The Empirical Economics Letters, 5(1): (January 2006)

Evaluating the Impacts of Tainan Science-Based Industrial Park on the Southern Region in Taiwan

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Abstract: In this paper, the three most common regional impact analysis models- Input-Output (I-O), Social Accounting Matrix (SAM), and Computable General Equilibrium (CGE) model - were constructed and applied to analyze the economic impact of constructing Tainan Science-Based Industrial Park (TSBIP) locating in the Southern Taiwan. Model results show that the impacts of the program on the regional economy were marginal in terms of output, income, and employment. In general, the SAM yielded the largest impact estimate followed by I-O, with the CGE yielding the smallest change. The research results provide a valuable reference for decision-makers in formulating industrial and regional policies, as well as helping business managers with strategic planning.

Keywords: Input-Output Model, Social Accounting Matrix, Computable General Equilibrium, Taiwan, Tainan Science-Based Industrial Park

JEL classification Number: D58

1. 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 (IMPLAN Group, 1996). 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 group, 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 (Shaffer, 1989). There are several tools available to the analyst assess regional impacts of programs. 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 analytic approach because they are often focus on specific sectors, thus ignoring the larger economy-wide effects. Unlike partial equilibrium models, a general equilibrium models account for the interindustry linkages in an economy and is viewed as 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.

In Taiwan, I-O model is the most common application of general equilibrium techniques used for regional economic impact analysis. Recently, CGE model has been proposed as an alternative analytical tool for policy analysis on a regional scale (Seung et al., 2000; Alavalapati et al., 1999; Schreiner and Marcouiller, 1999; Partridge and Rickman, 1998; Park, 1995; Harrigan and McGregor, 1989). However, little attention has been devoted to inquiring about the economic impact analyze of importance investment on a regional scale in Taiwan. 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 modeling techniques (Shoven and Whalley 1992). The CGE approach permits prices of inputs to vary with respect to changes in output prices and, thus, allows it to capture the behavior 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.

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

2. Model Formulation

The three general equilibrium model used in this study share many similarities in basic accounting structure. In particular, the I-O model is imbedded in the SAM. Therefore, all the sectoral and institutional accounts present in the I-O are also part of the SAM model of the same economy. The SAM is also the initial starting point for building a CGE structure of the economy under consideration.

2.1 Southern Taiwan I-O and SAM

In I-O model, households provide factors of production, receive income, and make expenditures on final goods and services. However, the SAM makes the linkage between household income earned from firms and resulting household spending much more explicit, partially by accounting for so-called leakages such as savings and taxes. Further, interactions with other institutional accounts supplement these household activities in SAM models. Hence, by using more information, a SAM model may provide a more detailed picture of the structure of an economy than an I-O (Rose et al., 1992). The main disadvantage of the SAM is its more extensive data requirements and the fact that a SAM is based on similar restrictive assumptions as an I-O, such as fixed relative price. The structural relationships of the I-O and SAM accounts in the models as shown in table 1 is therefore a necessary starting point for use of both regional models.

2.2 The Structure of Southern Taiwan Computable General Equilibrium (STCGE)

CGE model is based on a SAM structure but has been less frequently utilized than either the I-O model or SAM model. A CGE is a system of simultaneous, empirically, and numerically solvable economy-wide model of equilibrium prices and quantities in all markets. In recent years, a growing number of researchers have begun to use the computable general equilibrium models to analyze the impacts of regional policies (Seung et al., 2000; Alavalapati et al., 1999; Schreiner and Marcouiller, 1999; Partridge and Rickman, 1998; Park, 1995; Harrigan and McGregor, 1989). Therefore, in analyzing the impacts of constructing TSBIP locating in the Southern Taiwan, a computable general equilibrium approach is generally considered an appropriate tool. In the Southern Taiwan

CGE (STCGE) model, there are two economic regions, Southern Taiwan and the rest of the word, which includes the 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 in 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 & steel, (7) electrical & electronic machinery, (8) precision instruments, (9) other manufacturing, (10) construction, (11) electricity, gas & water (12) transport, (13) trade & eating-drinking places, and (14) finance, service and others. The five equal divisions of household are specified, using the classification of The Report on the Survey of Family Income and Expenditure in Taiwan Area (DGBAS, 1999). A disaggregate social accounting matrix given in Table 1 is designed to reflect the circular flow of the Southern Taiwan economy that is embodied in Southern 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 Southern Taiwan's computable general equilibrium model. The production process is assumed to take place in a two-stage process. In the first stage, producers select optimal quantities of capital and labour, using Cobb-Douglas (C-D) production function (Shoven and Whalley, 1992). In the second stage, firms choose the intermediate inputs in combination with the primary inputs using a fixed-proportion Leontief production technology. Other production technology may be used at this stage. However, in most regional applications, the Leontief production technology is the preferred choice (Rickman, 1992). Factor demands are derived from first-order conditions, using a conventional profit maximization approach. Labour 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 Cobb-Douglas utility function for each representative consumer, this allows for different marginal budget shares for five household groups. The household budget account constitutes income revenue and expenditure. The main sources of household income revenue include labour 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 nonprofit enterprise, using the aggregate catalogue of National Income in Taiwan Area (DGBAS, 1999). 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 held, it implies that Southern Taiwan cannot affect world price with its exports and imports. The model assumes float exchange rate mechanism and contains a balance-of-trade constraint. The value of total exports includes export trade, net labour 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 (Armington, 1969). Thus, the import demand for a specific sector becomes derive 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 price level of domestic goods. In a market equilibrium condition, we assume that the total supply of commodities equals the total demand for the commodities. As stated previously, total supply of composite commodities is a CES combination of domestic goods and imports. Total

