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# THE RELEVANCE OF PRICE-ENDOGENOUS MODELS

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## ABSTRACT

The essence of economic reform in many developing countries is to allow prices to adjust to some market forces. A model framework that assumes fixed prices is therefore not appropriate for such an analysis. This paper argues that computable general equilibrium (CGE) models, that treat prices endogenously, is a useful alternative tool for policy analysis. Most CGE models for developing countries departed quite liberally from the Walrasian tradition: markets are assumed highly segmented and not all of them are cleared by price adjustment. The model structure described in this paper shows such features. A more realistic multiplier, compared to that of fixed-price models, is also described. Two applications of CGE models are particularly discussed, i.e., capital flows and terms-of-trade shock, by using data from an oil-producing developing country. It is finally argued that although some complexities may be involved in the construction of CGE models, when it is believed that the external shocks or policy changes influence not only macroeconomic variables but also microeconomic and intersectoral linkages, as seems to be the case in many real situations, the entry into CGE modelling is worthwhile.


## INTRODUCTION

In recent years, probably no policy study is more important than the analysis of economic reform undertaken by many governments, especially those in developing countries. While there are a number of important ingredients in such a policy package, a major core of the reform is to make prices to change more according to the market forces. While there are still some commodities whose prices remain controlled by the government even after the reform, be it through strict direct control or through a price stabilization program, the essence of economic reform is precisely to allow prices to adjust to market forces[1]. A model framework that assumes fixed prices is therefore not appropriate for such an analysis.

Allowing the process of adjustment to take place in response to changing incentives would imply more complex relations among variables and economic agents, for which the use of various substitutions and non-linear relations is inevitable.

This paper is written to serve as a background argument for the use of price-endogenous models, more particularly computable general equilibrium (CGE) models. A few equations central to the models are discussed, followed by some applications. In the last section the distinction between CGE models and fixed-price models are discussed by making use of their corresponding multipliers.

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1. The degree of pre-reform price distortion in many developing countries is usually high. As an illustration, in the *World Development Report 1983*, the World Bank reports price distortion indexes for thirty-one developing countries, ranging from the least distorted (Malawi) to the most distorted (Ghana). With all their limitations, such data are useful as a starting point towards understanding the degree to which an economy is governed by market forces versus bureaucratic commands.

## WHY CGE MODELS?

An early source of support for endogenous price models came from the growing dissatisfaction with planning models in the 1960s and 1970s. Most planning models at that time were designed with the assumption that the appropriate development strategy would be to set quantitative targets, and through a certain model, the most notable one of which is an input-output model, a particular economic structure will be generated (Seers, 1972). The policy makers could then determine each sector's growth that would be consistent with the predetermined quantitative targets. The resulting economic structure is to be used as a reference by which some policy guides are made. The poor performance of a number of developing countries that have adopted such models was clearly in marked contrast with the achievement of those countries that rely less on quantity targetting and more on price mechanism. The "economic miracle" of East Asian countries is an often quoted example of the latter category (World Bank, 1993).

The current trend of the globalized economic system, which was significantly intensified during the 1980s through deregulation in financial markets and rapid growth in the communication technology, has created a situation in which practically no country can take a domestic policy without taking into account the external environment. For many developing countries, a series of external shocks during the 1980s, e.g., worsening terms of trade, reduced foreign borrowing, and the world's economic recession, have forced them to make major policy reforms. Most of these reforms are aimed at the working of the market, and the emphasis is often given to the export-generating policy in order to improve efficiency and to acquire the much needed foreign exchange. Hence, the impact of external shock and the alternative policy response would be best analyzed through a model that embodies market price mechanism. CGE is one such model.

There are a rapidly growing number of CGE models built for developing countries, and most of them departed quite liberally from the Walrasian tradition. Markets are assumed highly segmented (the presence of market imperfection), and not all of them are cleared by price adjustment.

Foreign trade is probably the most common application of developing country CGE models, partly because of the presence of various external shocks noted earlier. Policy instruments often analyzed are those related to taxes (Shoven and Whalley, 1974; Dahl et al, 1988 and Mitra, 1987), tariffs (Devarajan and Lewis, 1989; de Melo, 1977) as well as an alternative composition of government expenditures (Thorbecke, E et al., 1992). The use of imperfect competition in international trade analysis was discussed, among others, in de Melo & Roland-Holst (1990). Since the nature of reform programs in many countries are unanimously pro-market, a major amendment in the way prices behave is important to make.

Most countries have gone through a long period of import-substitution strategy prior to the reform era. During that period, domestic consumption was mainly satisfied by domestically produced goods with few imported products. However, imported capital and intermediate goods are hard to substitute. Indeed, a trade reform is likely to change the degree of substitutability between different products. Hence, a specific assumption has to be postulated as to what degree of substitution a particular group of commodities is likely to have. Models ignoring such a substitution factor, for example those that assume Leontief technology, will surely miss an important part of the reforms. Unlike in the past, where most CGE models incorporated a variety of different features, in recent years these models are more focused, e.g., for trade policy analysis, for tax policy, or for the analysis of capital flows. Another set of models also increasingly used deal specifically with environmental issues (Glomsrod et al, 1990; Bergman, 1989). There are also models intended restrictively for a single purpose, for example those used to analyze the order of sequencing of the liberalization policy (Azis, 1996). Still another set of CGE models are dynamic in nature; they are designed to analyze the forward looking behaviour of some major variables, e.g., consumption and investment (Go, 1989).

**Model Framework**

Policy-oriented CGE models are based on the socio-economic structure of a social-accounting matrix (SAM). Consequently, all of the favourable features of SAM, i.e., comprehensiveness, consistency and macro-micro linkages, are maintained in the models. However, unlike in the SAM framework, CGE models allow an adjustment process to take place when policy changes occur. Such a process is governed by the behaviour of incentive variables, i.e., commodity and factors prices, exchange rates, and interest rates. While these variables are treated endogenously in the model, they can be indirectly influenced by government policies (e.g., on taxation and subsidies).

Some of the equation specifications in CGE models share common features, but others may be adapted for a particular situation. The following are some of the core equations in CGE models.

In the production side, a nested production function specifies two-level production relating output and two categories of inputs, primary and intermediate. The primary inputs enter the production function for value-added, and along with the composite intermediate inputs this value added component appears in the right-hand side of the production function for output.

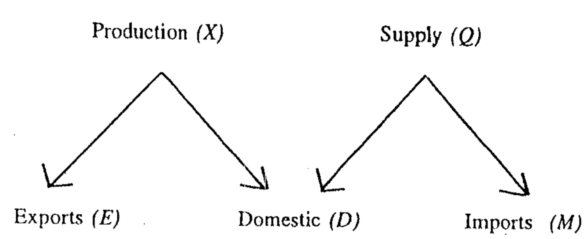
What is the optimal composition of value-added and the composite intermediate inputs? With a CES form of production function, a standard optimization program will give the following form of demand for intermediate inputs:

$$INTM_i = VA_i/[(PINTM_i/PVA_i).\ (\delta_i/(1-\delta_i))]^{1/(1+\rho_i)} \qquad i \in n$$

where *PINTM* and *PVA* are the prices of intermediate inputs and of value -added (the "net" price), $\delta$ is the distributive parameter, $\rho$ is the substitution parameter, and $n$ is the number of economic sectors. A simpler specification can also be made by taking a fixed coefficient relation between intermediate inputs and output, such that only substitutions between different primary inputs are permitted in the system, that is, only one production function (for output) is used. The drawback of such a specification is that, it will not be able to capture a more realistic impact of a major commodity price shock, particularly the impact in terms of a shift in the production technology as often reflected through a change in the value-added output ratio.

