 1 Structure of Shanghai Economic CGE Model



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. 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).[1] The basic structure and features of the model are presented in Figure 1.[2]

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.

[1] Fourteen industries include Agriculture, coal, oil and gas, electricity, water supply, manufacturing, construction, wholesale, transportation, telecommunications and software, finance and insurance, real estate, leasing and commerce, other services.

[2] The lower left corner of Figure 1 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.

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 both ROC and ROW, making these prices exogenous to the Shanghai economy. 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). 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 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. 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 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[3]

$W_U \cdot \left(L_U - \overline{L}_U^S\right)$	(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)

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
2012	2	1E-12	0	0	0	0	0	0	0	(0)	0	0
2013	393	1E-12	0	0	0	0	(0)	0	1	0	(1)	(0)
2014	386	1E-12	0	0	0	0	(0)	0	1	0	(1)	(0)
2015	380	1E-12	0	0	0	0	0	0	1	(0)	(1)	(0)
2016	370	1E-12	0	0	0	0	(0)	0	1	(0)	(1)	(0)
2017	363	1E-12	0	0	0	0	(0)	0	1	0	(1)	(0)
2018	349	1E-12	0	0	0	0	0	0	1	(0)	(1)	(0)
2019	341	1E-12	0	0	0	0	(0)	0	0	0	(1)	(1)
2020	341	1E-12	0	0	0	0	0	0	1	(0)	(1)	(1)

Note: "Year" is the calculating period, "EPS" is the calculating accuracy, and "NIT" is thei 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.[4].

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

[4] See equation (94) in the appendix on equations for the details.

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 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 2012 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.

The first task in using the CGE model is to establish the baseline scenario (for 2012-2020) 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 2012-2020 labor, nominal wage, real investment, and TFP of each industry, respectively. These values accord well with the recent experience. Scale parameter of exports in each industry is extrapolated based on the growth performance of exports in the past. Exchange rate is fixed at the 2012 level, and the coefficients of intermediate inputs are assumed to remain the same as in the 2012 input-output table.

Table 3: Shanghai Social Accounting Matrix (SAM), 2012 in 10 Million Yuan

Expenditures / Receipts		Activities	Commodities	Factors		Institutions			Investment	Trade		Total
				Capital	Labor	Enterprises	Households.	Government		ROC	World	
Activities			24676							31140	15543	71359
Commodities		51039					8721	2807	7675			70242
Factors	Capital	7910										7910
	Labor	8389										8389
Institutions	Enterprises			7910								7910
	Households				6096	5895						11991
	Government	4021			2293	2015						8329
Savings							3270	5522		-5151	4034	7675
Trade	ROC		25989									25989
	World		19577									19577
Total		71359	70242	7910	8389	7910	11991	8329	7675	25989	19579	

Table 4 presents the baseline scenario in terms of average growth rates of key macroeconomic variables and gross value added by industry during 2012-2020. 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 4: Baseline of Shanghai Economy, 2012-2020 in 10 Million Yuan

	Growth rate(%)	2012	2003	2014	2015	2016	2017	2018	2019	2020
Real GDP	6.2	20320	21641	23075	24637	26336	27796	29376	31077	32894
Nominal GDP	11.6	20320	22634	25120	27816	30702	34121	37586	41044	44437
Nominal savings	11.6	8791	9807	10915	12122	13434	15148	16995	18986	21138
Nominal investment	18.0	7675	8592	9612	10742	11994	14980	18677	23244	28875
Real investment	14.9	7675	8442	9286	10215	11237	13484	16181	19417	23300
Real house consume.	9.6	8721	9566	10482	11477	12554	13812	15158	16590	18147
Real gov. consump.	6.1	2807	2940	3106	3282	3477	3682	3922	4190	4516
Real demand of Shanghai market	12.8	24676	26537	28605	30903	33453	36848	40895	45714	51442
Real import from ROW	10.1	19577	21260	23111	25148	27388	30337	33745	37690	42263
Real export to ROW	8.4	15542	16811	18205	19741	21432	23134	25060	27241	29705
Real import from ROC	11.0	25980	28496	31264	34321	37697	42096	47180	53066	59882
Real export to ROC	8.4	31140	33620	36370	39391	42721	46116	49980	54378	59371
GDP deflator	3.8	1.000	1.046	1.089	1.129	1.166	1.228	1.279	1.321	1.351

3. The Simulations and their results

3.1 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. First, 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 1, so to speak. Secondly, looking from the Shanghai side, simulations are designed to study the influence of Shanghai economy's investment and the progress in total factor productivity (TFP). 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. Four simulations are conducted under category 1, and these allow one percent increase in Shanghai's import from ROC and ROW and in Shanghai's export to ROC and ROW from 2017 to 2020. Two simulations are conducted under category 2. The first of these focuses on possible increases one percent in Shanghai's propensity to invest from 2017 to 2020. In particular, this simulation allows the growth rate of real investment to increase from baseline's one percentage point in every year. The second 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 2 percent to 3 percent in all sectors from 2017 to 2020. The two simulations under category 3 allow Yuan to appreciate or depreciate, as the case may be, by 10 percent from 2017 to 2020.

3.2 Simulation Results

Table 5 presents the highlights of the simulation results in normalized form in order to make the comparison easier.[5] Looking at the results of the simulations of category 1, it may be noticed that the increase in Shanghai's import from ROC and ROW (simulation 1 and 3) has a positive effect on her real GDP and nominal GDP. An increase in Shanghai's export to ROC and ROW (simulation 2 and 4) leads to an almost proportionate increase in

[5] In table 5, the numerical values those are divided by the reference term are calculated based on simulation results, 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.

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 3) leads to a decline in Shanghai's import from ROC. The increase in Shanghai's export to ROW (simulation 4) leads to a decrease in Shanghai's export to ROC, at the same time increasing Shanghai's import from both ROC and ROW. Looking at the results of the simulations under category 2, we see that an increase in Shanghai's real investment by one percent (simulation 5) has a slight impact on real GDP and nominal GDP (-0.86 and 0.89 percent by 2020), increasing Shanghai's import from ROW by much more than import from ROC (1.06 percent compared to 0.43 percent in 2020). However, higher investment increases the production capacity and leads to an increase in Shanghai's nominal GDP. Increase in all sector's productivity by one percent (simulation 6) enlarges Shanghai's productive capacity, has a relatively large effect on real GDP and nominal GDP (4.57 and -6.23 percent by 2020), increasing her exports to ROC and ROW to a similar extent (by 3.21 and 3.10 percent, respectively, by 2020). The process however leads to more slight effects on Shanghai's import. While the import from ROW increases 1.06 percent, the import from ROC increases 0.38 percent by 2020. 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.

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

	Import Quantity from ROC 1 % Raise		**Export Quantity to ROC 1 % Raise**		**Import Quantity from World 1 % Raise**		**Export Quantity to World 1 % Raise**	
	2017	**2020**	**2017**	**2020**	**2017**	**2020**	**2017**	**2020**
Real GDP	1.22	1.41	-1.44	-1.93	1.63	2.00	-0.54	-0.74
Nominal GDP	0.58	0.50	5.77	5.70	2.78	2.79	2.01	2.02
Total Supply	0.06	0.07	0.27	0.27	0.27	0.31	0.15	0.15
Demand by Shanghai	-0.05	-0.05	-0.34	-0.30	-0.34	-0.33	-0.14	-0.13
Demand by ROC	0.12	0.13	1.00	1.00	0.55	0.64	-0.05	-0.03
Demand by World	0.13	0.15	-0.23	-0.19	0.67	0.77	1.00	1.00
Total Demand	0.17	0.16	0.78	0.75	0.80	0.83	0.31	0.31
Supply by Shanghai	-0.05	-0.05	-0.34	-0.30	-0.34	-0.33	-0.14	-0.13
Supply by ROC	1.00	1.00	0.80	0.77	-1.22	-1.33	0.31	0.31
Supply by World	-0.71	-0.70	2.41	2.40	1.00	1.00	0.97	0.98
	Real Invest. Quantity 1 % Raise		**TFP in All Sector 1 % Raise**		**Yuan Appreciation +10%**		**Yuan Depreciation +10%**	
	2017	**2020**	**2017**	**2020**	**2017**	**2020**	**2017**	**2020**
Real GDP	-0.15	-0.86	0.94	4.57	4.89	5.84	-5.56	-6.64
Nominal GDP	0.20	0.89	-1.51	-6.23	0.59	0.42	-0.18	-0.03
Total Supply	0.01	0.25	0.83	3.34	0.19	0.21	-0.17	-0.19
Demand by Shanghai	0.15	0.99	0.94	3.63	-0.39	-0.39	0.31	0.31
Demand by ROC	-0.06	-0.15	0.79	3.21	1.47	1.52	-1.31	-1.35
Demand by World	-0.07	-0.22	0.76	3.10	-1.43	-1.37	1.32	1.27
Total Demand	0.12	0.77	0.46	1.73	1.01	0.98	-0.81	-0.78
Supply by Shanghai	0.15	0.99	0.94	3.63	-0.39	-0.39	0.31	0.31
Supply by ROC	0.08	0.43	0.12	0.38	-3.77	-3.82	3.53	3.58
Supply by World	0.18	1.06	0.32	1.06	-0.63	-0.71	0.53	0.60

