Agricultural Economics Research Review
Vol. 20 January-June 2007 pp 1-28

State-of-the-Art in Regional Computable General Equilibrium Modelling with a Case Study of the Philippines

U-Primo E. Rodriguez

Abstract

The developments in regional Computable General Equilibrium (CGE) models have been reviewed with a view to identify future directions for modelling in the Philippines. It is observed that regional CGE models have been used extensively in the analysis of national and regional issues. These models can be divided into three classes: region-specific, bottom-up and "partial" models. This paper asserts that existing models of the Philippines generally belong to the third class. This implies that there is very little scope for evaluating region-specific issues in the Philippines.

Introduction

The key provisions of the Local Government Code (RA 7160 of 1991) call for a deeper involvement of local government units in pursuing social and economic objectives. This suggests the need to strengthen the capacity to formulate and implement plans at this level. Economywide models can help accomplish such an objective. These tools allow planners to evaluate the impacts of proposed initiatives and other events. Moreover, as these models generally have flexible and well-defined structures, decision-makers will be equipped with a coherent framework that can be modified to suit the changing economic landscape.

Computable general equilibrium (CGE) models are one of the many economywide models that can be used in the planning process. With an explicit treatment of the behaviour of and interaction between economic agents, these models allow users to examine the effects of policies and exogenous events on various economic indicators. Among others, they

---

Department of Economics, University of the Philippines at Los Banños, College, Laguna 4301, Philippines . E-mail: uper@edsamail.com.ph
The author thank the anonymous referees for their constructive suggestions.

provide information on the overall impact of the changes as well as identification of winners and losers.

CGE models can be useful to local government units in two ways. The first is the determination of the regional impacts of national policies and events. This enhances the capacity of local authorities to participate in the national debate on such issues. With a properly designed model, a CGE may also help them evaluate alternative courses of action at the local level which can mitigate the harmful effects or enhance the benefits of the national policy/event.

Second, CGE models can evaluate the impacts of exogenous events and proposed policies at the local level. This allows the decision-makers to make judgments which are based on a sound, well-defined and transparent analytical framework. A well-designed CGE model can also help local authorities to examine the effects of local events and policies beyond its borders. This implies a more comprehensive assessment of the impacts.

The general objective of this paper is to review the existing literature on regional CGE models. It has four specific objectives. First, it aims to describe the range of issues to which regional CGE models can be applied. Second, it seeks to identify the key ingredients of these models. Third, it examines the extent to which regional CGEs have been used in the Philippines. Finally, it identifies future directions for regional CGE modelling in the Philippines.

At this stage, it is worth noting three limitations of this paper. First, this paper focuses on CGE models only. It does not discuss other economywide models which have also been used in regional analysis. Examples of tools omitted in this paper are Social Accounting Matrix (SAM) multiplier and Input-Output (IO) models.[1]

Second, there are two ways in which regions are modelled in a CGE. One defines a region as a country within a global or multi-country model,[2] and the other defines a region (e.g., state, province, town, village, etc.) located within a country. With one notable exception, this paper focuses on the second type of models only.

Third, so many CGEs have been developed that it makes almost impossible to discuss all the existing models. As this is true even for regional CGE models, the strategy in this paper is to concentrate on fairly recent

[1] Examples of SAM multiplier models are presented in Xioping *et al.* (2003) and Hughes and Vlosky (2000). On the other hand, Kpodar (2006), Lofgren and Robinson (1999), Zacharrias *et al.* (2002) and Garcia-Negro *et al.* (2004) provide examples of regional IO models.

[2] Examples of multi-country models can be found in Hertel (1999), McKibbin and Sachs (1989), Deardorf and Stern (1986a, 1986b) and Brown and Whalley (1980).

models. Hopefully, this is sufficient to identify the extent to which these models have been used in the Philippines relative to the rest of the world.

The rest of the paper is organized as follows. Section 2 discusses the various classes and applications of regional CGE models. Section 3 describes the applications of these models in the Philippines. Section 4 concludes the paper.

2. CGE Models and Regional Economic Units

2.1. Overview of CGE Models

CGE models are numerical tools which depict the interaction of economic agents in the different markets of an economy. Such models generally contain equations which describe the (a) different sources of and demands for goods and inputs, (b) determination of input and output prices, (c) household income and expenditure, (d) international trade, and (e) macroeconomic variables. More sophisticated variants may also include, among others, environmental (e.g. emissions) and developmental (e.g. poverty and inequality) indicators.

An easy way to describe a CGE is to imagine a two-commodity economy that does not engage in foreign trade; a closed economy.[3] This economy has three agents. The first is a household which earns income from its ownership of factors of production. Ignoring transfers and savings, its after-tax income is spent for the consumption of goods and services. The second is a set of firms in industries that produce goods using different factors of production. The last agent is government. Its role in this simple economy is to collect taxes on various transactions and spend its revenues on goods and services.

The household will be represented in the model by equations that depict its sources of income and demands for goods. The demand equations are usually based on the assumption that the household seeks to find the quantities of goods which maximize utility subject to its income. This behaviour implies that at the optimum, the total expenditure of the household is equal to its after-tax income.

Each industry is represented by equations for its production (supply) and input demands. These equations are usually based on the assumption that there exists a representative firm in the industry that seeks to maximize profits or minimize costs. Assuming constant returns technology and that no

[3] A formal presentation of the equations of a simple CGE model can be found in Sadoulet and de Janvry (1995) and Shoven and Whalley (1992 and 1984).

firm has control over output and input prices, each firm earns zero profits in the long-run.

Equilibrium is depicted by a set of equations which specify the equality of supply and demand for inputs and outputs. These equations effectively force input and output prices to adjust in order to achieve equilibrium.

Macroeconomic indicators are integrated into the model through a series of aggregating equations. For example, assuming that there is no intermediate demand, GDP is the sum of value of production of all industries.

A CGE requires specific functional forms and numerical values for its parameters and variables. The functional forms are fairly standard mathematical formulations used in economics. For example, demand functions may be based on the assumption that the consumer has a Cobb-Douglas, Constant elasticity of substitution (CES) or Stone-Geary utility function. The values of the variables are usually taken from a SAM of the economy.[4] A subset of the parameters, elasticities for example, is typically borrowed from other studies or models. In some cases however, these parameters are estimated using econometric techniques.[5] The remaining parameters are then calibrated to ensure that the base solution of the model replicates the values in the SAM.

Once the model is specified, experiments are implemented by changing the values of the exogenous variables. In the simple economy being described, this may include changes in factor endowments, taxes and government expenditures.

Existing CGE models are of course more complex than the one described earlier. First, most of these models incorporate external trade. This is done by allowing domestic and foreign agents to interact though exports, imports and capital flows. Second, price rigidities are also introduced to account for the existence of excess supply or demand in markets. For example, unemployment is usually accommodated by assuming that the wage rate is fixed. Third, existing models tend to have a finer disaggregation of economic agents. Models generally have more than two industries/commodities and one household. Fitting the topic of this paper, models also disaggregate the economy into regions. Fourth, there are also models which allow for the increasing returns and imperfect competition. Finally, the simple model described above is static in the sense that, in experiments, it only compares two equilibrium positions. Many sophisticated models go beyond this specification by incorporating dynamic elements. This facilitates the analysis of the economy as it moves from one equilibrium position to the next.

---

[4] For an introduction to the SAM, see King (1991).

[5] An example of such an effort is the APEX model of Clarete and Warr (1992).

Developments in CGE modelling have made these tools very useful for evaluating a wide range of issues. In general, these models have been used for evaluating issues on international trade, fiscal policy, public finance, energy, environment and natural resource-use, poverty, income distribution, regional development, etc. As a discussion of these developments and applications of CGE models is beyond the scope of this paper, the interested reader may consult van Tongeren (2005), Davies (2004), Bergman and Henrekson (2003), Devarajan and Robinson (2002), van Tongeren *et al*. (2001), Sadoulet and de Janvry (1995), Rodriguez and Briones (1997), Devarajan (1995), Shoven and Whalley (1992 and 1984), de Melo (1988), and Srinivasan and Whalley (1986).

2.2. Definition and Treatment of Regions in CGE Models

There are two ways in which regions are defined in CGE models. Some models disaggregate an economy into rural and urban regions (for example, *see* Bautista and Thomas, 2000; Jung and Thorbecke, 2001). Others identify specific states, cities, provinces, towns, and even villages in a country. Levantis (2006), for example, disaggregates Australia into its 6 states and 2 territories. On the other hand, Domingues and Haddad (2002) divide Brazil into Sao Paolo and the rest of the country.

There are also models which use both definitions of regions. For example, models of the Philippines tend to divide the country into the National Capital Region, and rural regions (*see* Cororaton *et al*., 2005; Bautista and Thomas, 1997; Gaspay, 1993; Bautista, 1987). In some instances, a region in a country is disaggregated further into sub-regions. For example, Nakayama and Kaneko (2003) have identified the rural and urban regions of Beijing and Shanghai.

The existing regional CGE models can be grouped into three classes. The first are region-specific models which focus on a particular area in a country. These models assume that changes in the region do not have an impact on the economy as a whole. The other classes are bottom-up and, for lack of a better term, "partial" regional CGE models. These models specify a country which is divided into two or more regions. They differ in the degree to which regional economic units are integrated in the model. The succeeding sections will discuss the applications and issues in the formulation of these models.

2.3. Region-specific CGE Models

A region-specific CGE model is designed for a particular area (e.g., state, province, city, town or village) in a country. It has a structure which is very similar to models of a country. It identifies households, industries, government and foreign agents in a region. Moreover, the behaviour of these agents is also specified in the same way as in standard models. Finally, the base dataset is the SAM.

The most significant difference between a national and region-specific CGE is the treatment of the foreign sector.[6] In a national CGE, the foreign sector represents the rest of the world. In contrast, the foreign sector in a region-specific CGE model is composed of the rest of the country and other countries.

Region-specific CGEs are also capable of examining issues which tend to be ignored in national models. These may be local concerns which are not too relevant at the national level. These may also be important issues at the national level but simulations in (national) models are not expected to have noticeable impacts. In such instances, the costs of modelling the issue in national CGE are high relative to its returns.

Horridge (1999) has provided an example of an issue that was examined using a region-specific CGE. The paper has analyzed the effects of higher transport costs (which may be due to higher fuel taxes or road tolls) in Melbourne, Australia. It examines the impacts on, among others, the proportion of residents who work in the same zone (area), average distance commuting from home to office and proportion of residents who live in high density housing (i.e., flats). Another example is the work of Holden *et al*. (2005) for the Ethiopian highlands. In this paper, one of the experiments involves examining the impact of removing fertilizer subsidies on land degradation in the region.

Region-specific CGE models are, of course, not confined to the evaluation of policies/events for a particular region. The analysis of national policies is actually quite common in these models (*see* Table 1). For example, the aforementioned experiment with fertilizer subsidies (Holden *et al*., 2005) could easily be a national policy. However, it may simply be the case that the interest of the study is on its regional impacts only.

In evaluating the impacts of a national policy/event, region-specific models are sometimes used in tandem with a national CGE. For example, San *et al*. (2005) have examined the effects of a devaluation on the Sumatera region of Indonesia. In implementing the analysis, the authors followed a two-stage process. The first stage implemented the devaluation in a CGE model of Indonesia. In the second stage, the impacts on prices from the simulation were used as inputs in the region-specific model.

[6] For the rest of the paper, a national CGE is a model of a country that has no regional disaggregation.

Table 1. Selected region-specific models

Model	Region	Applications
Andre *et al.* (2004)	Andalusia, Spain	Taxes of CO_2 and SO_2 emissions, payroll taxes, income taxes
Aryal (2005)	Mardi Watershed, Nepal	Internal and international remittances to households
de Miguel and Manresa (2004)	Extremadura, Spain	Agricultural subsidies and social contributions of employers
Floros and Failler (2004)	Salerno, Italy	Experiments with formulations of the biological function of fish
Holden and *et al*. (2005)	Ethiopian Highlands (Hidi, Hora Kilole and Borer Guda)	Output taxes and fertilizer subsidies
Horridge (1999)	Melbourne, Australia	Planning and transport policies
Kuiper and van Tongeren (2004)	Village in Jianxi, China	Trade reforms
Nakayama and Kaneko (2003)	Beijing and Shanghai, China	Promoting selected industries through higher investment shares
San *et al*. (2000)	Sumatera, Indonesia	Devaluation of the real exchange rate
Stoombergen and Stuart (2003)	Horowhenua-Kapiti, New Zealand	None*

*The paper provides a list of experiments that can be implemented using the model.

Kuiper and van Tongeren (2004) have conducted an even broader set of experiments. This study has examined the impacts of removing tariffs and other import barriers of OECD countries on a specific village in Jianxi, China. The authors have initially implemented the experiment in a global model. The impacts on prices and labour demand from the simulations were then used as inputs in the CGE model for the village.

Consistent with the developments in CGE modelling as a whole, there are also noticeable differences between region-specific models. For one, there is no clear pattern with respect to size of the regions for which such models have been built. Horridge (1999) and Nakayama and Kaneko (2003) have constructed models for relatively large cities (*see* Table 1).[7] In contrast, Kuiper and van Tongeren (2004) have used a model for a village in China that is composed of less than one thousand households. Similarly, the model

[7] Melbourne is the second largest city in Australia. On the other hand, San *et al*. (2005) state that Sumatera accounts for about a quarter of the GDP of Indonesia.

of Stroombergen and Stuart (2003) represents a region in New Zealand that has a population of 73,000 only.[8]

Models also differ in the degree of disaggregation. Among the models in Table 1, the number of commodities range from 2 (Horridge, 1999) to 37 (Floros, 2004). At the level of households, Andre *et al*. (2004) had only one representative household for the region while de Miguel and Manresa (2004) had 11. The models of Nakayama and Kaneko (2003), San *et al*. (2005) and Horridge (1999) also included a regional disaggregation in their models. The first two models contained an urban-rural disaggregation while the third divided the region (Melbourne) into 9 zones.

Another interesting difference between the models is the way in which households are classified. San *et al*. (2005) and de Miguel and Manresa (2004) disaggregate households according to location (rural-urban), income and age. These are categories usually found in models of a country. On the other hand, some models use classifications which appear to be more relevant to the region being studied. For example, Holden *et al*. (2005) classify households in the Ethiopian Highlands according to their ownership of oxen. On the other hand, Aryal (2005) disaggregate households in the Mardi Watershed of Nepal according to caste.

A more substantive difference among these models is in the formulation of household decisions. Most of the models in this paper follow a standard specification in which consumption and production decisions are unique to households and producers, respectively. However, there is a difference in treatment of Holden *et al*. (2005) and Kuiper and van Tongeren (2004). These models assume non-separability in the production and consumption decisions of households. In other words, households make these decisions jointly.

The models presented in this paper have shown that there is a place for region-specific models in the economist's toolkit. Its biggest advantage is the ability to simulate the impacts of policies and events, both regional and national, at the regional level. This information is valuable to local authorities in terms of evaluating policies/events and, if necessary, formulating alternative courses of action.

The biggest constraint in constructing a region-specific model is the data. SAMs or IO tables are often not available at the regional level, especially for the developing countries. This means that a modeller has to assemble such a matrix, most likely using primary data, before any serious work can begin.

---

[8] The estimated population of New Zealand in 2003 was 4 million persons (Statistics New Zealand, 2006).

Another difficulty is that these models are not capable of evaluating the effects on other regions and on the country as a whole. This is a serious concern, especially if the region being modelled is large relative to and/or highly integrated with the rest of the economy. In such a situation, local policies/events could spill over to other regions. Hence, region-specific models provide an incomplete picture of the impacts. Worse, the inability to capture the feedback effects from the other regions means that the results for the region in question could be misleading.

2.4. Bottom-up Regional CGE Model

Bottom-up CGE models divide a country into two or more regions. Each region is assumed to be composed households, firms, government and foreign agents. Households and firms are represented by the regional demands for commodities and inputs, and supplies of outputs. Government consumes goods and services, provides and receives transfers, and collects taxes. Foreign agents are also represented through exports, imports and capital flows. In a nutshell, bottom-up models can be thought of as specifying a CGE for each region and then aggregating the regional outcomes to generate results at the national level.

Apart from the regional disaggregation, two features distinguish bottom-up models from other models of a country. First, like region-specific models, the foreign sector for each region is composed of agents in other regions of the country and the rest of world. Second, unlike standard CGEs, bottom-up models tend to have more than one government entity. In many of the bottom-up models, there is a clear distinction between the regional and national governments. Australian models, for example, provide an explicit treatment of the state and federal governments (*see* Horridge *et al*., 2003; Adams *et al*., 2000).

Bottom-up CGEs are superior to region-specific models in three ways. First, bottom-up models are able to capture effects of a regional policy/event on other regions and the economy as a whole. This is partly facilitated by inter-regional trade which allows changes in one region to spill into other regions. The aggregation of the regional outcomes in turn allows the generation of results at the national level. Second, bottom-up models can provide a more direct assessment of a national policy/event. Unlike many applications of region-specific models, these do not require a second model in the implementation of the experiments.[9] This is so because these models also contain policy levers and exogenous variables which apply to the country

[9] Of course, this statement does not apply to cases in which the changes are based on multilateral agreements among countries.

as a whole. Third, bottom-up models provide a more comprehensive view of the effects on a particular region. Unlike region-specific models, the effects on a particular region are likely to include the direct effects of a policy/event and the responses of other regions.

Bottom-up models have been applied for a wide range of national and regional issues. In Table 2, examples of applications to national policies/ events are found in Productivity Commission (2005), Haddad and Perobelli (2005), Domingues and Lemos (2004), Jean and Laborde (2004), Canning and Tsigas (2000), Lofgren and Robinson (1999) and Horridge *et al*. (2003). To cite a specific example, Domingues and Lemos (2004) have examined the effects of alternative trade reform strategies for Brazil. In one experiment, the authors have found that the proposed *Free Trade of the Americas (FTAA)* is expected to raise the real GDP of the country. However, the authors have also found that the benefits are due mostly the gains to Sao Paolo as the real GDP of the *Other Regions* is expected to contract.

On the other hand, Dixon and Wittwer (2003), (cited in Dixon and Rimmer, 2003) and Appels *et al*. (2004) have provided applications to regional policies/events. Dixon and Wittwer (2003), for example, have examined the effects of a strike in the construction industry of Victoria, Australia. One of outcomes is that the strike will reduce the total employment of the country. However, the authors also find that this is generally due to the direct impacts on Victoria as the employment of the rest of the country is expected to rise.

There are also noticeable differences in the regional disaggregation of bottom-up models. Domingues and Haddad (2002) and Domingues and Lemos (2004) have used a model in which Brazil is divided into two regions only – Sao Paolo and the rest of the country (*see* Table 2). This pales in comparison to the TERM (“The Enormous Regional Model”), which accommodates up to a 57 region disaggregation of Australia (Horridge *et al*., 2003).

At this point, it is also interesting to note that the use of bottom-up models is not confined to a single country. Jean and Laborde (2005) have used a model that divides 25 countries in the Europe into 119 regions. In this model, some countries are disaggregated into many regions.[10]

The degree of detail within each region also varies from one model to the next. For example, Lofgren and Robinson (1999) have used a model in which each region has at most 5 industries. This is small compared to 113

[10] The United Kingdom for example, is divided into 12 regions. These are North East, North West, Yorkshire, East Midlands, West Midlands, Eastern, London, South East, South West, Wales, Scotland and Northern Ireland.

Table 2. Selected bottom-up regional CGE models

Model	Country (No. of regions)	Applications
Adams *et al*. (2002) / MMRF-Green and MMR	Australia (8)	None[1]; Appels *et al*. (2004): trade of irrigation water in the Murray-Darling Basin; changes in labour productivity and service prices in selected infrastructure activities (Productivity Commission, 2005); strike in the construction industry of Victoria (Dixon and Wittwer, 2003, cited in Dixon and Rimmer, 2003);
Canning and Tsigas (2000)	United States (10)	Tax policy
Domingues and Haddad (2002) / B-Maria-SP	Brazil (2)	Indirect taxes on interregional flows
Domingues and Lemos (2004) / SPARTA	Brazil (2)	Trade policy
Haddad and Perobelli (2005) / B-Maria	Brazil (27)	Trade policy, transport costs (also see Haddad and Hewings, 2004)
Horridge *et al*. (2003) / TERM	Australia (57)	Drought
Jean and Laborde (2004) / DREAM	Europe (119)[2]	Trade policy
Levantis (2006) / AusRegion	Australia (at least 8)[3]	None[1]
Levantis (2006) / AusState	Australia (8)	None[1]
Lofgren and Robinson (1999)	Mozambique (4)	World prices and transport costs

1. No applications were provided in the paper. However, the reference provides a list of possible experiments.
2. The model is composed of 25 countries in the Europe.
3. Levantis (2006) states that the model can be disaggregated to sub-state data in accordance with Australian Bureau of Statistics classifications. For example, the paper states that the state of Victoria can be disaggregated into Goulburn and the rest of the state. Sub-state disaggregation of the model is done on a per project basis.

industries that can be accommodated in each region of the MMRF-GREEN (Adams *et al*., 2002).

More substantive differences in these models are found in the formulation of interregional and international trades. Most of the models in this paper assume that a region trades with other regions in the country and the rest of the world. However, an alternative formulation is presented in the model of Lofgren and Robinson (1999). This model divides the economy into border, urban and two rural regions. It assumes that the rural regions only trade with the urban region. These regions do not trade with each other or with the rest of the world. On the other hand, the urban region trades with the border region and rural regions but not (at least, directly) with the rest of the world. Finally, the border region only transacts with the urban region and the rest of the world.

The approach adopted by Lofgren and Robinson (1999) is suitable for countries which do not have sufficiently detailed data on regional flows. This is so because all trade among the regions (i.e. rural and urban) is treated as domestic trade. It is tantamount to assuming that the port through which international transactions take place is located near the urban region. A comment that can be made about this model is the superfluous introduction of a border region. Without seriously altering the results, the authors could have assumed that all international trade takes place in the urban region.[11]

Another difference between the models is in the specification of transportation costs. All the models assume the existence of a transport industry that facilitates the movement of goods from one region to the next. Moreover, most of the models specify transport costs as directly related to the size of the flow (export/import) between regions. In other words, transportation costs are higher if more goods are being exported or imported.

Without alternating the fundamental relationship above, Haddad and Perobelli (2005) have introduced a “geo-coded transportation” network. The authors have assumed that inter-regional trade takes place in the state capitals. They then have incorporated the time and distance from one capital to the next in the specification of transport costs.

While the discussion above clearly shows the benefits of using a bottom-up CGE model, the biggest stumbling block to its construction is the availability of data. This is clearly much larger than those of a region-specific model since it requires data for all regions in the model. Moreover, it requires information of interregional trade.

2.4. “Partial” Regional CGE Models

As a point of reference, it is important to recall two important features of bottom-up models. First, these models explicitly specify the behaviour of households and industries at the regional level. Second, these models provide

[11] An example of such a formulation can be found in Dufournaud *et al*. (2000).

an explicit treatment of interregional trade. Models which do not contain at least one of these ingredients can be classified as, for lack of a better term, "partial" regional CGE models.[12] By not incorporating one of the assumptions above, the results from these models tend to flow in one direction only, from national to regional. In other words, there is weak or no feedback from the regional to the national results.

"Partial" regional CGE models can be grouped into three categories. The first only contains a regional disaggregation in the production side of the economy. The second category only focuses on households. The third, and least common, provides a disaggregation of production and households.

"Partial" CGEs that provide a regional disaggregation of the production side typically fall into the classification of top-down models. These are models in which a national CGE is augmented with a separate module that disaggregates the production results (output, employment, etc.) to the regional level. Typically, the analytical procedure involves imposing a shock in the CGE model and then feeding the selected results to the regional module.

A well known example of a top-down model is the ORANI (*see* Dixon *et al*. 1982; Table 3). This is a 115 commodity model which can generate results for the 6 states of Australia. It has been applied to the analysis of, among others, tariff changes (Dixon *et al*., 1982) and foreign tourism (Adams and Parmenter, 1993). It has also evolved into a dynamic version, the MONASH model, which generates regional results for the 6 states and 2 territories of the country (Dixon and Rimmer, 2002; 2003). Moreover, it has been applied to countries like South Africa (Horridge *et al*., 1995) and Papua New Guinea (Levantis, 1998).[13]

ORANI-style models follow the strategy of Leontief *et al*. (1965; *also see* Dixon *et al*., 1978; 1982) in generating regional results. The general idea behind this approach is as follows.[14] First, the CGE model is shocked in order to generate results at the national level. Second, the model assumes that the change in the output of a regional industry is proportionate to the change in the output of the national industry.

This implicitly assumes that the share of regional industry in the output national industry is constant. Third, the model computes the effects on the aggregate output of the region. Given this approach, differences in regional output are due to differences in the changes in industry output and the relative importance of the industries in the regional total.

[12] This should not be confused with partial equilibrium models.

[13] Other applications of this model are available from http://www.monash.edu.au/policy/oranig.hml and http://www.monash.edu.au/ policy/archivep.hml.

[14] This paper provides a highly simplified presentation of the procedure. For details, the interested reader may consult the studies cited in the text.

Table 3. Selected top-down and "partial" models

Model	Country	Regional disaggregation	Applications
Production			
Dixon and Rimmer (2003, 2002) – MONASH	Australia	6 States and 2 territories	e-Commerce
Dixon *et al*. (1982) – ORANI	Australia	6 States	Trade policy; foreign tourism (Adams and Parmenter, 1993)
Horridge *et al*. (1995)	South Africa	9 Provinces	Government expenditures
Levantis (1998)	Papua New Guinea	Urban: formal, murky[1] rural: village, plantation	No application in paper
Households			
Bautista and Thomas (2000)	Zimbabwe	Urban: high income, low income rural: large scale commercial owner/ manager, large scale commercial farm laborer, small holder	Trade policy, government expenditures, land redistribution
Bourguignon *et al*. (2003)	Indonesia	Urban rural	Prices of crude and processed oil products, foreign savings
Clements (2003)	Indonesia	Urban: non-agricultural low income earners, non-agricultural high income earners rural: agricultural employees, small farmers, medium farmers, large farmers, non-agricultural low income earners, non-agricultural high income earners	Reduction of petroleum subsidies
Cury *et al*. (2004)	Brazil	Urban: poor family headed by an active individual, poor family headed by a non-active individual, average income rural: poor, average income others: high average income, high income	Trade policy

Contd

Table 3. Selected top-down and "partial" models — *Contd*

Model	Country	Regional disaggregation	Applications
Jung and Thorbecke (2001)	Zambia and Tanzania (separate models)	Urban: poor, non-poor Rural: poor, non-poor	Education spending
Karl (2004)	Colombia	Poor rural households and 7 other groups	Trade, value added tax, foreign inflows
Octaviani (2005)	Indonesia	Urban: low income, middle income, high income Rural: landless, small land owner, mid-size land owner, high income	Avian flu
Production and Households			
Filho and Horridge (2005)	Brazil	27 Regions	Trade policy

1. "Formal" refers to the region that Levantis (1998) calls "urban". The "urban murky" sector refers to 2 industries in the model (crime and informal)

There are also "partial" CGEs which divide regions at the level of households. For example, Marcel and Bautista (2000) have disaggregated households in Zimbabwe into 9 groups, based on location (rural or urban), income and source of income (*see* Table 3).

In many applications, like Marcel and Bautista (2000), each group is assumed to have a representative household that earns income from its endowment of the factors of production and uses this income (adjusted for taxes and transfers) for consumption and savings. As endowments are typically assumed to be exogenously determined, changes in income are due solely to changes in factor prices.

It is important to note that the treatment of households in CGE models has undergone substantial transformation in recent years. The current trend is to veer away from the use of representative households and move towards exploiting, in full, the information in income and expenditure surveys. This has strengthened the capacity of these tools to evaluate impacts on poverty and income distribution.[15]

[15] Discussing the rich literature on CGE models which integrate information from the survey data is beyond the scope of this paper. For more information, the interested reader may consult Savard (2003, cited in Filho and Horridge, 2005), Khan (2004), Davies (2004), Agenor *et al*. (2003) and Bourguignon and Pereira da Silva (2003).

An example of this approach is presented in Bourguignon *et al*. (2003). The paper simulates the impacts of changes in the prices of crude and processed oil products in Indonesia. The experiment is implemented in a standard CGE model and selected results are used as inputs in a micro-simulation module which contains the information from the survey. The procedure allows the authors to generate indicators for urban and rural regions like per capita income, gini ratio, poverty gap index, head count, etc.

Unlike the top-down approach used for modelling industries, the household disaggregation in CGE models is not exactly devoid of feedback from the regional to the national level. In the approach, the representative households, for example, employ the sum of the consumption of the regional households as part of the equilibrium condition for each commodity. Hence, the responses of the regional households affect prices, and consequently other variables, at the national level. Despite this, such models still fit well into the definition of a "partial" model because it omits a regional disaggregation of industries and interregional flows.

It is of course possible to introduce a regional disaggregation in production and household sides of the economy. An example is the model of Filho and Horridge (2005) for Brazil. Dividing the country into 27 provinces, the production side has been disaggregated in the same way as ORANI-based models. On the other hand, the household disaggregation exploits information from a survey of about 112 thousand households.

Despite its inability to capture interregional flows and weaknesses in modelling feedback from the regional to the national level, there are advantages in using "partial" models. First, unlike region-specific CGE models, it can be used directly to evaluate the regional impacts of national policies/events. Second, it is less demanding in terms of data. The reason is that "partial" models usually exploit available secondary data. As such, there is no need to conduct the specialized surveys found in the construction of region-specific CGE models. Moreover, it does not require information on interregional flows that are found in bottom-up models.

3. Regional CGE Models of the Philippines

The earliest CGE models of Philippines were built by Clarete (1984) and Habito (1984). Applied to trade and tax policies, respectively, these models did not incorporate a regional dimension to the analysis. The first model to do so was constructed by Bautista (1987). This was a "partial" model that assumed a representative household for the National Capital Region (NCR), other urban and rural regions. The model was applied to the analysis of stabilization policies and investment.

While the issues which were evaluated vary from one paper to the next, most of the regional CGEs developed since Bautista (1987) are "partial" in nature (*see* Table 4). Gaspay (1993) and Bautista and Thomas (1997), for example, have analyzed trade policies using models that have a similar disaggregation to Bautista (1987). With a slightly different treatment, Inocencio *et al*. (2001) have presented results for households classified by income groups. The model has explicitly identified the sources of income at the regional level and, with some revision, can easily calculate regional incomes. This model has been applied to issues in the international trade and environmental policy (also see Rodriguez and Cabanilla, 2006; Elca, 2005; Rodriguez, 2003).

Following recent trends in CGE modelling, Cororaton (2003; 2004; 2005) has presented models which exploit information from the 'Family Income and Expenditure Survey'. This strategy has enriched regional CGE analysis in the Philippines in two ways. First, it has enhanced the calculation of poverty and income distribution indicators at the national and regional levels. Second, it has allowed a finer regional disaggregation of the results. To illustrate, Cororaton (2003) has evaluated the impact of the 1994-2000 tariff changes on, among others, income, poverty and income distribution in 15 regions, each with a rural-urban disaggregation, of the country. In the analysis, he has found that the tariff changes tend to reduce poverty but, with the exception of the NCR, causes a deterioration in income distribution for all regions.

Not all models of the Philippines disaggregate regions at the level of households. The APEX and TARFCOM models actually provide a disaggregation in the production side of the economy. The APEX model (Clarete and Warr, 1992) assumes that there is an industry that is located in each of the three main island groups (i.e., Luzon, Visayas and Mindanao). Moreover, each industry produces 12 agricultural crops and livestock products. However, the regional disaggregation in the model is incomplete. There are 38 other industries in the model for which there is no regional disaggregation. The APEX has been used in the analysis of technical change in agriculture (Warr and Coxhead, 1992), fertilizer subsidies (Tolentino and Balisacan, 1992) and trade policy (Clarete and de la Peña, 1992; Cororaton and Cuenca, 2000).

Unlike the APEX, the TARFCOM is an ORANI-style model (Horridge *et al*., 2001) that disaggregates all industries at the regional level. Theoretically, each of its 16 regions is capable of producing at most 229 commodities. This allows for finer disaggregation of the results. For example, Rodriguez and Cabalu (2006) find that the removal of tariffs is likely to raise

Table 4. Regional CGE models of the Philippines

Model	Disaggregation	Applications
"Partial"		
Bautista (1987)	Households: National Capital Region (NCR), rural, other urban	Devaluation, non-agricultural investment, monetary contraction
Bautista and Thomas (1997)	Households: rural large farm, rural small farm, other rural, NCR, other urban	Trade policy
Clarete and Warr (1992) / APEX	Production: 3 regional industries specific to Luzon, Visayas and Mindanao. These industries produce 12 agricultural commodities	None in the cited paper; technical change in the agricultural sectors of regions (Warr and Coxhead, 1992); fertilizer subsidy (Tolentino and Balisacan, 1992); trade policy (Clarete and dela Pena, 1992; Cororaton and Cuenca, 2000)
Cororaton *et al*. (2005)	Households: NCR, other urban, rural	RP-Japan free trade agreement
Cororaton (2004)	Households: urban and rural households are each classified into 6 socio-economic classes	Rice quota
Cororaton (2003)/ MICRO-PCGEM	Households: NCR and 14 other regions	Trade policy
Gaspay (1993)	Households: National Capital Region, rural, other urban	Trade policy
Horridge *et al*. (2001) / TARFCOM	16 Regions	Competition policy, trade policy (Rodriguez and Cabalu, 2006)
Inocencio *et al*. (2001)	Sources of household income: rural and urban labour, rural and urban net operating surplus	Trade policy. emission tax (also see Elca, 2005), RP-US free trade agreement (Rodriguez and Cabanilla, 2006), commercial log ban (Rodriguez, 2003)
Bottom-up		
Dufournaud *et al*. (2000)	NCR, rest of RP	Transport costs, trade policy (also see Rodriguez, 2000)

the GDP of the Philippines. However, such a policy also widens the output gap between the NCR and the other regions of the country.

The Philippines has one bottom-up model. Constructed by Dufournaud *et al*. (2000), this model divides the country into two regions — NCR and the rest of the country. Its structure closely resembles the Lofgren and Robinson (1999) in the assumption that all international trade occurs in one region (NCR) only.[16] It also accounts for interregional trade flows and transport costs. However, its treatment of transport cost differs from all the other papers reviewed. One difference is that the model does not account for an explicit transport sector. Another is its formulation of transport cost using the iceberg assumption (Samuelson, 1952).[17]

The work of Dufournaud *et al*. (2000) is at best a prototype of a bottom-up model of the Philippines. While based on the 1989 SAM, interregional flows and transport costs were constructed using ad hoc techniques. The results from its experiments should therefore be viewed as broadly indicative rather than precise outcomes at the regional level.

4. Concluding Remarks

Regional CGE models have been applied to a wide range of issues. Such models have been implemented in the analysis of international trade, government expenditure, public finance, environment, poverty, income distribution, exogenous shocks, etc. Without saying that the aforementioned applications are purely national concerns, the models have also been used for the assessment of region-specific issues. For example, this paper has cited examples on transport policy, trade in irrigation water, labour strikes, etc.

This paper has also identified three classes of regional CGE models. The first are region-specific models which focus on a particular region in a country. For all intents and purposes, these are standard models in which the rest of the country and world are treated exogenously. The primary advantage of these models is their ability to specify and evaluate regional concerns. Their main shortcomings are (a) inability to evaluate the impacts of local policies on the country as a whole, and (b) costs in assembling the dataset.

The second class of models are bottom-up CGEs. These are national models which explicitly specify the behaviour of agents at the regional level

[16] Unlike Lofgren and Robinson (1999), the model of Dufournaud *et al*. (2000) does not assume a border region.

[17] This assumption specifies that a certain proportion of commodities "melt" while being transported from one region to the next.

and interregional trade. Its appeal arises from the ability to directly simulate national and regional policies/events. Of all the classes of models, these are also the best equipped to capture the impacts of regional policies on the economy as a whole. The major constraint in the construction of such models is the cost of assembling a dataset.

The third class of models may, for lack of a better term, have been referred to as "partial" regional CGE models. These are national models which have a regional disaggregation that is not as detailed as bottom-up models. In most cases, these models just disaggregate one side of the economy; either production or consumption. Moreover, these models do not include information on regional trade flows. The popularity of these models stems mainly from their (a) ability to simulate the effects of national policies on regions, and (b) smaller appetite for data. However, the primary weakness of these models is the inability to fully capture the interaction among the different regions and limited capacity for simulating regional policies/events.

An examination of the existing regional CGE models of the Philippines has clearly indicated how far these models are relative to their counterparts overseas. While the country does not appear to have a shortage of "partial" regional CGE models, it has no region-specific CGE model. Moreover, it practically does not have a bottom-up model. As a consequence, existing models are by their design not suited for evaluating regional policies/events.

While not discussed in the paper, the biggest constraint to the construction of region-specific and bottom-up CGE models in the Philippines is the availability of official input-output data at the regional level. As there are no indications that such information will be available any time soon, regional information may have to be assembled using primary data.

Since collecting information for all the regions of the country is an expensive task, a possible strategy might be to assemble the data from one region only. Once completed, work can begin on a region-specific CGE model. If the data are comparable with the existing (national) input-output data, it might also be possible to construct a bottom-up model that disaggregates the country into two regions.

References

Adams, P. and B. Parmenter, (1993) *The Medium-Term Significance of International Tourism for the State Economies*, report commissioned and published by the Bureau of Tourism Research, Australian Government Publishing Services, Canberra, Australia

Adams, P., M. Horridge and G. Wittwer, (2002) *MMRF-GREEN: A Dynamic Multi-Regional Applied General Equilibrium Model of the Australian Economy*, Based on the MMR and MONASH Models, prepared for the Regional GE Modeling Course, 25-29 November.

Agenor, P., D. Chen and M. Grimm, (2003) Linking representative household models with household surveys for poverty analysis, paper presented at the *Policy Modeling International Conference*, Paris, June 30-2 July.

Andre, F., M. Cardenete and E. Velazquez, (2004) Performing an environmental tax reform in a regional economy: A computable general equilibrium approach, paper presented at the *Input-Output and General Equilibrium Data, Modeling and Policy Analysis Conference*, Brussels, Belgium, 2-4 September.

Appels, D., J. Fry, G. Dwyer and D. Peterson, (2004) Water trade in the Southern Murray-Darling Basin, paper presented at the *Fourth Biennial Regional Modeling Workshop*, Melbourne, Australia, 16-17 September.

Armington, P., (1969) A theory of demand for products distinguished by place of production, *IMF Staff Papers*, **16**: 159-78.

Aryal, J.P., (2005) Assessing the impact of remittance income on household welfare and land conservation investment in Mardi Watershed of Nepal: A village general equilibrium model, paper prepared for the *European Summer School in Resource and Environmental Economics*, Venice, Italy, 3-9 July; downloadable at http://www.feem-web.it/ess05/11downb.html

Bautista, C., (1987) *Macroeconomic Adjustment: An Applied General Equilibrium Approach*, PhD Dissertation, University of the Philippines School of Economics, Quezon City, Philippines.

Bautista, R. and M. Thomas, (1997) Income effects of alternative trade policy adjustments on Philippine rural households: A general equilibrium analysis, *TMD Discussion Paper No. 22*, Trade and Macroeconomics Division, International Food Policy Research Institute, Washington D.C., USA.

Bautista, R. and M. Thomas, (2000) Trade and agricultural policy reforms in Zimbabwe: A CGE analysis, paper prepared for the *Third Annual Conference on Global Economic Analysis*, Melbourne, Australia, June.

Bergman, L. and M. Henrekson, (2003) CGE Modeling of Environment Policy and Resource Management, manuscript, Stockholm School of Economics, Stockholm, Sweden, downloadable at http://72.14.203.104/search?q=cache:6nq7Nsx4pBsJ: www.ictp.trieste.it/~eee/workshops/smr1533/Bergman%2520-%2520Handbook- 1.doc+ CGE+Modeling +of+ Environmental+ Policy+and+Resource+Ma nagement&hl=tl&gl=ph &ct=clnk&cd=1.

Bourguignon, F. and L. Pereira da Silva (Eds), (2003) *The Impact of Economic Policies on Poverty and Income Distribution*, World Bank and Oxford University Press.

Bourguignon, F., A. Robilliard and S. Robinson, (2003) *Representative versus Real Households in the Macroeconomic Modeling of Inequality*, DT/2003-10, Developpement et Insertion Internationale (DIAL), Paris, France.

Brown, F. and J. Whalley, (1980) General equilibrium evaluations of tariff-cutting proposals in the Tokyo round and comparisons with more extensive liberalization of world trade, *Economic Journal,* **90**: 838-66.

Canning, P. and M. Tsigas, (2000) *Regionalism, Federalism, and Taxation: A Food and Farm Perspective*, Technical Bulletin No. 1882, Economic Research Services, U.S. Department of Agriculture, USA.

Clarete, R. and B. dela Pena, (1992) *Options for Tariff Protection Policy in the Philippines*, Apex Project, downloadable at http://rspas.anu.edu.au/economics/apex/papers.php.

Clarete, R. and P. Warr, (1992) *The Theoretical Structure of the APEX Model of the Philippine Economy*, Apex Project, downloadable at http://rspas.anu.edu.au/economics/ apex/papers.php.

Clarete, R., (1984) *The Costs and Consequences of Trade Distortions in a Small Open Economy*, PhD Dissertation, East-West Center, Hawaii, USA.

Clements, B., H. Jung and S. Gupta, (2003) *Real and Distributive Effects of Petroleum Price Liberalization: The Case of Indonesia*, Working Paper WP/03/204, International Monetary Fund.

Cororaton, C. and J. Cuenca, (2000) *An Analysis of Philippine Trade Reforms in 1995-2000 Using the 1994 APEX Model*, Discussion Paper Series No. 2000-36, Philippine Institute for Development Studies, Makati, Philippines.

Cororaton, C., (1994) *Structural Adjustment Policy Experiments: The Use of Philippine CGE Models*, Discussion Paper No. 94-03, Philippine Institute for Development Studies, Makati, Philippines.

Cororaton, C., (2003) *Analysis of Trade Reforms, Income Inequality and Poverty Using Microsimulation Approach: The Case of the Philippines*, Discussion Paper Series No. 2003-09, Philippine Institute for Development Studies, Makati, Philippines.

Cororaton, C., (2004) *Philippine-Japan Bilateral Agreements: Analysis of Possible Effects on Unemployment, Distribution and Poverty in the Philippines Using CGE Microsimulation Approach*, Discussion Paper Series No. 2004-1, Philippine Institute for Development Studies, Makati, Philippines.

Cororaton, C., (2004) *Rice Reforms and Poverty in the Philippines: A CGE Analysis*, Discussion Paper Series No. 2004-14, Philippine Institute for Development Studies, Makati, Philippines.

Cororaton, C., J. Cockburn and E. Corong, (2005) *Doha Scenarios, Trade Reforms, and Poverty in the Philippines: A CGE Analysis*, MTID Discussion Paper No. 86, Markets, Trade and Institutions Division, International Food Policy Research Institute, Washington DC , USA.

Cury, S., A. Coelho and C Corseuil, (2004) A computable general equilibrium model to analyze the distributive aspects in Brazil with a trade policy illustration, paper presented at the *Input-Output and General Equilibrium Data, Modeling and Policy Analysis*, Brussels, Belgium, 2-4 September.

Davies, J., (2004) *Microsimulation, CGE and Macro Modeling for Transition and Developing Economies*, paper prepared for the United Nations University/ World Institute for Development Economics Research (UNU/WIDER), Helsinki, downloadable at http://72.14.203.104/search?q=cache:3tq8LS_KdzIJ: www.ssc.uwo. ca/ economics/faculty/Davies/Microsimulation.pdf+village+cge&hl=tl&gl=ph&ct=clnk& cd=17.

de Melo, J., (1988) *Computable General Equilibrium Models for Trade Policy Analysis in Developing Countries: A Survey*, WPS-0003, Trade Policy Division, World Bank.

de Miguel, F. and A. Manresa, (2004) Suppression of agricultural subsidies in the extramadura region: An applied general equilibrium analysis, paper presented at the *Input-Output and General Equilibrium Data, Modeling and Policy Analysis Conference*, Brussels, Belgium, 2-4 September.

Deardorf, A. and R. Stern, (1986a) *The Michigan Model of World Production and Trade*, North Holland.

Deardorf, A. and R. Stern, (1986b) The structure and sample results of the Michigan model of world production and trade. In: *General Equilibrium Trade Policy Modeling*, Eds: T. Srinivasan and J. Whalley, Cambridge University Press.

Devarajan, S., (1995) Environment and trade in general equilibrium: Theory, methodology and evidence: Discussion, *American Journal of Agricultural Economics*, **77**: 786-788.

Devarajan, S. and S. Robinson, (2002) The impact of computable general equilibrium models on policy, paper presented at the *Frontiers in Applied General Equilibrium Modeling Conference*, Yale University, Connecticut, USA, 5-6 April.

Dixon, P., B. Parmenter, J. Sutton and D. Vincent, (1982) *ORANI: A Multisectoral Model of the Australian Economy*, Contributions to Economic Analysis, North-Holland Publishing Company.

Dixon, P. and M. Rimmer, (2002) An overview of MONASH, paper presented at the *Third Annual Conference on Global Economic Analysis*, Melbourne, Australia, 27-30 June.

Dixon, P. and G. Wittwer (2003) *Forecasting the Economic Impact of an Industrial Stoppage Using a Dynamic Computable General Equilibrium Model*, Center of Policy Studies, Monash University, Victoria, Australia.

Dixon, P. and M. Rimmer, (2003) *State-Level Dynamic CGE Modeling for Forecasting and Policy Analysis*, Working Paper No. IP-82, Center of Policy Studies and the Impact Project, Monash University, Victoria, Australia.

Domingues, E. and E. Haddad, (2002) Analyzing the spatial impact of tax policies: An interregional CGE framework for Brazil, paper presented at the *Policy Modeling International Conference*, Brussels, Belgium, 4-6 July.

Domingues, E. and M. Lemos, (2004) Regional impacts of trade liberalization strategies in Brazil, paper presented at the *Input-Output and General Equilibrium Data, Modeling and Policy Analysis Conference*, Brussels, Belgium, 2-4 September.

Dufournaud, C., U. Rodriguez and R. Briones, (2000) *Trade Barriers and Regional Economic Activity: The Role of Transport Costs and Tariffs*, paper prepared for the Center for Integrative Studies, University of the Philippines.

Elca, C., (2005) *Health and Economic Impacts of Air Pollution Reduction in the Philippines*, M.S. Thesis, University of the Philippines Los Baños, Laguna, Philippines.

Filho, J. and M. Horridge, (2005) The Doha Round:, Poverty and regional inequality in Brazil, