Chapter 2

Literature review

2.1 Input-output Based Multiplier Analysis

2.1.1 The structure of the Input and Output Table for China

As the essential data source, the China economy input and output table was taken for the establishment of our SAM. On 1986, China government decided to build a national level IO table and the first IO table was accomplished in 1987. Since then, a regular IO table has been set up every five years, and an extensive table, based on the regular IO table and small size sampling, has been established with advanced statistic technique once every three years. Since then, the IO tables of 1987, 1992, 1997 and 2002 have already been published. Furthermore, the IO extensive table of 1990, 1992 and 1997 were also published. Moreover, a provincial level IO table is also available. It will be an important data resource for this research.

Table2.1 an open-economy input and output table of China

Input ↓ Output→		Intermediate-use				End-use					Total output
		1	2	…n	Sum	Consumption	Capital formation	Export	Import	Sum	
Intermediate input	Sector 1										
	Sector 2										
	…										
	Sector n										
	Sum										
Initial input	depreciation										
	Payment for labor										
	Tax and interest										
	Sum										
Total input											

Source: The input and output table China 2002

There are 3 types of balances in the table:

(1) row balance is represented by that the summation of intermediate-use and end-use is equal to total output:

$$\sum_{j=1}^{n} x_{ij} + Y_i = X_i \tag{1}$$

(2) column balance is represented by that the summation of intermediate-input and initial input is equal to total input:

(3) gross balance is represented by that:

$$\sum_{i=1}^{n} x_{ij} + N_j = X_j \tag{2}$$

(3.1) the total input is equal to the total output;

$$\sum_{j=1}^{n} X_j = \sum_{i=1}^{n} X_i \tag{3}$$

(3.2) the summation of input of each sector is equal to the total output of the sector;

$$\sum_{i=1}^{n} x_{ij} + D_j + V_j + M_j = \sum_{j=1}^{n} x_{ij} + C_i + I_i + EX_i - IM_i \quad \text{when } i = j \tag{4}$$

(3.3) the summation of intermediate input is equal to the summation of intermediate output;

$$\sum_{j=1}^{n}\sum_{i=1}^{n} x_{ij} = \sum_{i=1}^{n}\sum_{j=1}^{n} x_{ij} \tag{5}$$

(3.4) the summation of initial input is equal to the summation of end-use.

$$\sum_{i=1}^{n} Y_i = \sum_{j=1}^{n} N_j \tag{6}$$

2.1.2 IO Multiplier Analysis

Three types of multipliers can be calculated from the basic I-O model as: output, employment and, income.

Output multiplier can be used to fox example to calculate change in the local output i associalted with a change in exports by industry j.

$$T_{ij} = \frac{dQ_i}{dE_j} \tag{7}$$

Q_i represents the total turn over by industry i, E_j is the exports by industry j and T_{ij} in a regional setting maybe interpreted as the regional trade coefficient. Now the sum over industry i is the total output multiplier for industry j.

Employment multiplier can be used to calculate the effects of any increase in output, exports, introduction of new technology etc. on the industry-specific or over all regional employment.

$$U_j = EQ^{-1}(I - A)^{-1} \quad (8)$$

E represents the employment in industry and Q is the total production.

Income multiplier can be obtained by the following equation:

$$U_j = YQ^{-1}(I - A)^{-1} \quad (9)$$

Y represents the household income and Q is the total production

In terms of direct, indirect and induced effects, the multiplier analysis in the I-O framework can be categorized as type I and type II multipliers.

Type I multiplier can be calculated as direct plus indirect effect divided by direct effect. This implies that Type I includes initial spending and indirect spending (e.g. businesses or selling to each other). Type II multipliers incorporate Type I plus the induced effects (e.g. household spending based on income earned from the direct and indirect effects).

2.2 SAM-Based Multiplier Analysis

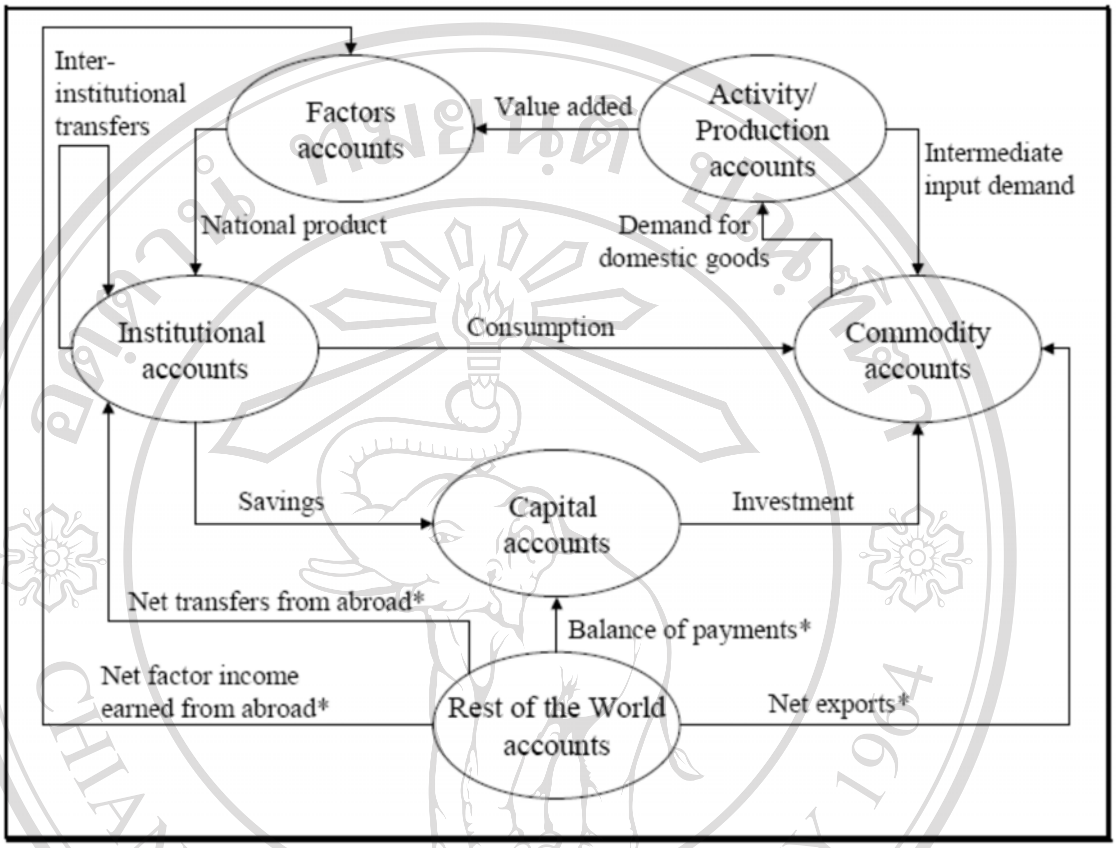
2.2.1 SAM structure

Richard Stone, 1984, said that “An economic system is one in which goods and services are produced with the ultimate object of satisfying human wants.”

"Production, consumption and accumulation are the three basic forms of economic activity;" "The production of a given country is supplemented by imports, and all the final product of a country is not exhausted by domestic consumption and accumulation but in part flows abroad as exports."

A Social Accounting Matrix (SAM) is a comprehensive, economy-wide database that contains information about the flow of resources associated with all transactions that have taken place between economic agents in an economy during a given period of time. It is used beyond that of serving as a summary of transactions that have taken place in an economy. The SAM approach to modeling makes use of the SAM format to present economic theory. The versatility of SAMs has made them the preferred databases for economic modeling. The structure of a SAM, touching on issues such as economic accounting, illustrates the circular flow of resources in the economy. Under the framework of the SAM, the whole economy is aggregated by six accounts in term of factor, activity (or production), commodity, capital, institutional and the rest of world. All the flow of resources could be indicated by the following figure. The arrow with star mark mean the both way relation is valid.

Figure2.1: The flow of resources in a multi-sector economy



Source: social accounting matrices and economic modeling: The Provincial Decision-Making Enabling (PROVIDE) Project, 2003.

The conventional way to present a circular flow diagram is to show the movement of goods and services through the economy. Since a SAM is interested in the flow of resources in the economy, the arrows in Figure2.1 point in the opposite direction. Figure2.1 can be explained by starting with the commodity accounts. Resource flows into these accounts originate from the rest of the world (net exports), capital accounts (investment demand), the institutional accounts (household and government consumption), and the activity accounts (intermediate input demand).

The combined income of these accounts for domestic demand from the activity accounts as well as commodity taxes to the institutional accounts.

Activities are involved in production; hence the activity accounts are also called production accounts. Final goods supplied to the commodity accounts are produced by employing factors that add value to intermediate inputs purchased from the commodity accounts. These resource flows are represented by payments to the factor accounts and the commodity accounts respectively. Factor use taxes or production taxes may also be payable to government in the institutional accounts. Apart from receiving remuneration from the activity accounts, factors supplement their income with transfers from abroad (rest of the world accounts). Since factors are 'owned' by institutions, factor account income is paid to the institutional accounts. Typically households own capital and/or labour, while enterprises and government may own capital. Since transactions also take place between institutions, inter-institutional transfers are also included in the figure. These include tax payments from households and enterprises to government, inter-household transfers, transfers from government to households such as social security grants, and all other inter-institutional transfers. Inter-institutional transfers can easily be identified in the more detailed institutional breakdown typically used in a SAM. Net transfers from abroad supplement institutions income, provided these are positive.

All income not spent by households, enterprises and government is saved. Government savings can be negative (budget deficit) or positive (budget surplus).

Institutional savings flow from institutional accounts to the capital accounts. A positive balance of payments would also contribute to the pool of savings. The entire pool of savings is utilized for investment purposes. This is shown here as a flow from in the capital accounts to the commodity accounts, i.e. investment goods are purchased from the commodity accounts. The following section proceeds to explain how these flows can be represented in a SAM-format that uses the same accounts as those in Figure2.1. It will however be shown that greater detail is now possible since accounts can easily be disaggregated into various sub-accounts.

Table2.2 a macroeconomic SAM

Expenditures Receipts	1. Commodities	2. Activities	3. Factors	4. Households	5. Enterprises	6. Government	7. Savings-investment	8. Rest of the world	TOTAL
1. Commodities Intermediate		inputs(USE matrix)		Private/ consumption		Government/ consumption	Investment	Exports	Demand
2. Activities	Domestic production (MAKE matrix)							Activity income (gross output)	
3. Factors		Value-added						Factor income from RoW	Factor income
4. Households			Factor income to households	Inter-household transfers	Transfers to households	Transfers to households		Transfers to households from RoW	Household income
5. Enterprises			Factor income to enterprises			Transfers to enterprises		Transfers to enterprises from RoW	Enterprise income
6. Government	Sales taxes, tariffs, export taxes	Indirect taxes, factor use taxes	Factor income to government, factor taxes	Transfers to government, direct household taxes	Transfers to government, direct enterprise taxes			Transfers to government from RoW	Government income
7. Savings-investment				Household savings	Enterprise savings	Government savings		Balance of payments	Savings
8. Rest of the world	Imports		Factor income to RoW		Transfers to RoW	Government transfers to RoW			Foreign exchange outflow
TOTAL	Supply	Activity expenditures	Factor expenditures	Household expenditure	Enterprise expenditure	Government expenditure	Investment	Foreign exchange inflow	

Source: Punt, C. (2003). Social accounting matrices and economic modeling: The Provincial Decision-Making Enabling (PROVIDE) project.

Table2.2 which lists as below is actually a typical SAM with 8 accounts which institutional accounts are aggregated to 3 accounts such as households, enterprises and government. That is an essential framework of a SAM. The column represents the input (or expenditure) and the row represents the income. The transfer between two accounts can be obviously indicated from the table. It is open-economy SAM which includes not only the domestic economy but also the external economy.

The methodology introduced by Cecilia Punt's article has been adopted to build the SAM and Computable General Equilibrium (CGE) model of this thesis. Actually, this is the most essential and important part of a SAM which helps to understand what is the structure of a SAM and how does it work and how could use it to analyze the research.

2.2.2 SAM-based multiplier analysis

Multipliers are a key element in measuring disaggregated impacts as the seminal works of Stone (1978), Pyatt & Round (1979), and Defourny & Thorbecke (1984) show. Further development by Pyatt & Round (1985), and Robinson & Roland-Holst (1987) attest to the continuous and innovative use of the methodology. A particular empirical application for the Spanish economy is that of Polo, Roland-Holst & Sancho (1991).

As described above, the Input-Output models analyze inter-industry flows or interactions, however, the interdependence of or interrelationships among various accounts as well as interactions within accounts or sub-sectors are not captured by the Input-Output models. Leontief Input-Output models basically examine the amount of one sector's output that is required for the production of output in another sector. Unlike Input-Output models, the SAM comprehensively covers the interrelationships between and among accounts. When SAM multipliers are compared with the Input-Output multiplier, the former are seen to be larger. Multipliers refer to coefficients in the various column generated by changes in any of exogenous accounts. Whereas in the input-output analysis intermediate demand for inputs serves as a multiplier, in the SAM, the value added and incomes generate demand linkages, hence the larger multipliers in the latter. (Sadoulet & de Janvry, 1995)

When the SAM multiplier analysis is to be undertaken, it is necessary to determine which accounts are endogenous and which are exogenous. Endogenous accounts comprise those that can be influenced within the system or those which level of expenditure is directly influenced by changes in income. Exogenous accounts constitute those which expenditures are independent of the changes in income. The standard practice is normally to treat government, capital and the rest of the world accounts as exogenous accounts.

In SAM multipliers analysis, there are several important underlying hypotheses. Firstly, we must recall that prices are supposed to remain constant in all time. This means that we implicitly assume that there exists an excess capacity of production. Secondly, production technology and resource endowments are given. As a result the analysis is necessarily a short term one and no dynamic of any kind can be taken into account. Thirdly, expenditures propensities of endogenous accounts remain constant. Finally, at least one of the accounts must be exogenous. The principle of the analysis itself implies that only accounts as a whole can be supposed exogenously.

While SAM multipliers analysis provides detailed information about economic linkages, income distribution, etc, there are indeed formidable problems facing them. Firstly, in many cases certain accounts such as factors and households might be too aggregated to convey an understanding of economic relationships. Further, households differ by income levels and sources of income. Some households depend on wages and self-employment, while others subsist on transfers and remittances. Relying to only one household type in economy-wide models can be misleading in policy designs or responses.

2.2.3 Applications of SAM and SAM Multiplier Analysis

Sri Lanka: A SAM for Sri Lanka 1970 is a pioneering study which uses not only accounting and multiplier but also the multiplier decompositions outlined earlier. A number of other used it as a model to build their SAM. Only three labor accounts and three household groups were distinguished representing urban, rural and estate households/workers alongside twelve production sectors. The income multiplier was considerably lower for estate households than for urban or rural households, except when the injection was in the tea or rubber sectors (e.g. an increase in exports of tea or rubber). This suggested that indirect effects could not be relied upon to alleviate poverty in this, the poorest, sector and that estate households needed to be targeted directly. A second observation was to show that the input-output multipliers (M_1) were low relative to the "between-account" multiplier (M_3). This further suggested that more emphasis needed to be placed on tracing and mapping the income generated to factors and the transmission of this factor income to households, rather than estimating inter-industry linkages, as the latter are so weak.

Ghana: 1993 SAM for Ghana contributed to a multiplier analysis held by Powell and Round (2000). The research adopting the additive decomposition procedure explains that an extra 100 unit of income into the cocoa sector (arising say from additional cocoa exports) leads to additional household incomes of 107 in urban areas and 71 in rural areas, after taking into account the various transfer (within-account), spillover and feedback effects. The "cross" (M_2, or spillover) effects account for income effects of 40 (urban) and 28 (rural), while the "between-account" (M_3) multipliers account for a further 67 and 43 respectively. It is noticeable how large the "between-account" (M_3) effect is relative to the spillover effect from the receipts of factor incomes (M_2).