Simulations with respect to the exchange rate show that appreciation of Yuan has an equivalent impact with depreciation of Yuan. Appreciation of Yuan by 10 percent (simulation 7) leads to large decrease in Shanghai's import from ROC and a smaller decrease in her import from ROW. Shanghai's exports to ROW decline, accompanied by an almost offsetting increase in her exports to ROC. Shanghai's GDP increases, in both nominal and real terms. Depreciation of Yuan by 10 percent (simulation 8) has almost mirror opposite effects, though less pronounced in degree. It increases Shanghai's exports to ROW and imports from ROW. On the other hand, the depreciation decreases Shanghai's exports to ROC and increases her imports from ROC. However, on the whole, the appreciation 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.

4. Conclusions

Results from simulations focusing on changes in ROC and ROW show that 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 real GDP and increase in nominal GDP. The substitution effect between import from ROC and ROW is larger than the substitution effect between the export to ROC and ROW. 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 increases Shanghai's import from ROC while increasing the import from ROW. Similarly, an increase in Shanghai's consumption propensity 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.

Simulations with respect to the exchange rate show that appreciation of Yuan has an equivalent impact with depreciation of Yuan. Appreciation of Yuan brings about a steep decrease in Shanghai's import from ROC, and causes moderate decline in the import from ROW. The appreciation decreases Shanghai's export to ROW, but this decline is offset by equivalent increase (through substitution effect) in Shanghai's export to ROC, so that the real GDP of Shanghai does not suffer much more. Depreciation of Yuan leads to an increase in Shanghai's export to ROW and decreases export to ROC, via the substitution effect. It has bigger effects on Shanghai's import from ROC. On the whole, the depreciation leads to a decrease in Shanghai's GDP in both nominal and real terms. 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 on these relationships will require the development of two-region China link CGE model of Shanghai-ROC and use of such a model to do conduct pertinent simulations. Meanwhile, compared with the finding of study last time (Sun, 2005), the relationship of Shanghai and ROC, ROW has undergone some changes, and further study is need in future.

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

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

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

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

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

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

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

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

Production Function:

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

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

Demand for Labor:

(11) $L_1 = L_{U1}$

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

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

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

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

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

Unskilled Labor Market:

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

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

(17) $W_{U1} = W_1$

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

Skilled Labor Market:

(1) $L_{W1} = 0$

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

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

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

(5) $L_W = \sum L_{Wi} \quad (L_W = \overline{L}_W^S) \quad and \quad W_W = W_W^e \ (W^e\text{: } equilibrium\ wage) \ (i \neq 1)$

(6) $L_W^{*} = \sum L_{Wi}^{*} \qquad (i \neq 1)$

(7) $\lambda_W = L_W^{*} / L_W^S \quad (\lambda_{W0} = 1.0,\ L_W^S = L_W^{*},\ \sum W_{Wi} L_{Wi}^{*} = W_W L_W^{*} \quad for\ \ 2002)$

Capital Stocks by Industry:

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

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

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

Income Distribution and Savings:

Capital income

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

Labor Income

(12) $YL_{Ui} = W_{Ui} \cdot L_{Ui} \quad YL_U = \sum YL_{Ui}$

(13) $YL_{Wi} = W_{Wi} \cdot L_{Wi} \quad YL_W = \sum YL_{Wi}$

Skilled Labor Income Tax

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

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

Enterprise Income Tax

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

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

Rural Household Income

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

Urban Household Income

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

Central Government Income

(20) $Y_{GC} = TYEC + TYL_{WC}$

$$+ \sum t_{DCi} \cdot PX_i \cdot X_i + t_{mi} \cdot PM_i / (1 + t_{mi} + t_{ni}) \cdot M_i - t_{ei} \cdot PE_i / (1 + t_{ei} + t_{ni}) \cdot E_i$$

Regional Government Income

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

Institute Savings

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

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

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

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

Real Consumption Expenditure by Rural Residents:

(1) $C_{Aj} = \gamma_{Aj} \cdot (1 - \overline{s}_{PA}) \cdot Y_{PA} / P_j$

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

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

Real Consumption Expenditure by Urban Residents:

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

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

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

Real Consumption Expenditure by Regional Government:

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

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

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

Real Consumption Expenditure by Central Regional Government:

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

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

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

Fixed Capital Formation:

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

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

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

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

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

Demand for Shanghai, ROC and World Goods:

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

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

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

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

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

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

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

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

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

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

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

Demand for Shanghai Exports by World:

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

Demand for Shanghai Exports to ROC: by ROC:

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

Supply for Shanghai Imports by World:

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

Supply for Shanghai Imports from ROC:

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

Foreign Capital Inflow:

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

Equilibrium Conditions:

Shanghai Products Markets:

(6) $DSD_i = DSS_i^S$ and $PDSS_i = PDSS_i^e$ $(PDSS_i^e\text{: } equilibrium\ price)$

Shanghai Export to ROC Markets:

(7) $EOD_i = EO_i^S$ and $PEOS_i = PEOS_i^e$ $(PEOS_i^e\text{: } equilibrium\ price)$

Shanghai Import from ROC Markets:

(8) $MOD_i = MO_i^S$ and $PMOD_i = PMOD_i^e$ $(PMOD_i^e\text{: } equilibrium\ price)$

Shanghai Export to World Markets:

(9) $E_i = E_i^S$ and $PE\$_i = PE\$_i^e$ $(PE\$_i^e\text{: } equilibrium\ price)$

Shanghai Import from World Markets:

(10) $M_i = M_i^S$ and $PM\$_i = PM\$_i^e$ $(PM\$_i^e\text{: } equilibrium\ price)$

Foreign Exchange market:

(11) $F\$ = \sum PM\$_i \cdot M_i - \sum PE\$_i \cdot E_i$ and $ER = \overline{ER}$ (exogenous in regional model)

GDP Identity:

(12) $E = \sum E_i$

(13) $EO = \sum EO_i$

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

(15) $M = \sum M_i$

(16) $MO = \sum MO_i$

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

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

$$= PC_A \cdot C_A + PC_N \cdot C_N + PGS \cdot GS + PGC \cdot GC + PI \cdot I$$
$$+ PE \cdot E - PM \cdot M + PEO \cdot EO - PMO \cdot MO$$
$$= \sum \left(PX_i - \sum P_j \cdot \overline{a}_{ji}\right) \cdot X_i^S + \sum \overline{tm}_i \cdot PM\$_i \cdot M_i \cdot ER + \sum \overline{te}_i \cdot PE\$_i \cdot ER \cdot E$$
$$+ \sum MOD_i \cdot PMOD_i + \sum EOD_i \cdot PEOS_i$$

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

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

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

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

Social Welfare:

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

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

Law of Walras:

(25)
$$\begin{aligned} & W_{LU} \cdot \left(L_U - \overline{L}_U^S\right) + W_W \cdot \left(L_W - \overline{L}_W^S\right) + R \cdot \left(\sum K_i - \overline{K}^S\right) + \sum PDS_i \cdot \left(DSD_i - DS_i^S\right) \\ & + \left[\sum PMOD_i \cdot \left(MOD_i - MO_i^S\right) + \sum PEOS_i \cdot \left(EOD_i - EO_i^S\right)\right] \\ & \quad + \sum PE\$_i \cdot \left(E_i - E_i^S\right) + \sum PM\$_i \cdot \left(M_i - M_i^S\right) \\ & + \left(S + F + FO - I^n\right) \\ & \quad + ER \cdot \left\{\sum PM\$_i \cdot M_i - \sum PE\$_i \cdot E_i - \overline{F\$}\right\} \equiv 0 \end{aligned}$$

Capital Stock Accumulation and Allocation for the Next Period:

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

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

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

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

$$\begin{aligned} & \mathit{where} \quad S + F + FO - I^n = \Delta M^D - \Delta M^S = M^D - M^S \\ & \quad \Delta M^D = M_t^D - M_{t-1}^D \quad \Delta M^S = M_t^S - M_{t-1}^S \quad M_{t-1}^D \equiv M_{t-1}^S \\ & \quad M^D / PGDP = \overline{M} \sigma \ GDP^{\psi} \quad M^S = \overline{M}^S \end{aligned}$$

