Journal of Marine Science and Technology

Volume 19 | Issue 2 Article 2

THE IMPACT OF THE TAIPEI PORT CONTAINER TERMINAL ON THE NORTHERN REGION OF TAIWAN: A COMPUTABLE GENERAL EQUILIBRIUM MODEL

Wen-Sheng Chen
Department of Business Administration National Kaohsiung University of Applied Sciences; Department of Resources Engineering, National Cheng Kung University, Taiwan, R.O.C.

Chia-Yon Chen
Department of Resources Engineering, National Cheng Kung University, Taiwan, R.O.C.

Feng-Chin Chen
Department of Innovation Management, Aletheia University, Taiwan, R.O.C., fcchen@mt.au.edu.tw

Chun-Chu Liu
Department of International Business, Chang Jung Christian University, Taiwan, R.O.C.

Recommended Citation
Chen, Wen-Sheng; Chen, Chia-Yon; Chen, Feng-Chin; and Liu, Chun-Chu (2011) "THE IMPACT OF THE TAIPEI PORT CONTAINER TERMINAL ON THE NORTHERN REGION OF TAIWAN: A COMPUTABLE GENERAL EQUILIBRIUM MODEL," *Journal of Marine Science and Technology*: Vol. 19: Iss. 2, Article 2.
DOI: 10.51400/2709-6998.2145
Available at: https://jmstt.ntou.edu.tw/journal/vol19/iss2/2

THE IMPACT OF THE TAIPEI PORT CONTAINER TERMINAL ON THE NORTHERN REGION OF TAIWAN: A COMPUTABLE GENERAL EQUILIBRIUM MODEL

Wen-Sheng Chen*, Chia-Yon Chen**, Feng-Chin Chen***, and Chun-Chu Liu****

Key words: computable general equilibrium, social accounting matrix.

ABSTRACT

There are some primary modelling tools, including econometric forecasting models, fixed price input-output (I-O) multi-sector models, social accounting matrix (SAM) and computable general equilibrium (CGE) models, used to analyse regional economic issues. CGE models combine the advantages of econometric, I-O models and SAM, strengthening the theoretical basis of the modelling effort and thus enabling more precise policy analysis. Current CGE literature includes models used to analyse international trade, tax reform, energy and environment issues. However, application of this technique on a regional scale is rare in the scientific literature. In this paper, a small regional computable general equilibrium model is constructed and applied to analyse the economic impact of constructing Taipei Port Container Terminal (TPCT) locating in northern Taiwan. The research results provide a valuable reference for decision-makers in formulating ocean shipping and regional policies, as well as helping business managers with strategic planning.

I. INTRODUCTION

Impact analysis can be defined as an assessment of change in overall economic activity as a rule of some special change in one or several economic activities [21]. Impact analysis in a region focuses on interaction between economic policy changes and the implications of these changes for the local economy. In particular, it may reflect local or national concern about the effect of change on a variety of actors or agents within the local economy, such as specific socioeconomic groups, specific sectors, or specific locations. Changes in the level and distribution of local employment, income, sales, and wealth are often the target of analysts in the context of regional planning [38].

There are several tools available to the analyst to assess regional impacts of programmes. For example, partial equilibrium models (export-base models, benefit-cost analysis and econometric models) and general equilibrium models (I-O model, SAM model, and CGE model) may be used. Partial equilibrium models are limited in their analytical approach because they often focus on specific sectors, thus ignoring the larger economy-wide effects. Unlike partial equilibrium models, general equilibrium models account for the interindustry linkages in an economy and is viewed as a more appropriate framework for conducting economic impact analysis. General equilibrium models can be categorized into fixed-price models (I-O models and SAM models) and flexible price modes (CGE models). It is critical to the relative accuracy of estimates from the above two general equilibrium models. Fixed-price I-O models and SAM models provide an internally consistent representation of regional economic structure. However, this consistency is arguably more realistic and explicit in CGE than in either I-O or SAM.