In most CGE models, cross-hauling through simultaneous exports and imports (two way trade) at the sectoral level is allowed. The implication is seen among others through the specification of total domestic production $X$ and total supply $Q$.

**Figure 1: Nested Production**



As shown in Figure 1, some parts of the domestic production are consumed domestically *(D)*, and other parts are exported *(E)*. Meanwhile, total supply consists of domestically produced *D* and imported goods *M*. The allocation of sales between domestic and export markets is given by a CET function :

$$X_i = AT_i\,(\gamma_i \,.\, E_i^{\,\kappa} + (1-\gamma_i).\, D_i^{\kappa})^{1/\kappa} \qquad i \; \varepsilon \; exp$$

where *g* and *q* are the distributive parameter and substitution parameter respectively, *AT* is the shift parameter, and *exp* denotes exporting sectors. Similarly, a CES form, also known as the 'Armington function' (Armington, 1969), is used to describe the relation between imports and domestic production

$$Q_i = AC_i \,.\, [\pi_i\, M_i^{\,-\sigma_i} + (1 - \pi_i) \,.\, D_i^{-\sigma_i}]^{-1/\sigma_i} \qquad i \; \varepsilon \; imp$$

where *imp* denotes the importing sectors. An important implication of the above CET and CES specification is that relative prices are the only variable determining the ratios of exports and imports to domestic sales :

$$E_i = D_i \,.\, [PE_i/(PD_i\,(1-tv_i-tx_i)) \,.\, (1-\gamma_i)/\gamma_i]^{1/(\kappa-1)} \qquad i \; \varepsilon \; exp$$

$$M_i = D_i \,.\, [(PD_i/PM_i) \,.\, n_i/(1-n_i)]^{1/(1+\sigma_i)} \qquad i \; \varepsilon \; imp$$

where *tv* and *tx* are the tax-rates for indirect tax and value-added tax respectively. Under the above specification, income does not play any role. Yet, this is more realistic than either the case of perfectly competitive exports and imports, or those that specify for tradable and non-tradable goods (Devarajan, Lewis & Robinson, 1993).

So much for the supply and trade side. What about the demand side? As in a standard utility maximization program, private consumption *PC* can be derived given a specific form of the utility function. For a Cobb-Douglas utility form, and assuming fixed expenditure shares *cc*, the following is simply obtained from a standard utility maximization program:

$$PC_i = [\, \Sigma_{hh}\, cc_{i,hh} \,.\, (1-mps_{hh}) \,.\, YHH_{hh} \,.\, (1-th_{hh})] \,/\, PQ_i$$

where *mps* and *th* are the marginal propensity to save and the household tax rate respectively, and *PQ* is the price of the composite output supply.[2] The output level and value-added will then determine other sets of prices, and, in turn, also incomes and savings of different institutions.

For the analysis of trade policy, the specification of domestic prices of imports and exports is very crucial :

$$PM_i = pwm_i \,.\, EXR \,.\, (1 + tm_i) \,.\, (1 + tv_i)$$

$$PE_i - pwe_i \,.\, EXR \,.\, (1 - te_i)$$

where *pwm* and *pwe* are world prices of imports and exports, *tm* and *te* are import tax rate and export tax rate, respectively; and *EXR* is the exchange rate.

The equilibrium between aggregate saving and aggregate investment, the core of the *Warlas Law,* is central in CGE Models:

$$INVEST = HHSAV + GSAV + CORPSAV + DCA.\, EXR$$

2. Government consumption is typically treated as exogenous; it is either assumed fixed or considered as a policy variable.

where *HHSAV, GSAV, CORPSAV* are household, government and corporate saving respectively, and the last term denotes the foreign savings, which is the balance of the current account *(DCA)* measured at local currency. In this sense, most CGE models are "saving-driven."

However, there have been a number of efforts to make modifications by incorporating some econometrically estimated equations into the models. These equations, estimated independently (outside the model), are expected to reflect better the behavioural movement of some variables. Such an approach is particularly useful if one wishes to construct dynamic CGE models.

One of the most common variables whose behaviour is estimated through an econometrically estimated equation is investment. We can, for example, modify the model closure by introducing an investment equation taken from an independent study. By doing so, we also ought to make an adjustment in the capital stock estimate when a multi-period simulation is conducted. Let us suppose the following equation of private investment, *PINV,* is used:

$$PINV_i = \lambda_i VA_i^{\lambda 1i} \cdot (1 + rloan)^{\lambda 2i}$$

where $\lambda s$ are constant and only $\lambda_2$ is negative, and *rloan* is the domestic real interest rate. Hence, the aggregate investment is :

$$INVEST = \Sigma i \ (GINV_i + PINV_i)$$

where *GINV* is government investment. The question is how will the aggregate saving adjust to this aggregate investment? In our specification, the domestic interest rate will function as the equilibrating factor. With domestic interest rate specified as endogenous, not only will saving adjust to investment, but something can also be done in the modelling of capital flows *(FCAP).* For example, we can take the differential between domestic and foreign interest rate as one of the determining factors in the capital flows estimation. It is also common to include at least two other variables in the equation, namely the 'country risk' *(RISK)* and the exchange rate expectation, where the latter can be measured by the rate of change of the exchange rate :

$$FCAP = \sigma_0 + degree. \ \sigma_1 \ . \ [RLOAN\text{-}RFLOAN - RISK - (EXER/EXRO)\text{-}1)]$$

There are several alternatives to estimate *RISK.* It is known that a number of specialized institutions regularly produced the so-called "country risk" indicator. We can use such indicators to represent *RISK,* meaning that the country risk factor is exogenously determined. However, we can also endogenize the risk by modelling it as being determined by some variables that could well represent what the public, including investors, perceive as the most important and readily available. One of such variables is the debt-service ratio. In other words, the following can be used:

$$RISK = a_0 + a_1 \ . \ [(\Sigma_{br} AMORT_{br} + \Sigma_{br} INTEREST_{br}) / \Sigma_i E_i \ . \ pwe_i]$$

where *a*'s are constant, *AMORT* and *INTEREST* are, respectively, the amortization and interest payments on foreign debts (subscript *br* indicates the borrowing institutions; for example: government, public companies, and private sector). Note that the terms within the bracket denote debt-service ratio.

