IMPROVING POLICY ANALYSIS BY LINKING AN INDONESIAN CGE AND AGRICULTURAL SECTOR MODELS

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ABSTRACT

Key Indonesian agricultural policies not only have significant impacts at the farm and sector levels but economy-wide as well, and should be analysed at all these levels. However, most analysis of these policies has been at a single level and with no integration of analysis across the various levels. In this paper, linkages between models used in analysis of agricultural policies at various levels are considered through the choice of specifications, in particular parameter estimates. Well-based estimates of key Computable General Equilibrium (CGE) model parameters are fundamental to the results obtained when using such models in policy analysis.

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Introduction

As with many developing countries, Indonesia's agricultural sector is a key component of its economy. This applies both in terms of resources used - the sector employing about half the workforce - and output produced - the sector contributing to over half of consumers expenditures. Thus major agricultural policies, such as those involving the subsidisation of key inputs or outputs, will not only have an impact at the farm and sector level but also economy-wide. The reverse situation can apply also - general policies applied at the economy-wide level, such as those affecting consumer demand, can have a significant impact at the farm and agricultural sector level.

Because major policies have wide ranging impacts, their analysis should be comprehensive, covering all levels. However, this is rarely the case. Most agricultural policies have been analysed either at the farm or sector level with very little consideration of their economy-wide impact. For example, the fertiliser subsidy aimed initially at assisting the uptake of new high yielding rice varieties, has been analysed directly with farm level models (for example, Sawit and O'Brien 1993) and sectoral models (for example, Rosegrant et al 1987, Piggot et al 1993), but only for its impact at these levels. What consideration there has been of the economy-wide impacts of such policies has generally been indirect via economy-wide level models analysing some specific aspect like the budgetary implications (for example, Behrman et al 1989). The reverse situation also applies with macroeconomic policies having rarely been analysed in terms of their sectoral impact, let alone their impact at the farm level. The fact that little of the analysis has considered the policies at more than one level was an aspect criticised in the Ellis Report (Ellis 1988) in relation to sectoral models not incorporating farm level information into their specification. If more than one level of analysis has been presented then it is generally in an independent fashion with no integration of the models used in the various levels of analysis.

How can models used in the various levels of analysis be integrated or linked? Basically, linkages can take place in any of the main components in a model's specification, namely the theoretical specification, the parameters and the data. Models used in the different levels of analysis may carry through consistent theoretical specifications, parameter estimates or be based on data that is consistent between levels.

One aspect that hinders integrated multi-level analysis, is that the models used in the analysis at the various levels can be based on different frameworks. For example, parameter estimates for the sectoral models are usually obtained from econometric estimation techniques aimed at maximising the goodness of fit to real world data. In contrast, economy-wide CGE model parameters are usually assigned on the basis of methods that try to capture the equilibrium specification of the model. A 'good' sectoral model estimate may not correspond to a 'good' CGE model estimate.

To integrate the models used in the analysis at the various levels requires at a minimum some unifying principle that applies in all the levels frameworks. The principle underlying the goodness of fit criteria applied in the econometric estimation of the parameters of the sectoral models concerns prediction. If model parameters 'predict' the best fit of past data then they will most likely predict best the fit of future data given no change in structure. A similar principle would appear to apply at the other levels of analysis, although in the case of the economy-wide CGE modelling the prediction may not always concern quantitative measures but economic theoretical outcomes or even required input specifications being satisfied.

The shortcomings of narrow and unintegrated analysis are addressed in this paper. Linkages between models used in analysis at various levels are considered in terms of the economic specification. A key focus in this development is the linkages between estimates for sectoral and CGE models. The theoretical developments analysed in the paper are applied to the determination of demand parameters for an Indonesian CGE model with strong linkages to a detailed agricultural sector specification (INDOGEM [Trewin, Erwidodo and Huang1993]).

Some linkages between different level models

Linkages in specifications

Consumer demand is a useful aspect for considering possible linkages in specification between the various level models. Sawit and O'Brien (1993) have developed a farm household model for Indonesia which has a number of implications for the specification of both sectoral and economy-wide models. Farm level analysis was seen as particularly important in determining more aggregate specifications (Ellis 1988). The farm household is treated both as a consumer and producer in the Sawit and O'Brien model. The household receives utility from consumption of market goods, its own agricultural products as well as leisure time. Households are assumed to allocate their discretionary time to working on the farm, to non-agricultural activities and to leisure (including home production). Part of food production is consumed within the household and part of the labour used on the farm is derived from family labour. Thus there are strong interactions between consumption and production.