CGE analysis has been applied to a wide range of policy issues, which include, among others, income distribution [17, 42], trade policy [4, 5, 20, 41], development strategy [1], taxes, long-term growth and structural change [10, 31]. However, most computable general equilibrium models have been used to capture the effects of policies and economic shocks at the national level. Recently, CGE models have been proposed as an alternative analytical tool for policy analysis on a regional scale [2, 18, 19, 22, 23, 25-29, 34-36].

In Taiwan, I-O models are the most common application of general equilibrium techniques used for regional economic impact analysis. Relatively few CGE models have been de-

Paper submitted 05/19/09; revised 10/23/09; accepted 11/12/09. Author for correspondence: Feng-Chin Chen (e-mail: fcchen@mt.au.edu.tw).
**Department of Business Administration National Kaohsiung University of Applied Sciences; Department of Resources Engineering, National Cheng Kung University, Taiwan, R.O.C.*
***Department of Resources Engineering, National Cheng Kung University, Taiwan, R.O.C.*
****Department of Innovation Management, Aletheia University, Taiwan, R.O.C.*
*****Department of International Business, Chang Jung Christian University, Taiwan, R.O.C.*

veloped in the Taiwan context [8, 26, 43]. Even fewer have been devoted to enquiring about the economic impact of local important investment on a small regional scale in Taiwan. This study attempts to fill this gap by developing a CGE model of the north Taiwan regional economy. CGE models allow for more flexibility and are more consistent with neoclassical economic theory and, thus, may generate less biased estimates when compared with other modelling techniques [39]. The CGE approach permits prices of inputs to vary with respect to changes in output prices and, thus, allows one to capture the behaviour of economic agents. It incorporates a variety of flexible production functions that allow producers to substitute cheaper inputs for more expensive inputs. This approach can also accommodate constraints on the availability of primary inputs and accounts for additional intersectoral linkages. For example, if factors of production are limited in supply, the expansion in some sectors will draw factors of production from other sectors thereby causing a contraction in those industries.

CGE models have been proposed as an alternative analytical tool for policy analysis on a regional scale and are the focus of this paper. Seung *et al.* (2000) contend that a regional CGE model is more theoretically grounded than supply-determined I-O models for impact analysis, where the productive capacity of sectors is reduced in a regional economy. They conclude that although supply-determined or mixed endogenous-exogenous SAM models are appropriate for addressing income distribution issues and are relatively easy to implement, they suffer from limited flexibility by assuming fixed prices and ignoring substitution effects in production and consumption. CGE models provide the flexibility necessary for improving analysis of a regional economy by overcoming the restrictive assumptions contained in I-O and SAM models. In a CGE model, prices adjust to clear markets of outputs and factors of production.

The organization of the paper is as follows. In the next section the computable general equilibrium model is briefly described. Thereafter, the data sources and simulation results are presented and discussed. The final section gives a summary and conclusions.

II. MODEL FORMULATION

In recent years, a growing number of researchers have begun to use the computable general equilibrium models to analyse the impacts of regional policies. Therefore, in analysing the impacts of constructing TPCT locating in northern Taiwan, a computable general equilibrium approach is generally considered an appropriate tool. In the northern Taiwan CGE (NTCGE) model, there are two economic regions, northern Taiwan and the rest of the world, which includes Taiwan and all other countries. Economic agents operating in the two regions consist of producers, private households, local government and central government.