* 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)

L_W^* = Total supply of skilled labor (in efficiency units)

$\overline{L}_U^S$ = Total supply of Un-skilled labor

$\overline{L}_W^S$ = Total supply of skilled labor

K_i = Capital stocks in industry i

K_i^S = Supply of capital stocks for industry i

$\overline{K}^S$ = 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 （$\overline{b}_{P_i}$ = rate）

IGS_i = Regional government investment demand for composite goods of I ($\overline{b}_{GS_i}$ = rate)

IGC_i = Central government investment demand for composite goods of I ($\overline{b}_{GC_i}$ = 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 ($\bar{s}_P =$ the rate of private savings)

$SGC =$ Central government savings ($\bar{s}_{GC} =$ the rate of central government savings)

$SGS =$ Regional government savings ($\bar{s}_{GS} =$ 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

$M^D =$ Demand for money (M_2)

$\overline{M}^S =$ Supply of money (M_2)

Parameters:

$\overline{A}_{T\,i} =$ Scale factor of CET (Domestic and world) transformation function for industry i

$\alpha_{ES\,i}, \alpha_{DS\,i} =$ Share parameters of CET transformation function for industry i

$\sigma_{Ti} =$ Elasticity of transformation in CET transformation function for industry i

$\rho_{T_i} = (\sigma_{T_i} - 1)/\sigma_{T_i}$

$\overline{A}_{TD\,i} =$ Scale factor of CET (Regional and ROC) transformation function for industry i

$\alpha_{EOS\,i}, \alpha_{DSS\,i} =$ Share parameters of CET transformation function for industry i

$\sigma_{TDi} =$ Elasticity of transformation in CET transformation function for industry i

$\rho_{TD_i} = (\sigma_{TD_i} - 1)/\sigma_{TD_i}$

$\overline{A}_{Qi} =$ Scale factor of CES (Domestic and world) composite goods function for industry i

$\alpha_{Mi}, \alpha_{Di} =$ Share parameters of CES composite goods function for industry i

$\sigma_{Qi} =$ Elasticity of composite goods in CES composite function for industry i

$\rho_{Q_i} = (\sigma_{Q_i} - 1)/\sigma_{Q_i}$

$\overline{A}_{Di}$ = 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

$\rho_{D_i} = (\sigma_{D_i} - 1) / \sigma_{D_i}$

$\overline{a}_{ij}$ = Intermediate input coefficient from industry i to industry j

$\overline{A}_{Li}$ = 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

$\rho_{L_i} = (\sigma_{L_i} - 1) / \sigma_{L_i}$

$\overline{A}_{Xi}$ = 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

$\rho_{X_i} = (\sigma_{X_i} - 1) / \sigma_{X_i}$

$\overline{M}_i^0$ = Scale factor of import supply function for idustry i

η_{Mi} = Price elasticity of import supply function for industry i

$\overline{MO}_i^0$ = Scale factor of import fron ROC supply function for industry i

η_{MOi} = Price elasticity of import from ROC supply function for industry i

$\overline{E}_i^0$ = Scale factor of export demand function for industry i

η_{Ei} = Price elasticity of export demand function for industry i

$\overline{EO}_i^0$ = Scale factor of export to ROC demand function for idustry i

η_{EOi} = Price elasticity of export to ROC demand function for industry i

$\overline{\gamma}_{Ai}, \overline{\gamma}_{Ni}$ =Share parameters of Cobb-Douglas utility function, rural and urban

$\overline{M}_0$ = 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:

$\overline{tm}_i$ = Import tariff rate of industry i

$\overline{tn}_i$ = Non-tariff barriers of industry i (tariff-equivalent rate)

$\overline{te}_i$ = Export subsidy rate of industry i

$\overline{td}_i$ = Indirect tax rate of industry i

$\overline{td}c_i, \overline{td}s_i$ = Central and regional indirect tax rate of industry i

$\overline{tylwc}, \overline{tylws}$ = Income tax rate of Central and regional government

$\overline{tyec}_L, \overline{tyes}_L$ = Property tax rate of central and regional government

$\overline{tyeha}, \overline{tyehn}$ = Income transfer rate of Enterprise to rural and urban households