Obviously, there are other ways to model capital flows. But if the above specification is used, and capital flows are definedar all flows that comprise of foreign investment *FORINV* and other borrowing, *BORROW,* then the change in foreign reserve, *DFR,* can be determined as follows :

$$DFR = Z_{br} AMORT_{br} - BORROW_{br} - FORINV - DCA$$

If we assume the amortization and the borrowing constant, any increase in foreign investment will automatically reduce *DFR*, which, by a standard concept of balance-of-payment would mean an improvement in the country's foreign reserves.

With the above specification we can identify the transmission process through which the economy will respond if, for example, capital flowr increase. With more foreign exchange available, imports are expected to rise. But domestic consumption could also rise, although at a less-than-proportional rate. The price ratio *PD/PM* will increase, and *PE/PD* will decline. Consequently, the real exchange rate tends to appreciate, lowering exports and enlarging the current account deficit.

What will happen with investment? First the domestic interest rate tends to fall with increased capital flows. As expected, the aggregate investment rises, due to growing private investment including foreign investment. With increased economic activity, factor income will rise, and so will the incomes of different institutions. It is through this mechanism that we will eventually be able to evaluate the income distribution between income groups. Meanwhile, the saving-investment balance is secured because the aggregate saving will be also be adjusting upward because of the income increase.

A refinement on the investment-savings model can be considered. In particular, one may be tempted to integrate the rational expectations hypothesis into the model. If agents can predict that the inflation rate will keep going up, for example as a result of increased money supply, they should be expected to behave such that the present values of their own assets can be maximized, that is, by reducing investment and savings and augmenting consumption (rational expectation). From the modelling point of view, the parameter describing marginal propensity to save (*mps* in the private consumption equation) may be adjusted downward, and the price variable will have to appear in the investment equation.

It would be interesting to evaluate whether the cutback in investment is greater (smaller) than the increase in consumption, since that will determine whether final demands decrease (increase), and in turn the endogenous price levels will fall (rise). Having fairly detailed information and specification of household income, the model simulation will enable us to evaluate the repercussions of such rational expectation hypothesies on income distributions.

More recent work on investment models pucemphasis on two important features, namely 'uncertainty' and 'irreversibility.' For modelling investment in developing countries, within the context of economic reforms, these factors are highly relevant. For one thing, most countries undergoing reform have paid more attention to capital goods investment, the expenditures on which feature precisely those two characteristics. Furthermore, an important direction of policy reform is to place greater reliance on private investment. Again, the above two characteristics are mostly, if not only, relevant for private investment. Taking into account these important factors, a more relevant investment function for developing countries may be constructed. As described in recent literature, by among others Pindyck (1993), the computation for such a model requires stochastic processes for the relevant state variables, and some parameters are not easy to measure. Nonetheless, attempts in this direction can be of great use for modelling investment in developing countries.

Another behavioural specification is often applied in the determination of wages. In neo-classical CGE models, widely used in developed countries' analysis, factors are assumed to be in an equilibrium state with full-employment. Obviously such an assumption is unrealistic for many developing countries. To capture the unemployment variable, we would need to have an independently estimated wages equation, from which demand for labour will be determined. An example of the wage equation is given below, in which prices (*PINDEX* and *PVA*) and changes in labour productivity (change in X/LAB) are basically the two important determinants:

$$WAGES_i = PINDEX^{vi} \, . \, (PVA_i/PVA0_i)^{(1-vi)} \, . \, (X_i/LAB_i/X0_i/LAB0_i)^{ni}$$

from which the factor price of labour is

$$FP_{il} = FP0_{il'} \, \Sigma_i \, WAGES_{i'} \, wshar_{i,il}$$

where *FP0* is a constant, and so is the parameter *wshare.* The above equation is to be substituted in both the factor demand and factor income equations.

The size of the unemployment can therefore be derived given the fixed labour supply (LBSUP):

$$UNEM = LBSUP - \Sigma_i LAB_i$$

Before we move to the model application, one more indicator will be specified, that is GDP in real terms, which is perhaps the most commonly quoted variable in a macroeconomic analysis. By defining real GDP from the expenditure side, we have :

$$RGDP = \Sigma_i \, (PC_i + INVEN_i + ID_i + + GC_i) + \Sigma_i E_i - \Sigma_i \, (1 - tm_i) \, M_i$$

The real imports in the equation are measured excluding tariffs, and the tariffs *tm* should be the rate at the base-year (real).

It should be noted that since the socio-economic structure of SAM is the basis of CGE models, the equation estimation is to be done within a 'system approach,' unlike the estimation in a standard econometric model.

**Model Application**

In what areas are CGE models applied? A common application is to simulate the impacts, both the direct and indirect, of external shocks on macroeconomic and social variables. The repercussion of certain policy changes ("if-then" type of analysis), is also best evaluated through these models. To the extent that CGE models are capable of generating results that encompass both target categories (macroeconomic and social variables), they could be very useful for policy analysis which seriously takes into account the various trade-offs between these target variables. The necessary policy choice can be determined through the selection of a scenario under which the resulting outcomes of model simulation are considered most favourable not only in terms of macroeconomic performance but also from the distributional perspective, be it distribution of welfare between socioeconomic groups or between different regions within a country.

While most equations described above are generally found in a CGE model, a number of variations and further extension are not less common. The specific type of the variation depends on the characteristic of the problem under observation.

**Terms-of-Trade Shock**

As stated earlier, one of the most common applications of CGE models is in the area of trade. We first examine what happens if there is a terms-of-trade shock. Let's assume the world price of imports, *pwm,* increases, a situation not uncommon in many developing countries. Obviously, due to the increase of *pwm* the domestic price of imports, PM, will rise, and so will tariffs. If value-added tax is applied to imports, revenues from such a tax will also rise due to a larger taxable base. There will be a tendency of declining volume of imports, reflected through the rotated balance-of-trade line from OT to $OT_1$ in the upper right quadrant in Figure 2. The exact size of the decline depend toward or for on the elasticity in the Armington equation. Whether the nominal values of imports rise or decline will depend on the new equilibrium exchange rate.

A standard analysis of such a terms-of-trade shock suggests that an increase in the world price of the imported good tends to alter not only the domestic prices of imports and exports but also the prices of domestically produced goods. In other worlds, the price ratios which determine the volume of exports, imports and domestic production in the model play a crucial role.

Under a simplified set of assumptions, changes in these price ratios will vary according to the elasticity. At one extreme, there are cases where the domestic production and imports are perfect substitutes, implying a very large, close to infinity, elasticity of substitution. At another extreme, there are cases with zero elasticity of substitution. If the latter applies, the domestic production will decline proportionately with imports—along the OS line in Figure 2—such that the price ratio of domestic production and imports *(PD/PM)* declines, reflected by the transformation of the consumption possibility frontier in the upper left quadrant. The new equilibrium consumption is at $B_1$, where both imports and domestic consumption decline, and the equilibrium point at the production possibility curve in the lower right quadrant moves from A to $A_1$. This implies a rise in *PE/PD*. Consequently, the real exchange rate *(RER)* tends to appreciate.