Given the above interactions it is not surprising that certain household characteristics and endowments, for example the number of workers in the household, influence household behaviour such as consumer demand. More specifically, in the Sawit and O'Brien model (Sawit and O'Brien 1993) commodity demand is estimated as a system of budget share equations[1] in five commodities (including leisure time) and including household characteristics as explanators along with the usual prices, incomes and costs. The number of workers in the household also acts as an input to agricultural production.

The model also demonstrated the need to distinguish between male and female workers. Different male and female responses are estimated in aspects such as production with respect to wages and labour supply with respect to rice prices.

The male/female responses and household characteristics/endowments/budget constraints may need to be incorporated in some fashion into sectoral and economy-wide models that purport to represent consumer behaviour. Traditionally such models have been applied empirically to aggregate market data without accounting for such aspects. When such models have been applied to less aggregate data, aspects such as commodities, regions and expenditure groups, and sometimes sex are distinguished, but rarely household characteristics (see for example, Rosegrant et al [1987] and CARD [1990]). The male/female responses are relatively simple to represent so long as separate series on male and female workers are available. A difficulty with household characteristics, individual tastes and so on is that differences are often averaged out or otherwise altered in the processing of the data prior to the analysis. An example of this is the conversion of household data into per capita terms which removes any household characteristics such as household size (Timmer and Alderman 1979). Even if the impact of farm level variables such as the number of workers in the household is not removed by the processing of the data prior to analysis, they may be more difficult to represent in higher level models. For example, a time series of average values of such variables may not be sufficient to represent their impact. Measures of their variability may also be required in sectoral models. This would be a similar situation to that faced in price stabilisation analysis (see for example Newbery and Stiglitz 1981).

The treatment of households as both producers and consumers in the model emphasises the endogeneity of household income. Household income is often treated as exogenous in sectoral models whereas CGE models offer the flexibility for it to be treated as either endogenous or exogenous. On the other hand, many CGE models such as the ORANI model (Dixon et al 1982) use traditionally determined demand elasticities as parameters. The farm level analysis would suggest more elaborate demand specifications would be required to determine these parameters if household characteristics/endowments/budget constraints and male/female responses are important. This aspect is covered in more detail in the next part

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[1] These equations are of the Linear Approximation to the Almost Ideal Demand System or LA AIDS variety (Deaton and Muellbauer 1980)

Linkages between estimates

Even if the models used in the various levels of analysis are linked by consistent specifications there is still the question of linkages between possible parameter estimates for the models. The main interest in the following is linkages between sectoral and CGE model parameter estimates. This is because the linkages between farm and sectoral model parameter estimates are relatively straight forward, being based on similar econometric frameworks. In contrast, CGE models have specifications concerned more about consistency with general equilibrium economic theory than econometric aspects such as goodness of fit to real world data.

Now that the processes of model building and solving have become less costly because of the developments of appropriate software, greater emphasis has been given to other aspects of applied general equilibrium modelling, such as parameter estimation. There is a growing appreciation that the results obtained from CGE models are highly dependent on some parameter estimates used in the models. Hertel states that a CGE model is only as strong as its partial equilibrium components representing producer and consumer behaviour (Hertel 1990). This statement assumes that CGE model parameters are derived from partial equilibrium models, which has not always been the case, but the basic sentiment holds true regardless.

How may CGE parameter estimates be determined? There are two basic forms reflecting the relative emphasis on econometric estimation versus computational derivation consistent with general equilibrium theory, for example calibration (Mansur and Whalley 1984). There are varying approaches within these basic forms, for example the econometric approach may be based on estimating a full system (see for example, Jorgenson 1984) or separate subsystems. The computational approach may derive the CGE model parameters directly or indirectly. An example of this last approach is the relationship between the required substitution elasticities, externally available own-price elasticities and shares information from input-output tables (Higgs 1986). Each form, or approach, has its advantages and disadvantages. For example, the costs of deriving econometric estimates can be high but this has to be balanced against the greater faith that may be placed in the estimates. Computationally derived CGE parameter estimates may be consistent with the underlying general equilibrium theory but not with real world data. Such tradeoffs could be important in determining the most appropriate approach. The objective should be to integrate as adequately as possible well specified estimates into a fully consistent optimising framework of CGE modelling.

An initial choice in the econometric approach to obtaining parameter estimates for inclusion in CGE models is what functional form should be applied. There is a basic dichotomy in this choice - simple and more restrictive versus more complex and flexible forms - and associated trade-offs. Whilst more flexible forms may fit the data better they are often more difficult to estimate and fail to satisfy requirements or restrictions implied by the underlying economic theory (Mansur and Whalley 1984). In addition, more flexible approaches such as those based on dual cost functions face greater data problems (Warr 1992).

Another choice involved in the econometric approach is whether to undertake full system or subsystem parameter estimation. Often there is no choice because full system estimation is not possible - the number of estimated parameters being too large to enable the system to be identified or to be estimated with available data. These may even be problems for a subsystem approach which has the added difficulty of requiring assumptions about what parts of the system may legitimately be estimated as subsystems. The attitude to this last aspect is somewhat schizophrenic - estimates are determined assuming certain variables are exogenous then inserted into a model that explicitly recognises the endogeneity of the variables!

As mentioned above, CGE model parameter estimates are often determined by computational, and not econometric approaches. One such approach is calibration, or choosing the parameters so that the model can reproduce base year data as a solution (Mansur and Whalley 1984). As with the econometric approach an initial choice in the calibration approach concerns what functional form should be used. The more restricted the functional form the less degrees of freedom available for the choice of parameter estimates. For example, if the Cobb-Douglas form is chosen then calibration will uniquely determine all parameters. However, if the commonly used Constant Elasticity of Substitution form is chosen then exogenously determined elasticity estimates will be required before the other parameters can be determined by calibration. These exogenously determined elasticity estimates are often obtained from a literature search of existing estimates. The computational approach has been criticised on a number of grounds including under identification, lack of flexibility and providing no measurement of reliability (see for example, Lau 1984).

The final stage before the actual calibration[2] can be undertaken is the construction of a benchmark equilibrium data set. This aspect is discussed in the next part on data linkages.

Data linkages

Data linkages concern more than the obvious aspects of data at each level having similar underlying measurement concepts and appropriate consideration of aggregation effects. As alluded to in the last part they also concern linkages between the data and the economic theory specification that is to be appropriately represented. For example, the data applied to the specification of a sectoral model is generally real world data. In contrast, the data applied to the specification of a CGE model should be data that reflects a general equilibrium situation. A little more detail on the calibration approach will make the distinction clearer.

A preliminary step in calibrating a model is to construct a benchmark data set and this normally involves substantial reorganisation of conventional national income and other accounts to represent a general equilibrium situation (Mansur and Whalley 1984). The national income accounts are designed mainly for determining macroeconomic aggregates. In general, they incorporate very few general equilibrium aspects and usually at an aggregate level, an example being the aggregate income-expenditure identity. Similar identities generally do not hold at less aggregated levels, for example household expenditure data is usually inconsistent with production-side data. Various adjustments are required for the data to represent a general equilibrium situation, covering differences in measurement concepts, classifications and data correction methods. In addition, some averaging over years is usually undertaken to smooth the data of extreme variations. All these adjustments are costly, an aspect that should be borne in mind when determining the estimation approach to be undertaken. However, such costs may be unavoidable if estimated parameters are to reflect an equilibrium situation, whether these are determined by calibration or econometric approaches. Either the data has to be adjusted to reflect the theoretical model or the theoretical model supplemented so that it not only incorporates the theoretical model but also better reflects real world data.

Testing the linkages

Testing linkages between specifications and parameter estimates requires some benchmark for assessing a specific model's performance. Generally, a model's performance is assessed on the basis of how 'adequately' it represents the real world in terms of its 'anticipated uses'. This assessment is often formal, based on predictive performance. However, assessment can mean more than this.

Assessment can also relate to how well the model specification represents reality in terms of the underlying economic theory, model structure and the level of disaggregation - for example, a regional dimension is often considered essential in modelling aspects of the Indonesian economy. Thus, a model may be assessed or validated by assumption as well as by results (Dermawan and Erwidodo 1993). Validation by assumption is not devoid of quantitative aspects, for example a particular assumed economic theory may have support from past quantitative studies.

How may a formal assessment based on predictive performance be implemented when a 'good' CGE model generally refers to how well it captures general equilibrium theory whereas real world data more than often reflects disequilibria? One method alluded to above was to adjust the data to be used in the modelling and assessment to reflect the general equilibrium situation. There is an

[2] An interesting aside concerns the calibration approach as applied to levels specifications and a similar approach as applied to differenced specifications. The computational approach as applied to differenced specifications involves the use of equilibrium shares from the input-output tables and exogenously determined elasticity estimates. As no calibration can be undertaken to reproduce the base year with a differenced specification it would appear that this may not be important in this approach. However, it has been found that updating procedures for simulating large changes in a differenced specification can go astray unless the underlying levels specification reflects a calibrated situation.

implicit model in the adjustments used in such an approach. An alternate approach would be to introduce this implicit adjustment model from the other direction. In other words, supplement the specification of the general equilibrium model so that it better reflects real world data. An approach along these lines is discussed in Hertel and Tsigas (1993) in which 'slack' variables are added to a usual CGE model specification so that the composite specification better reflects partial equilibria and real world data. For example, if a tradeable price is fixed then an associated endogenous 'slack' variable is specified to represent the excess supply or demand that will occur in any movement to a new market situation. Making CGE models more useful for predicting or forecasting appears a current focus (see for example Dixon 1993) and can only assist in providing better means of assessing the performance of such models. A key aspect of making CGE models more useful for forecasting is improvements in their dynamic specifications.