South-Korea: It is worthy to mention the SAM for South-Korea (1968) which has been used by Defourny and Thorbecke for a detailed structural path multipliers analysis (1984). It is a significance of this kind of research to demonstrate the methodology which is more complex than a matrix multiplier. In this thesis, these kinds of method will not be used. Nevertheless, they shall be outlined in short. A key table in Defourny and Thorbecke (1984) shows a selection of global influences (total multipliers) for various paths of injections and account destinations. For each global influence there may be several alternative loops (elementary paths) and the method computes the percentage of the global influence accounted for by one or more elementary paths. In particular the loops that define connections between an exogenous injection and the effects on a particular household group (e.g. a poor household) help to provide insights into the income transmission channel.

Indonesia: Keuning and Thorbecke (1992) use SAM-based multiplier to trace through the effects of government budget retrenchment in Indonesia in the 1980s on each of ten socio-economic household groups. The SAM is more disaggregated, the income mappings are more detailed and the effects on income distribution are therefore much more sensitive to the exogenous shocks.

Thailand: The 1998 Social Accounting Matrix for Thailand has been built by Jennifer Chung-I Li, University of North Carolina at Chapel Hill & International Food Policy Research Institute. It has 61 sectors, 3 households, 3 factors (labor, agricultural capital and non-agricultural capital), 2 enterprises, a government account and a rest-of-the-world account. There are 7 agricultural sectors, 19 manufacturing sectors, with the rest as service sectors. The agricultural sectors are: paddy rice, wheat, cereal grains, vegetables, fruits, nuts, oil seeds, sugar cane/sugar beet, plant-based fibers, crops, livestock, animal products, raw milk, wool silk-worm cocoons, forestry, and fishing. There are seven agricultural sectors, namely Paddy rice, other crops, vegetables and fruit, livestock, fishing, and forestry. The other sectors can be categorized into energy intensive manufacturing industries (15 total), other manufacturing industries (11 total), primary energy sectors (8 total), transportation sectors (5 total), and service sectors (15 total). The author is able to recommend a good policy suggestion for 8 primary energy sectors, 5 transportation sectors and a health and medical treatment commodity account.

Vietnam: 1996& 1997 SAM for Vietnam has been built by Chantal Pohl Nielsen, Danish Research Institute of Food Economics on Jan, 2002. The main data sources were obtained from national accounts statistics, government budget data, the official 1996 input-output table, 1997/1998 Vietnam Living Standards Surveys (VLSS), and COMTRADE trade data. The Vietnam SAM includes 97 producing sectors, 5 factors, 6 household types, one enterprise type, one government type, one investment/saving type and one rest-of-world type. The production sectors include 8 agricultural sectors, 2 agricultural services and 13 food processing industries; the 5 factor account was distinguished as 3 types labor by skill level, one type of capital and one type of land; 6 household types distinguished by rural/urban, agricultural/non-agricultural, wage/self-employed).

China: The 1997 SAM for China, the first SAM for China, contains 57 sectors, 5 production factors, 7 groups of households according to the income level, 1 enterprise account and other macro accounts such as government subsidies, production taxes, import, export and capital, etc. In order to simplify the analysis and simultaneously emphasize the key problem, this article merges the 57 sectors into 29 big sectors and takes the accounts relating to government, taxes, import, export and capital as a whole exogenous account. There is a 50×50 SAM with three group of endogenous accounts – production activities (including 29 sectors), factors (including 5 production factors), institutions (including 14 groups of households and 1 enterprise). It has been built by the Development Research Center of the State Council, China. Based on the Social Accounting Matrix (SAM) for China 1997, a research, *SAM-based multiplier analysis for China's economy,* completed by the Development Research Center, The State Council, P.R.C, conclude that although relative to IO table, SAM more comprehensively exhibits the social-economic accounting, and the structural path analysis method within the SAM framework brings some improvement to a certain degree. There is still some limitation in this analysis because of the strong presuppositions in terms of that the assumption of linear structure and average expenditure propensity does not accord with the reality and it is necessary to prepare sufficient basic data to compile a SAM.

2.3 The Linear Programming

A linear programming problem may be defined as the problem of maximizing or minimizing a linear function subject to linear constraints. The constraints may be equalities or inequalities.