If, on the other hand, imports and domestic production are perfect substitutes, a decline in imports due to their price increase will result in a more-than proportional *increase* in the domestic production—OS rotates to $OS_1$—such that *PD/PM* increases and *PE/PD* decreases (the production equilibrium moves to $A_1$; see Figure 3). Under such circumstances, *RER* tends to depreciate.

In the real world, however, those two extreme cases are rurely be found. In many developing countries, the elasticity of substitution is small but greater than zero. It must also be realized that such a simple analysis, while useful for a basic understanding of the relationship between production, trade and prices, assumes that there is only one aggregate sector for exports, imports and domestic production. The resulting changes in the exchange rate can consequently be predicted with less complexity. When there are several sectors in each category, however, the relationship between price ratio and exchange rate is more difficult to predict, simply because the direction of movement of prices in each sector may vary, such that no easy prediction can be made as to which direction the aggregate prices will move.

The lack of treatment of capital flows is also rather unrealistic. While one can still use such an analysis for looking at the impact of foreign capital flows, these flows and their changes are assumed exogenous. Yet, with the opening of the economy in many countries, capital flows, especially those of the private type, tend to move in response to some domestic, as well as external, variables (hence, endogenous).

Furthermore, no role of domestic interest rate is assumed whatsoever. Unlike a neo-classical saving-driven model, the model presented in the preceding section assumes that the trend of investment is determined by the interest rate fluctuation, *rloan*, as specified in the investment equation. Hence, it is important to examine the movement of the and interest rate. If, for example, the domestic interest rate rises, it would mean not only lower investment, lower economic activity,

3. There are several ways to define *real exchange rate* (RER). For simplicity, in our context we define *RER* as a deflated nominal exchange rate by using simply the price of domestic good *(PD)*. Hence, RER=EXR/PD. Obviously, over time changes of foreign currency (e.g., dollar) are neglected in such a definition.

but also less price increase. Overused Thus, even if the elasticity of substitution is small, a situation not uncommon in many developing countries, a terms-of-trade shock may *not* lead to a declining PD/PM and increasing *PE/PD*, which also suggests that RER will not necessarily depreciate. Too many other variables affect these price levels.

If, on the contrary, a worsening terms-of-trade makes *RER* appreciate, one can expect declining exports as well. Consequently, the current account balance tends to worsen. Furthermore, lower economic activity will also mean lower income. In turn, with lower income level one could expect a reduction in private consumption. In the end, having lower values of these expenditure components, real GDP *(RGDP)* is also expected to decline.

So much for the macroeconomic variables. What is the repercussion for in income distribution? The factor income tends to decline with lower GDP and investment. Inevitably, the household income is unfavourably affected. By looking at the per-capita income of different household groups (from SAM data), we can observe the change in the relative position of each group.

As indicated earlier, reduced volume of imports in some sectors, due to their price hike, may be substituted, albeit not without cost, by domestic production. Given the fact that import composition in most developing countries is of the non-agricultural category, it can be expected that the domestic production of this sector would increase. The question is, who will benefit from such an increase? Each economy has its own characteristic and own structure. No easy generalization can be made. However, if domestic production indeed increases, those who work in the non-agricultural sector, be it in rural or in urban areas, may be in a more advantageous position than those working in the agricultural sector.

However, taking into account the linkages, both backward and forward, that prevail in the economy, there may still be benefits reaped by some agricultural activities. In terms of income of different household groups, the relative benefits can go to either the "small farmers" or the "large farmers," depending on the predominant structure of production in the respective country.

Table 1 shows simulation results of the model presented above, using 1985 data from an oil-producing developing country, namely, Indonesia. The country's economy suffered from a series of shocks in early 1980s, the most devastating of which were the world economic recession and the plunge in oil prices. The effects of a terms-of-trade shock on the macroeconomic variables appear to be in conformation with the expectation: investment and GDP drop, current account position worsens, primarily due to the more expensive and less elastic imports, and the price level has in general decreased. The latter is due to, among others, a higher interest rate that reduces aggregate demand pressures. However, since there are thirty sectors dealt with in this particular application, a great deal of variation can be found across sectors. Domestic price increases are actually still detected in a number of non-agricultural sectors. Overall, however, there are more sectors experiencing a price decline than those showing a price increase, such that the average price level *(PD* hence *PINDOM)* is lower than that in the baseline.

Reduced imports in some sectors appear to favour the non-agricultural sector. In these import-reducing sectors, the domestic production increases. As a result, factor income and household income also change in favour of those who work in these sectors. More specifically, the largest increase of per-capita income is enjoyed by non-agricultural rural activities ("rural low" and "rural high"). From this stand-point, we can infer that a terms-of-trade shock would have enlarged the income gap between the agricultural and the non-agricultural households. In the urban sector, a slight widening gap of per-capita income between the rich and the poor is also detected, in which the "urban high" enjoys higher income growth than that experienced by the "urban low," that is, 0.6 versus 0.2%[4].

What general conclusion can one then infer in terms of income distribution as a result of a terms-of-trade shock? Taking into account that the number of employment in the agricultural sector is still dominant in Indonesia, a terms-of-trade shock will appear not only to reduce the income level but also to create a worsening income distribution.

**Increased Capital Flows**

Another interesting simulatation is to look at the impact of increased capital inflows. Theoretically, with more foreign exchange available, demand for imported goods may increase, affecting unfavourably the current account balance. Again, given the fact that in many countries there is some degree of substitutability between imports and domestic production, domestic production also tends to increase. More goods can now be consumed, which reflects the standard gain from trade (greater amount of *D* and *M* as shown in the upper left quadrant of *Figure 4*). A less-than proportional increase of domestic production, indicated by the rotation of the consumption possibility frontier, results in a new equilibrium point $B_1$ and in the production space the new equilibrium is at $A_1$, implying higher *PD/PM* and lower *PE/PD*. As a result, *RER* will appreciate.

In recent years, some countries in the so-called 'emerging markets', mostly in the Asia Pacific region, have experienced this phenomenon. Their fast growing and stable economies have attracted much capital from abroad, putting pressure on their currency to appreciate. To maintain the competitiveness of their currencies, however, the monetary authorities in those countries have to intervene by purchasing out of the increased foreign exchange. On the other hand, such a move will increase the money supply due to a larger size of reserve money, and in turn, the inflation rate will go up. This is a common dilemma faced by monetary authorities in countries that receive a large amount of capital inflows.

As capital flows continue, there will be pressures on the domestic interest rate to adjust downward. Consequently, increased investment and greater economic activity can be expected. Real GDP will increase, as will the overall income level. Who will gain the most from such an increase? Under the assumption that a large amount of imported goods are either directly or indirectly consumed more by urban rather than rural households, and most private capital flows have greater linkages with the urban area, it is expected that the income distribution tends to favour the urban household group.[4]

Applying the model to an actual case can help us understand better the mechanism through which macroeconomic and social variables are affected. The case of increased capital flows can be analyzed by adjusting upward the size of the parameter *degree* in the capital flows *(FCAP)* equation. Such an adjustment reflects a policy of liberalizing the capital account, such as through a removal of a rule that directly restricts the amount of capital regulatory dictum that will attract direct foreign investment and other portfolio investment.

In the Indonesian case, column 3 in Table 1 shows that increased capital flows indeed raise imports, worsen the current account balance, but induce greater GDP. The latter is also supported by higher investment due to a lower interest rate. The presence of aggregate demand pressures will push the price level up, but its increase turns out to be very minor, and the strain on the exchange rate is strong enough to make RER appreciate. This explains why exports decline, albeit only by a small amount. Such a decline contributes to a larger deficit on the current account, although by

4. It should be noted, however, that the static nature of the model precludes the possibility of migration, including the rural-urban migration, that may eventually "correct" the urban-rural income gap.

international standards the absolute level of the deficit (US $ 3.6 billion) remains relatively low. Hence, considering the significant increase of real GDP, and minor changes in prices and the current account balance, the overall macroeconomic picture is relatively better than that under the baseline scenario.

As expected, the resulting income distribution favours those who live in the urban area. Agricultural households are affected unfavourably by the reduction of exports due to the appreciation of *RER*. In fact, in absolute terms, the only non-urban households enjoying an income increase are those under the "rural-low" category (see *Table1*).

In sum, one can infer that while increased capital flows tend to affect favourably the country's macroeconomic performance, they are, on the other hand, likely to worsen the relative income distribution between urban and rural, and between agriculture and non-agriculture households. Given the fact that the largest population is in the agricultural sector, especially in the "small farmers" category, the country's overall income distribution would have also been worse.

But the trade-off between macroeconomic trend and income distribution is often grossly misstated. While the above exercise seems to support the presence of a trade-off, in practice a policy response is likely to emerge. Such a response may not necessarily be in the form of a single policy, but rather a *mixture* of policies. One such policy is with respect to government expenditures, in terms of both the size, as well as the sectoral or regional allocation (expenditure switching policy). Therefore, the simplified analysis above may not conform with the real situation. In the Indonesian case, for example, the actual income distribution during the period under observation, in the face of worsening terms-of-trade, turns out to be improving, not worsening, primarily due to a heavy emphasis placed by the government on expenditures for physical and social infrastructures.

Nonetheless, the model simulation helps us to understand better the complex relations between external shock, policy response, and a number of target variables.

### CGE Multiplier *Versus* SAM Multiplier

The inclusion of prices in the list of endogenous variables, which is central in CGE models, changes the whole set of interactions within the system. More specifically, it will produce a more complex multiplier than that under the SAM framework.

The operationalization of the SAM framework is basically reflected through the calculation of multipliers. Through these multipliers policy makers can learn about different impacts on poor groups of society for example, government injections for infrastructure development or curtailment of some public expenditures required by a stabilization program. These are very important policy questions since the success and sustainability of reforms often depend on the extent to which they can provide a sufficient safety net for the less-favoured groups.

However, due to the disaggregation of accounts, *n*, the number of sectors, *m*, the number of institutions and *k*, the number of value-added categories, the complete flows embedded in a SAM framework are too complex to identify unless a specific model is designed to unravel the 'black box.' Policy makers and their advisers tend to be reluctant to draw any conclusion or to recommend a particular policy based simply on the final outcome of multiplier analysis. It is unclear, for example, how an increase in exports is transmitted into an improvement in the relative position of the poor. Consequently, no generalization should be made as to what export-promoting policy will be the most optimal (optimality meaning a reduction of the balance-of-payment deficit and simultaneously an improvement in income distributions). Clearly, such a transmission process needs to be identified.

The SAM multiplier can easily be understood from a simple setting.

$$y = F(x, y)$$

where $y$ is endogenous and $x$ is a vector of exogenous variables. It can be readily seen that the resulting multiplier is more complex than a standard input-output multiplier:

$$dy = [I\text{-}Dy.\ F(x,y)]^{-1}\ Dx.\ Fx,y)\ dx$$

$$= [I\text{-}Dyy]^{-1}\ Dyx\ .\ dx$$

$$dy = M^{SAM}\ \Delta x$$

In the context of economic reform, the challenging question of how policy changes in the reform will affect the income distribution can be readily explained by using the above multiplier. When data permits, an analysis based on a multi-regional SAM would help policy makers to address the question of inter-regional impacts of reform. In large countries such as China, India Indonesia or Brazil, this is an absolutely legitimate issue to raise.

Let us now compare the above multiplier with the following Jacobian multiplier of CGE models. Since prices are endogenous, the following system generally applies in a CGE framework:

$$Y = \Psi\ (x,y,z),$$

where $y$ (quantity) and $z$ (price) are both endogenous, and $x$ is a vector of exogenous variables. a Jacobian multiplier can be derived:

$$dy = [I\text{-}Dyy + Dyz\ (I\text{-}Dzz)^{-1}\ Dzy]^{-1}\ [Dyx + Dyz\ )I\text{-}Dzz)^{-1}\ Dzx]\ dx.\ \Psi\ (x,\ y)]^{-1}\ Dx\ \Psi\ (x,y)\ dx.$$

$$= My^{CGE}\ \Delta x$$

$$dz = Mz^{CGE}\ \Delta x$$

The Jacobian multiplier captures the equilibrium dependence of the endogenous variables upon one another as well as upon exogenous shocks. Compared to the SAM multiplier, three new components appear : *Dyz, Dzz* and *Dzy*. It is easy to see that if these three components are set to zero, the above Jacobian multiplier collapses to the SAM multiplier.

| | *y* | *z* | *x* |
|---|---|---|---|
| *y* | *Dyy* | Dyz | *Dyx* |
| *z* | Dzy | Dzz | *Dzx* |

These three components, indicated by the shaded area in the above chart, have very important interpretations. *Dyz* and *Dzy*, the off-diagonal elements, represent linkages that work through variations in prices. In other words, should there be excess demand in the system, prices will adjust until the excess vanishes. Ignoring this mechanism fails to take account of an important process that often takes place following external shocks and policy changes.

*Dzz* reflects the price interaction in the system. At this juncture, it may be useful to think of economic reforms that have been adopted in many countries since the 1980s. While these reforms may be effective in creating a downward pressure on prices of some upstream industries, prices of many downstream sectors could also be favourably affected. Such a policy direction is among the most common and important phenomena in most economic reforms. In such circumstances *Dzz* should not be ignored in the calculation of multipliers.

A significant implication would be on the size and signs of multipliers. While all elements in a SAM multiplier matrix have positive signs, it is not so in a Jacobian multiplier matrix. Table 2 and Table 3 show an example of multipliers of SAM and CGE respectively, the latter also known as Jacobian multiplier, using US data of 1982.[5] A quick look at the elements of a Jacobian multiplier matrix clearly shows a mixtures of pluses and minuses, different from the all-positive multipliers in SAM. Needless to say, this very point has a very important ramification on the analysis of policy selection and evaluation.

Let's just look at one example. An injection or increased demand, in, say, a 'Light Consumer' industry such as food processing will have a favourable impact on some agricultural products (i.e., positive multipliers). On the other hand, the reverse may produce an opposite impact: increased demand in agricultural products may have detrimental effects upon a "Light Consumer" industry, because it *drives up prices* in this forward industry's input market. Consequently, the multipliers in the fourth row under the first three columns in Table 3 will have negative signs. This is in contrast with all-positive SAM multipliers in Table 2.

## Closing Notes

When a dynamic CGE Model can be constructed, analysts would be able to provide relevant trajectories of variables in the model, and thus would be capable of generating forward-looking policy scenarios. However, building such a model, especially for developing countries, is a daunting task, and in some cases even unrealistic, especially due to the absence of data (e.g., capital stock). Indeed, most CGE models are static in nature. While it is necessary for the models to entail a time frame required for all markets to reach a new equilibrium after a particular shock is made in the system, the time span does not have to be long enough for major dynamic effects to take place.

As final notes, it is worth to exploring the question: when not to use CGE models? As in the case of any model, the cost-benefit of building a CGE model needs to be examined carefully. Although empirical requirements to set up a CGE model are relatively small (no time-series numbers are needed) the disaggregated data required are often not easy to collect, not to mention the parameters that need to be calibrated within the system. An important factor to consider is the extent to which policy changes or external shocks are likely to create intersectoral and/or macroeconomic effects. Some shocks may induce only microeconomic and sectoral implications with no intersectoral repercussions. Under such circumstances, an elaborate CGE model is unnecessary. But when the shocks or policy changes influence macroeconomic variables as well as microeconomic and intersectoral linkages, the entry into CGE modelling would have been worthwhile.

5. The example is taken from Robinson, Sherman & David W. Roland-Holst, "Macroeconomic Structure and Computable General Equilibrium Models," *Journal of Policy Modelling*, 10(3) : 353-375, 1988.

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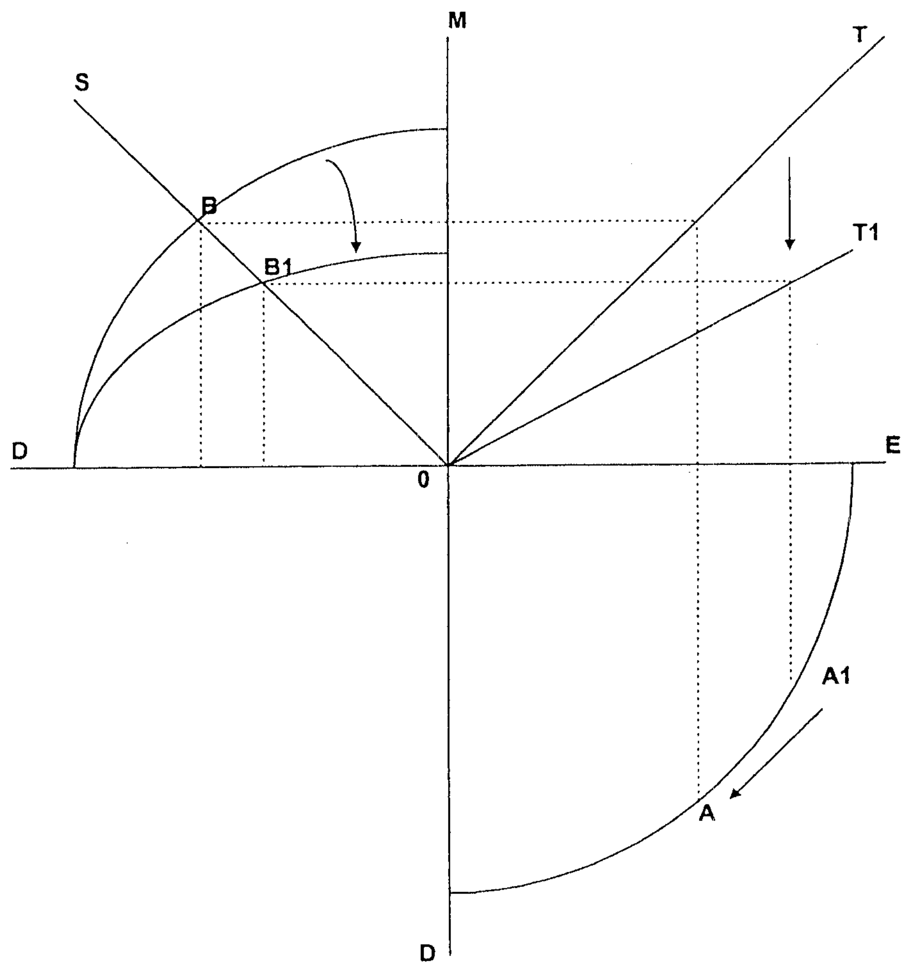