The computable general equilibrium model used is a static model, which follows closely the Dervis *et al.* (1982) tradition. Modifications include alternative function forms for production technology and disaggregate household groups. In the computable general equilibrium model, the Taiwan economy is divided into 14 sectors: (1) agriculture (i.e. agriculture, forestry and fishing), (2) mining, (3) processed food, (4) other chemical products, (5) petroleum refineries, (6) iron and steel, (7) electrical and electronic machinery, (8) precision instruments, (9) other manufacturing, (10) construction, (11) electricity, gas and water (12) transport, (13) trade and eating-drinking places, and (14) finance, services and others. Five equal divisions of household are specified, using the classifications from The Report on the Survey of Family Income and Expenditure in Taiwan Area [12]. A disaggregate social accounting matrix given in Table 1 is designed to reflect the circular flow of the northern Taiwan economy that is embodied in northern Taiwan's computable general equilibrium model is outlined below. The model is composed of production and factor markets, expenditure and income, foreign exchange market, prices, market equilibrium and macro close rule. The following paragraphs provide a general description of northern Taiwan's computable general equilibrium model. The production process is assumed to be a two- stage process. In the first stage, producers select optimal quantities of capital and labor, using a Cobb-Douglas (C-D) production function [39]. In the second stage, firms choose intermediate inputs in combination with primary inputs using a fixed-proportion Leontief production technology. Other production technologies may be used at this stage. However, in most regional applications, the Leontief production technology is the preferred choice [32]. Factor demands are derived from first-order conditions, using a conventional profit maximization approach. Labor and capital factors are perfectly mobile between economic sectors and are fully employed in the base year. The model has five household groups; for each household group there is a representative consumer who determines his consumption behavior from utility maximization. The consumer preferences are characterized by a Cobb-Douglas utility function for each representative consumer; this allows for different marginal budget shares for the five household groups. The household budget account constitutes income revenue and expenditure. The main sources of household income revenue include labor income, distributed profits, government transfer and net transfer from abroad. Each household expenditure is allocated to private consumption, direct taxes and private saving. The two levels of government accounted for in the model are local and central government. Government actions have a significant influence on the economy through its income revenue and spending changes. The main sources of government revenues include indirect taxes, tariffs, enterprise taxes and direct taxes. Government spending constitutes government consumption, transfer to enterprise, transfer to household and government saving. Our model assumes government income revenue equal to income spending. The enterprise in this model includes private companies, public companies and

Table 1. Structure of a social accounting matrix for Northern region in Taiwan.

2004 (million NT)

	Expenditures	**Factors**			**Institutions**				
Receipts	Activities	Commodities	Labor	Capital	Enterprises	Households	Government		Rest of world
Activities		Domestic sales 8,041,768							Exports 1,865,508
Commodities	Intermediate inputs 5,810,828					Private consumption 2,551,468	Government consumption 566,708	Investment 972,654	
Factors									
Labor	Wages 2,093,400								Net labor income from abroad -9,174
Capital	Rentals 1,383,508								Net capital income from abroad 20,466
Institutions									
Enterprises				Capital income 1,403,974		Government transfers 107,824			
Households			Labor Income 2,084,226		Distributed profits 1,161,362	Household transfer 93,218	Government transfers 14,606		Net transfer from abroad 62,398
Government	Indirect taxes 216,838	Tariffs 40,932			Enterprise taxe 159,674	Direct taxes 270,362			Net transfer from abroad 280
Capital account	Capital depreciation 402,702				Retained earnings 190,762	Private saving 461,784	Government saving -2,050		Net foreign borrowing -80,544
Rest of world		Imports 1,818,958				Foreign transfer 38,978	Foreign transfer 998		

Source: DGBAS (2004).

nonprofit enterprise, using the aggregate catalogue of National Income in Taiwan Area [12]. The main sources of enterprise revenues include capital income, government transfer and net transfer from abroad. Main enterprise outlays include distributed profits, enterprise taxes and retained earnings. It is also assumed that enterprise income revenues equal to outlays. In this model, small-open-economy assumptions are made, implying that northern Taiwan cannot affect world price with its exports and imports. The model assumes a floating exchange rate mechanism and contains a balance-of-trade constraint. The value of total exports includes export trade, net labor income from abroad, net capital income from abroad, net transfer from abroad to enterprise and net transfer from abroad to household. The value of total imports consists of import trade and net foreign borrowing. The model assumes imperfect substitution between imports and domestic goods, using the Armington constant elasticity of substitution function form [3]. Thus, the import demand for a specific sector becomes derived demand. On the export side, the export demand for a specific commodity depends on the world price of exported goods measured in foreign exchange units relative to the price level of domestic goods. In a market equilibrium condition, we assume that the total supply of commodities equals the total demand for commodities. As stated previously, total supply of composite commodities is a CES combination of domestic goods and imports. Total demand consists of intermediate inputs, private consumption, government consumption and investment. Finally, according to Rickman (1992), the results of neoclassical closure in a regional context often are more consistent with econometric models. Hence, the neoclassical closure is adapted in the NTCGE. In the computable general equilibrium model, the system can only determine relative prices, and solve for prices relative to a numeraire. Because the NTCGE is a regional model, the exchange rate is used as the numeraire good, following Sullivan *et al*. (1997).