2.3.1 The simplex method

The simplex tableau

Consider the standard minimum problem: find y to minimize $y^T b$ subject to $y \geq 0$ and. It is useful conceptually to transform this last set of inequalities into equalities. For this reason, we add slack variables, $s^T = y^T A - c^T \geq 0$. The problem can be restated: Find y and s to minimize $y^T b$ subject to $y \geq 0$, $s \geq 0$ and $s^T = y^T A - c^T$.

We write this problem in a tableau to represent the linear equations $s^T = y^T A - c^T$.

Figure 2.2 the simplex tableau

	s_1	s_2	$\cdots$	s_n	
y_1	a_{11}	a_{12}	$\cdots$	a_{1n}	b_1
y_2	a_{21}	a_{22}	$\cdots$	a_{2n}	b_2
$\vdots$	$\vdots$	$\vdots$		$\vdots$	$\vdots$
y_m	a_{m1}	a_{m2}	$\cdots$	a_{mn}	b_m
1	$-c_1$	$-c_2$	$\cdots$	$-c_n$	0

The last column represents the vector whose inner product with y we are trying to minimize.

If $-c \geq 0$ and $b \geq 0$, there is an obvious solution to the problem; namely, the minimum occurs at $y = 0$ and $s = -c$, and the minimum value is $y^T = 0$. This is feasible since $y \geq 0, s \geq 0$, and $s^T = y^T A - c$, and yet $\sum y_i b_i$ cannot be made any smaller than 0, since $y \geq 0$, and $b \geq 0$.

The pivot madly method

Pivot madly until you suddenly find that all entries in the last column and last row (exclusive of the corner) are nonnegative Then, setting the variables on the left to zero and the variables on top to the corresponding entry on the last row gives the solution. The value is the lower right corner.

This same "method" may be used to solve the dual problem: Maximize $c^T x$ subject to $x \geq 0$ and $Ax \leq b$. This time, we add the slack variables $u = b - Ax$. The problem becomes: Find x and u to maximize $c^T x$ subject to $x \geq 0$, $u \geq 0$, and $u = b - Ax$. We may use the same tableau to solve this problem if we write the constraint, $u = b - Ax$ as $-u = Ax - b$.

Figure 2.3 pivot tableau

	x_1	x_2	$\cdots$	x_n	-1
$-u_1$	a_{11}	a_{12}	$\cdots$	a_{1n}	b_1
$-u_2$	a_{21}	a_{22}	$\cdots$	a_{2n}	b_2
$\vdots$	$\vdots$	$\vdots$		$\vdots$	$\vdots$
$-u_m$	a_{m1}	a_{m2}	$\cdots$	a_{mn}	b_m
	$-c_1$	$-c_2$	$\cdots$	$-c_n$	0

We note as before that if $-c \geq 0$ and $b \geq 0$, then the solution is obvious: $x = 0$, $u = b$, and value equal to zero.

Suppose we want to pivot to interchange u_1 and x_1 and suppose $a_{11} \neq 0$. The equations

$$-u_1 = a_{11}x_1 + a_{12}x_2 + \cdots + a_{1n}x_n - b_1$$

$$-u_2 = a_{21}x_1 + a_{22}x_2 + \cdots + a_{2n}x_n - b_2 \quad \text{etc.}$$

become

$$-x_1 = \frac{1}{a_{11}}u_1 + \frac{a_{12}}{a_{11}}x_2 + \frac{a_{1n}}{a_{11}}x_n - \frac{b_1}{a_{11}}$$

$$-u_2 = -\frac{a_{21}}{a_{11}}u_1 + \left(a_{22} - \frac{a_{21}a_{12}}{a_{11}}\right)x_2 + \cdots \quad \text{etc.}$$

In summary, you may write the simplex tableau as

	x_1	x_2	$\cdots$	x_n	-1
y_1	a_{11}	a_{12}	$\cdots$	a_{1n}	b_1
y_2	a_{21}	a_{22}	$\cdots$	a_{2n}	b_2
$\vdots$	$\vdots$	$\vdots$		$\vdots$	$\vdots$
y_m	a_{m1}	a_{m2}	$\cdots$	a_{mn}	b_m
1	$-c_1$	$-c_2$	$\cdots$	$-c_n$	0

If we pivot until all entries in the last row and column (exclusive of the corner) are non-negative, then the value of the program and its dual is found in the lower right corner. The solution of the minimum problem is obtained by letting the y_i's on the left be zero and the y_i's on top be equal to the corresponding entry in the last row. The solution of the maximum problem is obtained by letting the x_j's on the top be zero, and the x_j's on the left be equal to the corresponding entry in the last column.