Table 1. Structure of a social accounting matrix for Southern Region in Taiwan, 1999 (million NT)

	Expenditures								
			Factors		Institutions				
Receipts	Activities	Commodities	Labour	Capital	Enterprises	Households	Government		Rest of World
Activities		Domestic Sales 4020884							Exports 932754
Commodities	Intermediate Inputs 2905414					Private Consumption 1275734	Government Consumption 283354	Investment 486327	
Factors:									
Lobour	Wages 1046700								Net labour income from abroad -4587
Capital	Rentals 691754								Net capital income from abroad 110233
Institutions:									
Enterprises				Capital Income 701987			Government Transfers 50997		

Table 1 continued

Households			Labour Income 1042113	Distributed Profits 580681	Household Transfer 46609	Government Transfers 7303	Net transfer from Abroad 31199
Government	Indirect Taxes 108419	Tariffs 20466		Enterprise Taxes 79837	Direct Taxes 132266		Net transfer from abroad 140
Capital Account	Capital Depreciation 201351			Retained Earnings 95381	Private Saving 230892	Government Saving -1024	Net foreign borrowing -40272
Rest of world		Imports 909479			Foreign Transfer 19489	Foreign Transfer 499	

Source: DGBAS (1999)

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 STCGE. In the computable general equilibrium model, the system can only determine relative prices, and solve for prices relative to a numeraire. Because the STCGE is a regional model, the exchange rate is used as the numeraire good, following Sullivan et al., (1997).

3. Region, Data Sources, Calibration and Elasticity Specification

Southern region in Taiwan is composed of eight distinct county or city: Chiayi city, Chiayi county, Tainan city, Tainan county, Kaohsiung city, Kaohsiung county, Pingtung County and Penghu County. This model is calibrated for the 1999 base year data set. The data on the Taiwan economy are organized into the social accounting matrix. A disaggregate social accounting matrix combines the Input-Output Table (DGBAS, 1999) with the national income accounting. Therefore, disaggregate social accounting matrix is based on the national income accounting, and adjust input-output data 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 labour, capital, income distribution matrix, various elasticities, and other parameters. The labour and capital data are from Year Book of Manpower Statistics (DGBAS, 1999) and The Trends in Multifactor Productivity (DGBAS, 1999). A multisector income distribution matrix is transformed income flows between industry and the five equal divisions of household. This matrix used is from The Report of Survey of Family Income and Expenditure (DGBAS, 1999). In order to model production technology, composite commodity and export demand function, we need a variety of elasticity. Elasticities of production technology are constructed on the basis of the elasticities used in Lin (1998) and Burniaux et al. (1992). 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 that is derived from above numerically specifies other parameters in this model. Simulation results are generated by using GAMS program (Brook et al., 1992).

4. Results

Analyzing the impact of the establishment of TSBIP on southern region in Taiwan's economy is performed. The construction planning of TSBIP will be implemented at two stages: the first stage is from July 1996 through December 2003, and the development area is 405.88 Hectares; the second stage is from January 2002 to December 2009 with 232.53 Hectares of development area. The total area developed covers 638.42 Hectares. They anticipated that the construction cost of TSBIP is 39.86 billion NT dollars, and the majority of the cost goes to land cost, planning application fee, construction cost, and maintenance & operation cost. The sales of TSBIP in 1999 were as many as 1580 million NT dollars. It is estimated that in 2010 the sales can reach 990 billion NT dollars, and 1584.7 billion NT dollars in 2021. A summary of the total impact of the TSBIP on the southern Taiwan economy as estimated with each of the three models in terms of output, income and employment effect.

In terms of output, changes in sectoral output were similar for the I-O, SAM and CGE. In general, the SAM yielded the largest impact estimate followed by I-O, with the CGE yielding the smallest change. In the STCGE model, Output effects reveal that the most impacted industries in southern Taiwan are iron and steel industry, other manufacturing industry, as well as service industry, which account for 53% of total output variation in southern Taiwan.

In terms of employment, changes in sectoral output were similar for the I-O, SAM and CGE. In general, the SAM yielded the largest impact estimate followed by I-O, with the CGE yielding the smallest change. In the STCGE model, Employment effects reveal that the industries, which have stronger employment effect in southern Taiwan, are iron and steel industry, other manufacturing industry, wholesale and retail industry, as well as food service industry, which claim 50% of total employment effect in southern Taiwan.

In terms of income, changes in sectoral output were similar for the I-O, SAM and CGE. In general, the SAM yielded the largest impact estimate followed by I-O, with the CGE yielding the smallest change. In the STCGE model, Income effects reveal that the industries, which have greater income effect in southern Taiwan, are iron and steel

industry, other manufacturing industry, as well as service industry, which explain 46% of total income effect in southern Taiwan.

5. Conclusions

In this paper, the three most common regional impact analysis models- Input-Output (I-O), Social Accounting Matrix (SAM), and Computable General Equilibrium (CGE) model - were constructed and applied to analyze the economic impact of constructing Tainan Science-Based Industrial Park (TSBIP) locating in the Southern Taiwan. Each of the three models utilized presents a different picture of the same economy (i.e., southern Taiwan), because they were each based on different assumptions. Overall the SAM tended to give the highest estimate of these impacts whereas the CGE always gave the lowest estimate of impact and the I-O usually resulted in impact estimates between these bounds.

Improvements in the STCGE model could also provide a more accurate and complete picture of policy impacts. The limitations to STCGE model regard the assumptions as to the functional form of the behavior of economic agents in consumption, production, and so on, additional research is needed to relax those assumptions. Therefore, this study's simulation results are only the first step of policy making. Further results should need more detailed calculations and judgments.

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