III. REGION, DATA SOURCES, CALIBRATION, AND ELASTICITY SPECIFICATION

The northern region of Taiwan is composed of seven distinct counties or cities: Taipei city, Taipei county, Keelung city, Taoyuan County, Hsinchu city, Hsinchu county, and Yilan County. This model is calibrated for the 2004 base year data set. The data on the Taiwan economy are organized into a

Table 2. Simulation of regional output, export, import at TPCT construction phase.

(million NT)

sector	output			export			import		
	base	Simulation	± %	base	Simulation	± %	base	Simulation	± %
agriculture	60,227	60,293	0.11	26,326	26,470	0.55	19,923	19,972	0.25
mining	36,708	35,717	2.70	4,980	4,914	1.31	25,570	25,358	0.83
processed food	26,258	24,216	3.26	19,675	19,350	1.65	18,334	18,196	0.75
other chemical products	421,052	422,820	0.42	214,504	215,319	0.38	104,936	105,198	0.25
Petroleum refineries	803,642	819,956	2.03	212,491	213,050	2.63	144,376	144,669	2.03
iron and steel	94,948	109,238	15.05	24,938	29,115	16.75	165,882	180,977	9.10
electronics and relatives	963,496	1,019,378	5.80	740,530	788,738	6.51	260,896	272,245	4.35
Precision machinery	592,656	598,701	1.02	388,960	392,655	0.95	138,020	139,055	0.75
other manufacturing	2,173,108	2,070,102	4.74	660,640	634,941	3.89	178,670	171,362	4.09
construction, civil engineering	717,508	838,408	16.85	63,804	74,797	17.23	21,048	24,190	14.93
electricity, gas and water	328,748	340,517	3.58	17,974	18,564	3.28	792	807	1.91
transportation	482,126	504,159	4.57	82,910	86,392	4.20	100,512	103,457	2.93
Wholesale, retail, and food services	970,586	1,034,159	6.55	258,178	269,021	6.38	182,110	189,758	4.20
finance, services and others	2,236,210	2,305,533	3.10	89,600	92,306	3.02	557,886	574,623	3.00

social accounting matrix. A disaggregate social accounting matrix combines the input-output table [12] with the national income accounting. Therefore, disaggregate social accounting matrix is based on the national income accounting, and input-output data is adjusted for consistency. In addition to the data in the input-output table and national income accounting, the database for our computable general equilibrium model includes labor, capital, income distribution matrix, various elasticities, and other parameters. The labor and capital data are from the Year Book of Manpower Statistics [12] and Trends in Multifactor Productivity [12]. A multi-sector income distribution matrix is transformed income flows between industry and the five equal divisions of household. This matrix is from The Report of Survey of Family Income and Expenditure [12]. In order to model production technology, composite commodities and the export demand function, we need a variety of elasticities. Elasticities of production technology are constructed on the basis of the elasticities used in Burniaux *et al.* (1992) and Lin (1998). Following Chu (1996) we set the elasticity between domestic and imported goods and elasticity of export demand function. Calibrating against a benchmark equilibrium data set derived from the above considerations numerically specifies other parameters in this model. Simulation results are generated using the GAMS program [6].

IV. RESULTS

Analysing the impact of the establishment of TPCT on the northern region in Taiwan's economy is performed in two stages. The first stage simulates the economic impact of the TPCT construction phase. The second looks at the economy of the TPCT when it is up and running. The construction planning of TPCT is to be implemented in two stages: the first stage was from May 2003 to December 2008, and the development area was 31.6 hectares; the second stage runs from January 2009 to December 2014 with a further 79.3 hectares of development area. The total area developed covers 110.9 hectares. The anticipated construction cost of TPCT is 20.315 billion NT dollars, and the majority of the cost is in planning application fees, construction costs, and maintenance and operation costs. It is estimated the sales by TPCT in 2009 will reach 1021 million NT dollars, and 5238 million NT dollars by 2014. Scenario 1, showing at the Tables 2-4, output effects reveal that the most impacted industries in northern Taiwan are iron and steel, civil engineering, other manufacturing industries, and service industries, which account for 28% of the total output variation in northern Taiwan. Industries having the strongest employment effects in northern Taiwan are the iron and steel industry, civil engineering, other manufacturing industries, wholesale and retail industry, and the food service industry, which claim 36% of the total employment effect in northern Taiwan. The industries having the greatest income effects in northern Taiwan are the iron and steel industry, other manufacturing industry, and the service industry, which explains 33% of total income effect in northern Taiwan.

Scenario 2, revealing in the Tables 5-6, output effects reveal that the export-oriented industries, which are induced and facilitated by TPCT for cargo shipping, having the largest output effect in northern Taiwan are the electronics and mechanical equipment manufacturing industry (IC, computers and peripheral equipment Mfg,, logistics and telecommunications), precision machinery manufacturing industry, and the iron and steel industry, which account for 73% of the total output effect in northern Taiwan. Employment effects in northern Taiwan are mainly observed in the electronics and mechanical equipment manufacturing industry (IC, computer

Table 3. Simulation of investment impact on employment, wages at TPCT construct phase.

(million NT)

sector	employment			wages		
	base	Simulation	± %	base	Simulation	± %
agriculture	507,362	508,072	0.14	114,724	114,322	-0.35
mining	22,352	21,748	-2.70	8,234	7,961	-3.31
processed food	84,700	81,939	-3.26	33,860	32,624	-3.65
other chemical products	60,342	60,203	-0.23	21,144	21,017	-0.60
petroleum refineries	5,138	5,251	2.20	5,250	5,299	0.93
iron and steel	24,336	28,047	15.25	13,482	15,336	13.75
electronics and relatives	44,300	45,540	2.80	15,924	16,235	1.95
precision machinery	195,082	195,901	0.42	53,994	53,702	-0.54
other manufacturing	1,013,622	925,031	-8.74	450,940	407,695	-9.59
construction, civil engineering	314,886	371,093	17.85	120,834	154,945	28.23
electricity, gas and water	26,616	27,393	2.92	25,446	26,011	2.22
transportation	249,628	256,043	2.57	125,214	127,743	2.02
wholesale, retail, and food services	893,034	912,234	2.15	273,824	279,656	2.13
finance, services and others	1,773,856	1,835,941	3.50	830,526	858,930	3.42

Table 4. Simulation of regional economic impact at TPCT construction phase.

(million NT)

Regional GDP	base	simulation	± %
+consumption	2,551,468	2,577,493	1.02
+investment	972,654	992,593	2.05
+government	566,708	629,896	11.15
+export	1,865,508	1,791,820	-3.95
-import	1,818,958	1,943,557	6.85
total	4,137,380	4,048,245	-2.29

Table 5. Simulation of regional output, export, import at TPCT operation phase.

(million NT)

Sector	output			export			import		
	base	Simulation	± %	base	Simulation	± %	base	Simulation	± %
agriculture	60,227	60,588	0.60	26,326	26,468	0.54	19,923	20,046	0.62
mining	36,708	35,897	-2.21	4,980	4,970	-0.20	25,570	25,621	0.20
processed food	26,258	25,436	-3.13	19,675	18,893	-3.97	18,334	17,769	-3.08
other chemical products	421,052	452,126	7.38	214,504	229,755	7.11	104,936	112,586	7.29
petroleum refineries	803,642	853,629	6.22	212,491	224,454	5.63	144,376	153,515	6.33
iron and steel	94,948	100,379	5.72	24,938	26,357	5.69	165,882	175,254	5.65
electronics and relatives	963,496	1,055,992	9.60	740,530	808,288	9.15	260,896	283,724	8.75
precision machinery	592,656	645,699	8.95	388,960	422,994	8.75	138,020	149,958	8.65
other manufacturing	2,173,108	2,046,850	-5.81	660,640	625,295	-5.35	178,670	172,327	-3.55
construction, civil engineering	717,508	692,395	-3.50	63,804	61,539	-3.55	21,048	20,391	-3.12
electricity, gas and water	328,748	336,967	2.50	17,974	18,384	2.28	792	811	2.45
transportation	482,126	529,615	9.85	82,910	90,728	9.43	100,512	110,119	9.56
wholesale, retail and food services	970,586	1,028,627	5.98	258,178	272,765	5.65	182,110	191,852	5.35
finance, services and others	2,236,210	2,428,524	8.60	89,600	97,171	8.45	557,886	603,744	8.22

Table 6. Simulation of investment impact on employment, wages at TPCT operation phase.

(million NT)

sector	employment			wages		
	base	Simulation	± %	base	Simulation	± %
agriculture	507,362	510,812	0.68	114,724	115,539	0.71
mining	22,352	21,800	-2.47	8,234	8,032	-2.45
processed food	84,700	81,430	-3.86	33,860	32,539	-3.90
other chemical products	60,342	61,446	1.83	21,144	21,567	2.00
petroleum refineries	5,138	5,354	4.20	5,250	5,468	4.16
iron and steel	24,336	25,346	4.15	13,482	14,035	4.10
electronics and relatives	44,300	48,198	8.80	15,924	17,190	7.95
Precision machinery	195,082	211,508	8.42	53,994	58,606	8.54
Other manufacturing	1,013,622	945,912	-6.68	450,940	423,478	-6.09
construction, civil engineering	314,886	301,471	-4.26	120,834	115,638	-4.30
electricity, gas and water	26,616	27,553	3.52	25,446	26,370	3.63
transportation	249,628	269,973	8.15	125,214	135,381	8.12
wholesale, retail, and food services	893,034	993,667	4.55	273,824	286,228	4.53
finance, services and others	1,773,856	1,895,542	6.86	830,526	887,168	6.82

Table 7. Simulation of the regional economic impact at TPCT operation phase.

(million NT)

Regional GDP	base	simulation	± %
+consumption	2,551,468	2,655,568	4.08
+investment	972,654	1,094,236	12.50
+government	566,708	595,157	5.02
+export	1,865,508	2,024,636	8.53
-import	1,818,958	1,992,850	9.56
total	4,137,380	4,376,747	5.79

and peripheral equipment Mfg., logistics and telecommunications), the precision machinery manufacturing industry, and then in the commerce and service industry. Industries subject to the greatest income effect in northern Taiwan are the same as those subject to the employment effect.

V. CONCLUSIONS

A regional computable general equilibrium model is constructed and is applied to analyse the economic impact of the establishment of TPCT on the northern region in Taiwan's economy. Construction of the model required the following steps. Reviewing the current literature on regional impact models, describing the model in detail, and collecting and reconciling data to fit the model, and completing the simulation analysis. The limitations to this model concern the assumptions about the functional form of the behavior of economic agents in consumption, production, and so on; additional research is needed to relax these assumptions. Therefore, this study's simulation results are only a first step in policy making. Further results need more detailed calculations and judgments.