2.3.2 Generalized duality

We consider the general form, so called generalized duality, of the linear programming problem, allowing some constraints to be equalities, and some variables to be unrestricted ($-\infty < x_j < \infty$).

The General Maximum Problem

Find $x_j, j = 1, \ldots, n,$ to maximize $x^T c$ subject to

$$\sum_{j=1}^{n} a_{ij} x_j \leq b_i \; for \; i = 1, \ldots, k \tag{10}$$

$$\sum_{j=1}^{n} a_{ij} x_j = b_i \; for \; i = k+1, \ldots, m \tag{11}$$

and

$$y_i \geq 0 \quad \text{for } i = 1, \ldots, k$$

$$y_i \text{ unrestricted for } i = k+1, \ldots, m$$

The General Minimum Problem

Find $y_i, i = 1, \ldots, m$, to maximize $y^T b$ subject to

$$\sum_{i=1}^{m} y_i a_{ij} \geq c_j \ for\ j = 1, \ldots, l \tag{12}$$

$$\sum_{i=1}^{m} y_i a_{ij} = c_j \ for\ j = l+1, \ldots, n \tag{13}$$

and

$y_i \geq 0$ for $i = 1, \ldots, k$

y_i unrestricted for $i = k+1, \ldots, m$

In other words, a strict equality in the constraints of one program corresponds to an unrestricted variable in the dual.

If the general maximum problem is transformed into a standard maximum problem by

1. replacing each equality constraint, $\sum_j a_{ij} x_j = b_i$, by two inequality constraints, $\sum_j a_{ij} x_j =\leq b_i$ and $\sum_j (-a_{ij}) x_j \leq -b_i$, and

2. replacing each unrestricted variable, x_j, by the difference of two nonnegative variables, $x_j = x_j' - x_j''$ with $x_j' \geq 0$ and $x_j'' \geq 0$,

and if the dual general minimum problem is transformed into a standard minimum problem by the same techniques, the transformed standard problems are easily seen to be duals by the definition of duality for standard problems.

Solving General Problems by the Simplex Method

The simplex tableau and pivot rules may be used to find the solution to the general problem if the following modifications are introduced.

1. Consider the general minimum problem. We add the slack variables, $s^T = y^T A - c^T$, but the constraints now demand that $s_1 \geq 0,\ \ldots, s_l \geq 0, s_{l+1} = 0, \ldots, s_n = 0$. If we pivot in the simplex tableau so that s_{l+1}, say, goes from the top to the left, it becomes an independent variable and may be set equal to zero as required. Once s_{l+1} is on the left, it is immaterial whether the corresponding $\hat{b}_i$ is the coefficient multiplying s_{l+1} in he objective function, and s_{l+1} is zero anyway. In other words, once s_{l+1} pivoted to the left, we may delete that row ---- we will never pivot in that row and we ignore the sign of the last coefficient in that row.

This analysis holds for all equality constraints: pivot $s_{l+1}, \ldots, s_n$ to the left and delete. This is equivalent to solving each equality constraint for one of the variables and substituting the result into the other linear forms.

2. top where they represent dependent variables. Once there we do not care whether the corresponding $-\hat{c}_j$ is positive or not, since the unconstrained variable y_i may be positive or negative. In other words, once y_{k+1}, say, is pivoted to the top, we may delete that column.

After all equality constraints and unrestricted variables are taken care of, we may pivot according to the rules of the simplex method to find the solution. Similar argument apply to the general maximum problem. The unrestricted x_i may be pivoted to the left and deleted, and the slack variables corresponding to the equality constraints may be pivoted to the top and deleted.

3. In summary, the general simplex method consists of three stages. In the first stage, all equality constraints and unconstrained variables are pivoted. In the second stage, one uses the simplex pivoting rules to obtain a feasible solution for the problem or its dual. In the third stage, one improves the feasible solution according to the simplex pivoting rules until the optimal solution is found.