**Figure 2: Terms-of-Trade Change, with Zero Elasticity**

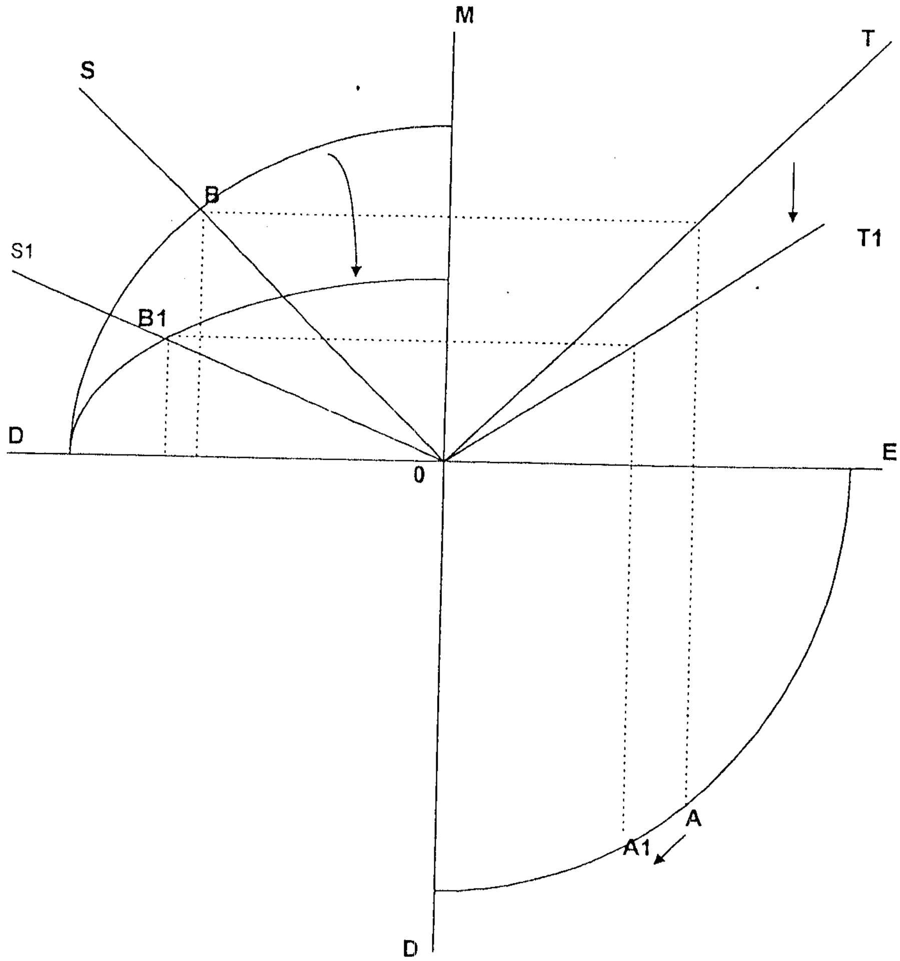


**Figure 3: Terms-of-trade change, with infinite elasticity**

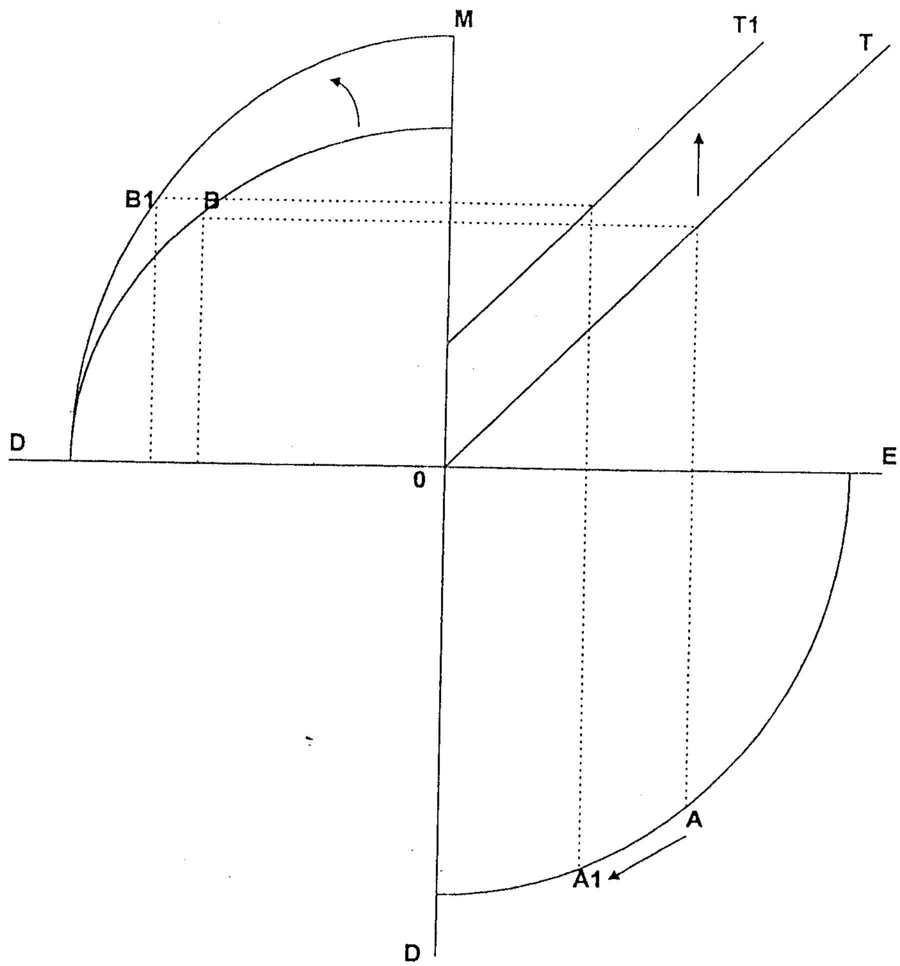


**Figure 4: Increased capital flows**

**Table 1: Results of CGE Model Simulation for An Oil-Producing Country**

| | Baseline | Terms-of-Trade Shock | Capital Flows |
|---|---|---|---|
| **MACRO DATA** | | | |
| RGDP | 1.0000 | 0.9549 | 1.0025 |
| Interest Rate | 1.0000 | 1.0824 | 0.9878 |
| Investment | 1.0000 | 0.8687 | 1.0208 |
| Imports | 1.0000 | 0.9739 | 1.0206 |
| Exports | 1.0000 | 0.9711 | 0.9955 |
| Current Account* | 1.0000 | 1.0241 | 1.1433 |
| Domstic Prices (PD) | 1.0000 | 0.9707 | 1.0024 |
| Import Price (PM) | 1.0000 | 1.1616 | 0.9878 |
| Export Price (PE) | 1.0000 | 0.9612 | 0.9873 |
| Capital Flows | 1.0000 | 1.0772 | 1.4604 |
| Nominal Exchange Rate | 1.0000 | 0.9552 | 0.9854 |
| Real Exchange Rate | 1.0000 | 0.9845 | 0.9829 |
| **MICRO DATA** | | | |
| Per-cap Household Income | 1.0000 | 0.9111 | 1.0050 |
| Per-cap Composition: | | | |
| ***Rural*** | | | |
| 1. Agriculture | | | |
| - Agric. Workers | 1.0000 | 1.0040 | 0.9997 |
| - Small Farmers | 1.0000 | 1.0024 | 0.9997 |
| - Medium Farmers | 1.0000 | 0.9951 | 0.9996 |
| - Large Farmers | 1.0000 | 0.9886 | 0.9997 |
| 2. Rural Low | 1.0000 | 1.0100 | 1.0001 |
| 3. Rural High | 1.0000 | 1.0150 | 0.9994 |
| ***Urban*** | | | |
| 1. Urban Low | 1.0000 | 1.0022 | 1.0006 |
| 2. Urban High | 1.0000 | 1.0057 | 1.0001 |

Note : (*) Since it is a negative number (deficit), greater-than unity means larger deficit.

**Table 2 : SAM Multipliers**

| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | Average |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1. Dairy & Meat | 1.289 | 0.089 | 0.062 | 0.175 | 0.043 | 0.044 | 0.055 | 0.044 | 0.049 | 0.052 | 0.071 | 0.060 | 0.053 | 0.054 | 0.153 |
| 2. Grains | 0.406 | 1.115 | 0.038 | 0.107 | 0.026 | 0.026 | 0.033 | 0.026 | 0.029 | 0.031 | 0.042 | 0.036 | 0.031 | 0.031 | 0.141 |
| 3. Other Agriculture | 0.091 | 0.067 | 0.091 | 0.074 | 0.027 | 0.027 | 0.037 | 0.026 | 0.032 | 0.034 | 0.045 | 0.038 | 0.034 | 0.033 | 0.118 |
| 4. Light Consumer | 0.727 | 0.449 | 0.426 | 1.771 | 0.391 | 0.400 | 0.604 | 0.398 | 0.447 | 0.460 | 0.626 | 0.534 | 0.475 | 0.482 | 0.578 |
| 5. Basic Int | 0.777 | 0.906 | 0.726 | 0.729 | 2.044 | 0.776 | 0.952 | 0.668 | 0.561 | 0.657 | 0.685 | 0.624 | 0.577 | 0.853 | 0.824 |
| 6. Capital Goods | 0.342 | 0.373 | 0.330 | 0.298 | 0.297 | 1.545 | 0.366 | 0.300 | 0.287 | 0.326 | 0.307 | 0.322 | 0.319 | 0.734 | 0.439 |
| 7. Construction | 0.314 | 0.349 | 0.312 | 0.273 | 0.267 | 0.230 | 1.267 | 0.210 | 0.266 | 0.312 | 0.254 | 0.272 | 0.274 | 0.807 | 0.386 |
| 8. Electric | 0.084 | 0.089 | 0.079 | 0.080 | 0.071 | 0.104 | 0.091 | 1.116 | 0.081 | 0.087 | 0.106 | 0.099 | 0.092 | 0.105 | 0.163 |
| 9. Whl & Ret Trade | 0.661 | 0.638 | 0.572 | 0.592 | 0.502 | 0.538 | 0.651 | 0.484 | 0.599 | 0.562 | 0.740 | 0.659 | 0.618 | 0.676 | 0.678 |
| 10. Services Industry | 1.434 | 1.408 | 1.283 | 1.357 | 1.254 | 1.257 | 1.458 | 1.142 | 1.460 | 2.421 | 1.863 | 1.578 | 1.463 | 1.421 | 1.486 |
| **Totals** | 6.124 | 5.483 | 4.918 | 5.456 | 4.922 | 4.946 | 5.413 | 4.413 | 4.812 | 4.941 | 4.740 | 4.223 | 3.935 | 5.195 | 4.966 |
| 11. Low 40% HH | 0.189 | 0.203 | 0.185 | 0.176 | 0.160 | 0.162 | 0.187 | 0.150 | 0.186 | 0.193 | 0.177 | 0.156 | 0.145 | 0.179 | 0.246 |
| 12. Med 40% HH | 0.715 | 0.741 | 0.696 | 0.689 | 0.615 | 0.665 | 0.755 | 0.612 | 0.747 | 0.744 | 0.690 | 1.611 | 0.571 | 0.723 | 0.755 |
| 13. High 20% HH | 0.813 | 0.858 | 0.794 | 0.769 | 0.693 | 0.725 | 0.830 | 0.668 | 0.823 | 0.836 | 0.771 | 0.681 | 1.636 | 0.793 | 0.835 |
| HH Totals | 1.717 | 1.801 | 1.675 | 1.634 | 1.468 | 1.552 | 1.772 | 1.429 | 1.756 | 1.773 | 2.638 | 2.448 | 2.351 | 1.695 | 1.837 |
| 14. Capital Acct | 0.434 | 0.498 | 0.431 | 0.377 | 0.354 | 0.311 | 0.371 | 0.288 | 0.373 | 0.424 | 0.338 | 0.387 | 0.398 | 1.353 | 0.453 |

**Table 3 : Jacobian Multipliers**

| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | Average |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1. Dairy & Meat | 1.089 | -0.100 | -0.049 | 0.089 | -0.008 | -0.012 | -0.008 | -0.012 | -0.017 | -0.015 | 0.005 | 0.002 | -0.002 | -0.016 | 0.068 |
| 2. Grains | 0.296 | 0.828 | -0.037 | 0.053 | -0.005 | -0.007 | -0.005 | -0.008 | -0.010 | -0.009 | 0.002 | 0.000 | -0.002 | -0.010 | 0.077 |
| 3. Other Agriculture | 0.005 | -0.031 | 0.535 | 0.010 | -0.007 | -0.011 | -0.008 | -0.011 | -0.013 | -0.011 | -0.003 | -0.005 | -0.006 | -0.012 | 0.031 |
| 4. Light Consumer | -0.114 | -0.476 | -0.305 | 1.007 | -0.037 | -0.049 | -0.016 | -0.059 | -0.092 | -0.079 | 0.084 | 0.060 | 0.038 | -0.073 | -0.008 |
| 5. Basic Int | -0.290 | -0.103 | -0.297 | -0.307 | 0.731 | -0.221 | -0.197 | -0.282 | -0.511 | -0.472 | -0.378 | -0.340 | -0.335 | -0.112 | -0.221 |
| 6. Capital Goods | -0.131 | -0.061 | -0.140 | -0.145 | -0.098 | 0.994 | -0.096 | -0.079 | -0.178 | -0.194 | -0.146 | -0.056 | -0.019 | 0.472 | 0.009 |
| 7. Construction | -0.045 | -0.056 | -0.074 | -0.012 | 0.021 | 0.014 | 0.993 | 0.022 | 0.006 | -0.028 | -0.012 | 0.097 | 0.145 | 0.868 | 0.139 |
| 8. Electric | -0.018 | -0.003 | -0.022 | -0.018 | -0.015 | 0.005 | -0.014 | 0.662 | -0.024 | -0.024 | -0.004 | 0.006 | 0.009 | 0.046 | 0.042 |
| 9. Whl & Ret Trade | 0.014 | 0.041 | -0.088 | -0.007 | 0.007 | 0.013 | 0.039 | -0.058 | 0.869 | -0.092 | 0.125 | 0.127 | 0.127 | 0.032 | 0.082 |
| 10. Services Industry | -0.027 | 0.110 | -0.188 | -0.041 | 0.040 | -0.007 | 0.000 | -0.148 | -0.082 | 0.696 | 0.344 | 0.255 | 0.232 | -0.214 | 0.069 |
| **Total** | 0.780 | 0.149 | -0.664 | 0.629 | 0.630 | 0.719 | 0.706 | 0.026 | -0.051 | -0.226 | 0.017 | 0.148 | 0.188 | 0.981 | 0.288 |
| 11. Low 40% HH | -0.028 | -0.015 | -0.048 | -0.006 | 0.007 | 0.014 | 0.012 | -0.023 | -0.009 | 0.002 | 0.998 | 0.000 | 0.001 | -0.145 | 0.054 |
| 12. Med 40% HH | -0.109 | -0.210 | -0.119 | 0.004 | -0.011 | 0.075 | 0.063 | 0.021 | 0.047 | 0.031 | 0.027 | 1.034 | 0.038 | -0.184 | 0.050 |
| 13. High 20% HH | -0.113 | -0.125 | -0.142 | -0.010 | 0.005 | 0.070 | 0.058 | -0.037 | 0.063 | 0.018 | 0.008 | 0.017 | 1.022 | -0.371 | 0.029 |
| HH Total | -0.250 | -0.349 | -0.309 | -0.012 | 0.001 | 0.156 | 0.133 | -0.038 | 0.044 | 0.051 | 1.033 | 1.051 | 1.061 | -0.699 | 0.134 |
| 14. Capital Acct | -0.123 | -0.242 | -0.163 | -0.009 | 0.039 | 0.063 | 0.060 | -0.023 | 0.080 | -0.038 | 0.000 | 0.220 | 0.318 | 1.772 | 0.140 |