REFERENCES

1. Adams, P. D. and Parmenter, B. R., "An applied general equilibrium analysis of the economic effects of tourism in a quite small, quite open economy," *Applied Economics*, Vol. 27, pp. 985-994 (1995).
2. Alavalapati, J., White, W., and Patriquin, M., "Economic impacts of changes in the forestry sector: A case study of the Foothills Region in Alberta," *Forestry Chronicle*, Vol. 75, pp. 121-127 (1999).
3. Armington, P., "A theory of demand for products distinguished by place of production," *IMF Staff Papers*, Vol. 16, pp. 159-178 (1969).
4. Augier, P. and Gasiorek, M., "The welfare implications of trade liberalization between the Southern Mediterranean and the EU," *Applied Economics*, Vol. 35, pp. 1171-1190 (2003).
5. Boyd, R. G., Krutilla, K., and McKinney, J., "The impact of tariff liberalization between the United States and Mexico: An empirical analysis," *Applied Economics*, Vol. 25, pp. 81-90 (1993).
6. Brook, A., Kendrick, D., and Meeraus, A., *GAMS: A User's Guide*, The Scientific Press, South San Francisco (1992).
7. Burniaux, J. M., Martin, J. P., Nicoletti, G., and Martins, J. O., "GREEN: A multi-sector, multi-region dynamic general equilibrium model for

quantifying the costs of cubing CO2 emissions: a technical manual," *Economics Department Working Papers*, No. 116, OECD, Paris (1992).
8. Chou, J., Kuo, N. F., and Peng, S. L., "Potential impacts of the SARS outbreak on Taiwan's economy," *Asian Economic Papers*, Vol. 3, pp. 84-95 (2004).
9. Chu, Y. P., "Effects of trade liberalization on Taiwan's economy: A computable general equilibrium model," *ISSP Working Paper*, Academia Sinica, Taipei, Taiwan (1996).
10. Conrad, K., "An econometric model of production with endogenous improvement in energy efficiency, 1970-1995," *Applied Economics*, Vol. 32, pp. 1153-1160 (2000).
11. Dervis, K., De Melo, J., and Robinson, S., *General Equilibrium Models for Development Policy*, Cambridge University Press, Cambridge (1982).
12. Directorate-General of Budget, Accounting, & Statistics (DGBAS), *The Report on the Survey of Family Income and Expenditure in Taiwan Area*, Executive Yuan, Taiwan (2004).
13. Directorate-General of Budget, Accounting, & Statistics (DGBAS), *National Income in Taiwan Area*, Executive Yuan, Taiwan (2004).
14. Directorate-General of Budget, Accounting, & Statistics (DGBAS), *Input-Output Table*, Executive Yuan, Taiwan (2004).
15. Directorate-General of Budget, Accounting, & Statistics (DGBAS), *Year book of Manpower Statistics*, Executive Yuan, Taiwan (2004).
16. Directorate-General of Budget, Accounting, & Statistics (DGBAS), *The Trend in Multifactor Productivity*, Executive Yuan, Taiwan (2004).
17. Hanson, K. and Rose, A., "Factor productivity and income inequality: A general equilibrium analysis," *Applied Economics*, Vol. 29, pp. 1061-1071 (1997).
18. Harrigan, F. and McGregor, P. G., "Neoclassical and Keynesian perspectives on the regional macroeconomy: A computable general equilibrium approach," *Journal of Regional Science*, Vol. 29, pp. 555-573 (1989).
19. Hoffman, S., Robinson, S., and Subramanian, S., "The role of defense cuts in the California recession: computable general equilibrium models and interstate factor mobility," *Journal of Regional Science*, Vol. 36, pp. 571-595 (1996).
20. Hosoe, N., "Crop failure, price regulation and emergency imports of Japan's rice sector in 1993," *Applied Economics*, Vol. 36, pp. 1051-1056 (2004).
21. IMPLAN Group, *User's Guide: IMPLANPro Social Accounting and Impact Analysis Software*, IMPLAN, Stillwater, MN (2005).
22. Jones, R. and Whalley, J., "A Canadian regionalgeneral equilibrium model and some applications," *Journal of Urban Economics*, Vol. 25, pp. 368-404 (1989).
23. Koh, Y., "Analysis of Oklahoma's boom and bust economy by means of a CGE model," Unpublished Ph.D. Dissertation, Oklahoma State University, Stillwater, Oklahoma (1991).
24. Lin, S. M., "Fuel taxes in Taiwan: Welfare impacts on regional and socioeconomic groups," *Academia Economic Papers*, Vol. 26, pp. 71-100 (1998).
25. Liu, C. C. "A study on the construction and application of regional computable general equilibrium model: The case of southern region in Taiwan," Unpublished Ph.D. Dissertation, Department of Resources Engineering, National Cheng Kung University, Tainan, Taiwan (2005).
26. Liu, C. C. "A computable general equilibrium model of the southern region of Taiwan: The impact of the Tainan science-based industrial park," *Applied Economics*, Vol. 38, pp. 1655-1661 (2006).
27. Park, I., *Regional Integration Among the ASEAN Nations: A Computable General Equilibrium Model Study*, Praeger Publishers, Westport, CT (1995).
28. Partridge, M. D. and Rickman, D., "Regional computable general equilibrium modeling: A survey and critical appraisal," *International Regional Science Review*, Vol. 21, pp. 205-248 (1998).
29. Patriquin, N., Alavalapati, R. R., Wellstead, M.,Young, M., Adamowicz, L., and White, A., "Estimating impacts of resource management policies in the Foothills Model Forest," *Canadian Journal of Forest Research*, Vol. 33, pp. 147-155 (2003).
30. Philippidis, G. and Hubbard, L. J., "Modelling hierarchical consumer preferences: An application to global food markets," *Applied Economics*, Vol. 35, pp. 1679-1687 (2003).
31. Piazolo, D., "Investment behaviour in transition countries and computable general equilibrium models," *Applied Economics*, Vol. 33, pp. 829-837 (2001).
32. Rickman, D. S., "Estimating the impacts of regional business assistance programs: Alternative closures in a computable general equilibrium model," *Papers in Regional Science*, Vol. 71, pp. 421-435 (1992).
33. Sattar, Z., "Privatizing public enterprises in Bangladesh: A simulation analysis of macroeconomic mpacts," *Applied Economics*, Vol. 21, pp. 1159-1176 (1989).
34. Schreiner, D. F. and Marcouiller, D. W., *Computable General Equilibrium Modeling for Regional Analysis*, West Virginia University, Web Book (1999).
35. Schwarm, W. and Cutler, H., "Building small city and town SAM and CGE model," *Review of Urban & Regional Development Studies*, Vol. 15, pp. 132-147 (2003).
36. Seung, C. K., Harris, T., and MacDiarmid, T., "Economic impacts of surface water reallocation policies: A comparison of supply determined SAM and CGE models," *The Journal of Regional Analysis and Policy*, Vol. 27, pp. 55-76 (2000).
37. Seung, C. K. and Kraybill, D. S., "Tax incentives in an economy with public goods," *Growth and Change*, Vol. 30, pp. 128-147 (1999).
38. Shaffer, R., *Community Economics: Economic Structure and Change in Smaller Communities*, Iowa State University Press, Iowa (1989).
39. Shoven, J. B. and Whalley, J., *Applying General Equilibrium*, Cambridge University Press, Cambridge (1992).
40. Sullivan, J., McCollum, W. D., and Alward, S. G., "Regional CGE models based on IMPLAN social Accounts: experiments in Arizona and New Mexio," Paper Presented at the Annual Meetings of the Southern Regional Science Association, Memphis, TN, April 17-19 (1997).
41. Tongzon, J. L., "China's membership in the World Trade Organization (WTO) and the exports of the developing economies of East Asia: A computable general equilibrium approach," *Applied Economics*, Vol. 33, pp. 1943-1959 (2001).
42. Yang, H. Y. "Carbon-reducing taxes and income inequality: General equilibrium evaluation of alternative energy taxation in Taiwan," *Applied Economics*, Vol. 32, pp. 1213-1221 (2000).
43. Yang, H. Y., "Carbon emissions control and trade liberalization: Coordinated approaches to Taiwan's trade and tax policy," *Energy Policy*, Vol. 29, pp. 725-734 (2001).