No matter what approach has been used to determine the parameters of a CGE model, sensitivity analysis is an important stage in assessing the model (Pagan and Shannon 1987). This stage is even more important when some of the data underlying the model may be unreliable as it puts greater emphasis on internal consistency (a change in one variable leads to other expected changes - a key aspect of sensitivity analysis), rather than predictability. Sensitivity analysis will identify what parameter choices will be critical to the results obtained and where estimation and assessment should be concentrated. Thus sensitivity analysis should be undertaken at an early stage of the overall specification search, once an initial model has been specified.

The terms 'adequately' and 'anticipated uses' are important in the above definition of performance assessment and raise issues such as whether the benefits of improving the model outweigh the costs; the model's performance relative to alternative models: and whether the model can contribute to 'better' decisions. It was mentioned earlier how benefit-cost tradeoffs were important in choosing between alternate models. An important aspect of any assessment is that a model can never be assessed as 'valid', only as 'invalid'.

Application with different demand estimates

Choice of estimates

There are a number of difficulties involved in using external estimates of CGE model parameters such as demand elasticities. For example, the underlying specification used in obtaining the external estimates may not correspond to that desired, say in terms of the level of disaggregation. In addition, various estimates will be available for use in the model each associated with different choices of economic specification, data and econometric technique. There is a question of the faith that can be placed in external estimates.

In the initial versions of INDOGEM, parameter estimates were obtained by expanding those provided in the Dee model (Dee 1991) from which INDOGEM was developed. Thus when agriculture was disaggregated into specific commodities such as rice, all the disaggregated commodities took the same parameter values as were assigned at the aggregate level in the Dee model. The estimates in the Dee model were based on judgement. For example, judgements were made as to whether commodities were 'necessities', 'luxuries' or somewhere in between before they were assigned the values 0.8, 1.0 or 1.2 for household expenditure elasticities[3]. Own and cross-price consumption elasticities were determined from relationships involving the expenditure elasticities, the Frisch parameter (assumed to be -3.0) and household budget shares (see Dixon et al 1982). In the case of rice, an own-price consumption elasticity of -0.27 would be determined.

The determined value of -0.27 for the own-price consumption elasticity of rice compares to the value -0.55 estimated using the Sawit and O'Brien farm household model (Sawit and O'Brien 1993) and the range of values -0.08 to -0.40 used in the Rosegrant et al sectoral model[4] (Rosegrant et al 1987). Rosegrant et al used 1981 SUSENAS data to obtain econometric estimates of rice demand elasticities. The household expenditure elasticities for rice were 1.02 in the case of the Sawit and

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[3] This was apart from the value assigned to other manufacturing commodities. The household expenditure elasticity value for other manufacturing commodities was calculated as a residual to ensure the share weighted sum of expenditure elasticities equalled unity (the Engel aggregation condition).
[4] The -0.08 value corresponds to high income/urban consumers and the -0.40 value to low income/rural consumers.

O'Brien model and 0.02 to 0.20 for the Rosegrant et al model. The higher values obtained by Sawit and O'Brien most likely reflect specific locational aspects plus the cross-sectional nature of the analysis rather than household characteristics. Timmer and Alderman (1979) obtained similar high values for low income classes in rural areas (0.9 to 1.2 for rural income elasticities and -1.9 to -1.5 for own-price elasticities). Timmer and Alderman (1979) interpret the estimates obtained from cross-sectional data as long-run responses after a number of years of adjustment to new income and price levels. Rosegrant et al adjusted downwards their estimates from cross-sectional data to obtain short run estimates.

The most recent and comprehensive estimates that correspond best to the INDOGEM classification are those produced for the Bappenas Agricultural Sector Model (Altemeier 1992). These estimates are based mainly on 1987 SUSENAS data and use the LA AIDS specification mentioned in relation to estimates from the farm household model. The expenditure elasticities were 0.31 for rice[5], 0.41 for maize, 0.75 for soybeans, 0.10 for other food crops, 1.00 for estate and other non-food crops, 0.82 for livestock and 1.00 for fisheries.

Some initial work on specific estimates for INDOGEM has been undertaken in CASER (Rachmat and Erwidodo 1994). Demand elasticities were estimated for the main foods with an AIDS specification using 1990 household data. Significant differences in the estimates were observed both regionally and for different income groups. The own price and expenditure elasticities were larger than those listed above. Reasons for these differences have already been given but Rachmat and Erwidodo give an additional reasons as the small number of commodities included in the analysis. If there is a consistent overestimation, then the significant variation in the estimates indicates the need to disaggregate households in INDOGEM on the basis of regions and income groups if the results are sensitive to the settings of the demand parameters. This work will be extended once the final specification of INDOGEM and critical parameters have been determined.

Policy analysis with the estimates

A number of key Indonesian agricultural policies have been analysed with models specified at various levels. One such policy is the subsidy of key inputs such as fertiliser and irrigation. These policies are financed from consolidated revenue mainly obtained from exports of oil

Sawit and O'Brien (1993) analysed a number of agricultural policies via the elasticity estimates obtained from their farm household model (see Table 1). With regard to the fertiliser subsidy, rice supply is estimated to be not very responsive to changes in fertiliser prices suggesting output price support could be a more effective policy. Moreover, increases in the price of fertiliser have almost no effect on household consumption and labour absorption. Also mentioned in the analysis, although not measured, were the benefits that may accrue from replacing the subsidy with other forms of expenditures.

Rosegrant et al (1987) have also analysed such policies via a multi-market food crops model designed to consider market balances, farm revenues, consumption expenditures, trade and government interventions. Scenarios such as 'low productivity growth' (a reduction in the irrigation development budget), a fertiliser subsidy phase-out and market output pricing are considered by altering the settings of exogenous variables such as areas under irrigation, modern rice varieties and intensification programs as well as fertiliser and crop prices. The main outcome of these scenarios was a decline in rice production over that likely to be achieved with a continuation of the policies (see Table 2). In fact, Indonesia was predicted to become a growing net importer of rice. Similar results were obtained with the Bappenas Agricultural Sector Model (Altemeier 1992) when pessimistic yield potentials were assumed. However, more optimistic yield potentials predicted a constant surplus. Another interesting result obtained from the analysis with this model was that agricultural output increases have not been matched by income from agricultural employment. The outcomes from all the sectoral models are highly dependent on the assigned parameters. For example, the small predicted growth in per capita rice consumption is a consequence of the relatively low income elasticity of demand. The effectiveness of the fertiliser subsidy is dependent on farmers remaining highly responsive to changes in the price of fertilisers. The assumed impact of Indonesian rice imports on world prices is also important for these outcomes, for example whether farmers or

[5] Published separate estimates for Java and off-Java differed little

consumers bear the brunt of the costs of the subsidy removal. The economy-wide implications of budget reductions were not considered, nor could they be in such sectoral models.

Aspects of Indonesian fertiliser and other policies have undergone some analysis with CGE models. In particular, Keyzer and van Veen (1990) considered a scenario which incorporated a 50 per cent reduction in Indonesian producer subsidies on rice, wheat products and fertiliser, compensated by a 0.75 per cent increase in value added at a flat rate of (consumption) tax. Income elasticity estimates of 0.46 for rice and 0.94 for livestock obtained from a restricted two-level AIDS/LES specification were only slightly larger than those used in the Bappenas model. In brief no dramatic impacts[6] were observed although this outcome can depend critically on the specification of the model, including its closure (whether variables such as wages are assumed exogenous or not). There are other relevant scenarios. Tolentino and Balisacan (1992) in a Philippines study reduced the real price of fertiliser through a negative tax (equivalent to a subsidy), financed via donor funds which did not involve a direct trade-off with the rest of the economy. Income elasticity estimates of 0.38 for cereal and 0.81 for fisheries obtained from a LA AIDS specification were around those used in the Bappenas model. Expected results were obtained, namely a rise in fertiliser use, agricultural production, consumption, the budget and trade deficits and GDP. In the Indonesian situation there would be trade-offs with the rest of the economy and restrictions such as revenue neutrality should be applied (through maintaining the real public sector borrowing requirement).

Further analysis of such scenarios was undertaken with the INDOGEM CGE model (Trewin, Erwidodo and Huang 1993), not only to analyse the significance of impacts in relation to those observed in lower level models but also to test the sensitivity of any impacts to the choice of certain parameters. The main aspects of the economic environment reflected in the closure of the model used in the analysis were as follows. Real wages of unskilled workers were assumed exogenous and employment levels endogenous. The reverse situation was assumed for professional workers. Industry rates of return on capital were fixed and capital stocks allowed to adjust through investment and inter-industry capital flows. Land was assumed mobile between agriculture and forestry.

The main shock analysed using the INDOGEM model was a 10 per cent increase the real price of fertiliser through a tax (equivalent to decreasing the subsidy), compensated by a 25 per cent lowering of consumption taxes so that the real public sector borrowing requirement remained fixed. The uncompensated situation along the lines of the scenario analysed in Tolentino and Balisacan (1992) was also analysed. The scenarios were analysed with the initial demand elasticity estimates and then with estimates obtained from recent sectoral modelling. The results of the analyses were measured in terms of changes in GDP, overall prices, exports and imports, commodity and factor activity levels, income and consumption.

The results for the compensated case with initial demand parameter estimates (Table 3) revealed expected increases in the price of fertiliser and large falls in activity levels for fertiliser and most food products, especially the smaller off-Java rice industries. Mineral processing was the only activity that increased significantly because of a marked rise in export demand. Because of relevant parameter settings, demand in mining industries export markets is highly responsive to price changes and hence to changes in domestic costs. The largest rice industry of irrigated rice/on-Java declined only slightly mainly as a consequence of the more expensive fertiliser being substituted with land. The other rice industries had significant falls in demand for fertiliser, land and labour inputs. Most of this land went into other rural production. These falling factor demands were reflected in the price of labour, capital and land declining for agricultural commodities. A large fall was observed in agricultural employment, however wages of professionals rose. There was also a fairly uniform drop in consumption across all commodities. Exports increased considerably more than imports, improving the balance of trade substantially. Real GDP fell only slightly.

The small drop in GDP and accompanying large increase in exports illustrates some of the important economy-wide impacts that sectoral policies can have and which should be measured. The CGE analysis also illustrated some desirable resource allocation effects with the activity levels of some low cost industries such as agricultural and minerals processing increasing. The increased activity in

[6] Small impacts are often observed in CGE models. Dixon (1993) puts this down to the modelling omitting key mechanisms such as the effects of increased competition on the structure of industries as well as management and union behaviour, and appropriate dynamics and adjustment costs. Such mechanisms can be captured by exogenous productivity improvements and so on but really should be incorporated explicitly in the modelling.

agricultural processing as a result of cheaper inputs whilst activity in most agricultural commodities fell away illustrated the importance of CGE modelling taking account of all intersectoral linkages.

The results for the compensated case with the new demand parameter estimates (Table 4) were similar in terms of the macroeconomic measures and most of the domestic commodity supply measures. The only significant changes were in those domestic commodity supplies in which the demand parameter estimates changed markedly. These results make sense in that the macroeconomic measures are determined mainly by the economic specification and the input-output information which have not changed between the scenarios. On the other hand, the domestic commodity supplies will be influenced by changes in the demand parameter estimates. The effect of using the new estimates was a dampening of the responsiveness of consumer demand for some key commodities such as rice to the simulated shock.

The results for the uncompensated case (Table 5) were as expected with the falls in GDP, activity levels, employment and consumption all increasing over those experienced in the previous scenarios. Falls in agricultural employment increased from around 10 to 15 per cent. Professional wages were down in contrast to the situation observed in the compensated scenarios. The increase in exports evident in the compensated scenarios was magnified by the additional deflationary impact of not compensating for the decline in the subsidy and in conjunction with a decline in imports resulted in the balance of trade improving substantially. The different simulated shocks required different macroeconomic assumptions such as in relation to the size and source of borrowings to fund policies. This illustrates the importance of considering the macroeconomic aspects of the policy being analysed as occurs with CGE modelling. It also illustrates that the choice of economic environment can often be a more important determinant of the results obtained than the choice of parameters.

Assessment of the estimates

At this stage it is not possible to do a full assessment of the demand parameters to be used in INDOGEM. Few specification specific estimates have been produced for assessment purposes, only initial aggregate estimates and more recent disaggregate estimates from other studies have been available for assessment. Obviously in terms of assessment by assumption, the disaggregated estimates are more believable. As the current version of INDOGEM has very little dynamics in its specification it is not appropriate that it be used for projections and therefore this means of assessment cannot be undertaken. Sensitivity analysis demonstrates that the macroeconomic measures are not affected greatly by changes in specific commodity demand estimates in contrast to some more specific measures such as domestic commodity supplies. In terms of the tradeoffs involved it would appear the substantial cost of determining specification specific estimates may not be worth the benefits gained in the case of demand parameters unless some very specific demand orientated policy was to be analysed. This would not always be the case and there is some evidence (for example Pagan and Shannon 1987) that some results are highly sensitive to the choice of estimates, for instance the Armington elasticity estimates.

Conclusion

In this paper, the integration of models at various levels has been considered. A number of general conclusions can be drawn from these considerations. Firstly, the development of specifications for higher level models such as CGE models should build on the results of analysis at lower levels where often the underlying theory is developed. This may mean including their influence in the specification or explaining why their influence may not be significant (for example, if their influence has been averaged out by data aggregation). Secondly, estimates should be linked via an econometric approach up to the point where the benefits of doing so outweigh the costs. This will invariably involve estimation of subsystems which should be chosen with care. Direct estimation of the required parameters should be attempted unless this involves problems in data availability, estimation or economic theory restrictions being satisfied. If such problems exist, relationships involving required parameters and generally available parameters should be used. If calibration is seen as necessary then this should be undertaken through adjustments to the constant terms. Thirdly, data used in the various levels of analysis should be reconciled through appropriate treatment of aggregation effects and through consistency with underlying measurement concepts and the economic theory specifications.

Conclusions in relation to testing the choice of parameters in a CGE model are that this should be based on the specification satisfying the underlying assumptions for the application, a forecasting form of the CGE model performing well and comprehensive sensitivity analysis having been undertaken on the model. The choice should also reflect consideration of the tradeoffs involved between the costs of obtaining new parameter estimates and the benefits that might be achieved over alternative estimates in terms of better policy action.

These conclusions were applied where possible in the application of new demand parameter estimates in the INDOGEM model. The demand parameter estimates were obtained from sectoral models whose specifications were compatible with that of INDOGEM. Thus the models were linked in terms of their economic specifications and the parameter estimates used. The analysis using INDOGEM illustrated the need to undertake policy analysis at all levels. The CGE modelling displayed significant economy-wide impacts of the policies being analysed, not evident from the modelling at the lower levels (for example, in exports). The economy-wide impacts appeared more dependent on the choice of macroeconomic environment than the choice of demand parameters. In addition, significant lower level impacts were also evident. The lower level impacts (for example, production responses) were consistent with those observed from sectoral model analysis. However, whilst some of the lower level impacts were consistent with those observed from the farm household model analysis (for example, consumption responses), others were not (for example, employment). The lower level models tend to measure only the direct impacts of the policies whereas the CGE models measure the multiplier effects given the reallocation of resources, the impact of constraints and the assumed economic environment.

It was not possible to make a full assessment of the demand parameters to be used in INDOGEM at this stage. This was because a full set of specification specific estimates were not yet available and because the current version of the model does not have enough dynamics built into its specification to allow assessment on the basis of the performance of projections. However, in terms of assessment by assumption there would appear a need for disaggregated demand parameter estimates. Sensitivity analysis also demonstrated the need for accurate parameter estimates for commodity specific results. On the other hand, macroeconomic measures were not greatly affected by the choice of demand parameters. In the case of the demand parameters, a comprehensive set of new estimates would not appear worthwhile unless the policy be analysed was commodity specific.

So what is the bottom line for incorporating parameter estimates into a CGE model ready to be used for policy analysis? Which of the two basic approaches of taking estimates (or 'guestimates') from elsewhere or deriving specific estimates should be implemented? From the analysis in this paper a hybrid approach would appear best. Available estimates should be used in the first instance to enable sensitivity analysis to be undertaken to identify any key parameters. Then specific estimates of these key parameters should be derived from well specified econometric models that are compatible with the specification of the CGE model.

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TABLE 1: Elasticities of Farm Household Responses

Elasticities with respect to	Output Supply		Commodity Demand			Family Labour Supply		Farm Labour Demand		Fertiliser Demand
	Rice	Palawiji	Rice	Palawiji	Market Goods	Male	Female	Male	Female	
Prices of: Rice	0.607	0.035	-0.554	-1.215	0.443	0.349	1.252	1.582	1.424	1.671
Palawjia	0.001	0.036	-0.731	-1.338	0.263	-0.002	-0.013	0.102	0.099	-0.764
Fertiliser	-0.074	1.559	-0.015	-0.010	-0.015	-0.001	-0.002	-0.065	-0.084	-0.341
Agricultural Wages: Male	-0.359	-1.068	-0.037	-0.478	-0.037	-1.414	1.353	-1.066	-1.019	-0.334
Female	-0.175	-0.562	-0.321	1.005	-0.403	0.453	-4.541	-0.553	-0.420	-0.232
Fixed Input: Cultivated area	0.992	1.832	0.207	0.143	0.210	0.008	0.025	1.026	1.088	1.065
Household Characteristics: Male worker	-	-	0.417	-0.045	0.222	2.104	2.943	-	-	-
Female worker	-	-	0.060	-0.098	0.177	0.793	3.038	-	-	-

Source: Sawit and O'Brien (1993)

TABLE 2: Summary of key results from fertiliser price and subsidy policy scenarios, 1995 projections

	Base Run, Fixed Domestic Rice Price	Elimination of Fertiliser Subsidy, Fixed Domestic Rice Price	Elimination of Fertiliser Subsidy, Domestic Rice Price Linked to World Price	Increase of Fertiliser Price to Rp140/kg, Domestic Rice Price Linked to World Price	Increase of Fertiliser Price to Rp160/kg, Domestic Price Linked to World Price
Domestic wholesale rice price (Rp/kg)	348	348	438	362	378
Paddy production ('000 mt)	47,657	42,675	44,890	47,114	46,373
Rice imports ('000 mt)	91	3,136	579	84	192
Cost of food imports (billion Rp)	1,197	3,126	1,570	1,218	1,314
Net farm revenue (billion Rp)	9,874	8,755	10,311	10,026	10,167
Consumer food expenditures (billion Rp)	14,146	14,137	15,326	14,435	14,765

Source: Rosegrant et al (1987)

TABLE 3: Elasticities of economic variables with respect to a compensated 10 per cent increase in fertiliser prices (lower subsidy), original demand parameters.

		Elasticities	
Macroeconomics variables			
GDP		-0.14	
GDP deflator		-0.55	
Aggregate imports		0.17	
Aggregate exports		3.96	
Aggregated household consumption		-1.66	
Agricultural employment		-9.83	
Total real disposable income		-1.65	
Domestic commodity supply			
Irrigated rice, Java)		-0.29)	
Irrigated rice, off-Java)	Rice industry	-18.21)	-2.03
Non-irrigated rice)		-28.45)	
Maize		-1.49	
Soybeans		-1.51	
Other foods		-1.94	
Estate		-0.85	
Livestock		-0.92	
Fisheries		-0.90	
Forestry		-0.35	
Mining		0.66	
Food processing		-1.64	
Agricultural processing		0.27	
Fertiliser		-5.75	
Mineral processing		8.29	
Other manufactured goods		-0.02	
Irrigation		0.38	
Services		1.07	

TABLE 4: Elasticities of economic variables with respect to a compensated 10 per cent increase in fertiliser prices (lower subsidy), new demand parameters.

		Elasticities	
Macroeconomic variables			
GDP		-0.15	
GDP deflator		-0.54	
Aggregate imports		0.17	
Aggregate exports		3.95	
Aggregated household consumption		-1.66	
Agricultural employment		-9.81	
Total real disposable income		-1.66	
Domestic commodity supply			
Irrigated rice, Java)		-0.28)	
Irrigated rice, off-Java)	Rice industry	-18.83)	-2.06
Non-irrigated rice)		-28.68)	
Maize		-0.84	
Soybeans		-1.51	
Other foods		-0.40	
Estate		-0.87	
Livestock		-0.95	
Fisheries		-1.14	
Forestry		-0.35	
Mining		0.66	
Food processing		-1.67	
Agricultural processing		0.27	
Fertiliser		-5.61	
Mineral processing		8.28	
Other manufactured goods		-0.01	
Irrigation		0.39	
Services		1.09	

TABLE 5: Elasticities of economic variables with respect to a uncompensated 10 per cent increase in fertiliser prices (lower subsidy), new demand parameters.

		Elasticities	
Macroeconomic variables			
GDP		-0.47	
GDP deflator		-0.55	
Aggregate imports		-0.38	
Aggregate exports		6.72	
Aggregated household consumption		-3.35	
Agricultural employment		-15.19	
Total real disposable income		-3.35	
Domestic commodity supply			
Irrigated rice, Java)	Rice industry	-0.91)	
Irrigated rice, off-Java)		-33.25)	-3.55
Non-irrigated rice)		-35.00)	
Maize		-1.53	
Soybeans		-2.69	
Other foods		-0.60	
Estate		-1.43	
Livestock		-1.95	
Fisheries		-2.29	
Forestry		0.22	
Mining		0.73	
Food processing		-3.07	
Agricultural processing		0.37	
Fertiliser		-6.28	
Mineral processing		12.24	
Other manufactured goods		-0.20	
Irrigation		-0.13	
Services		1.02	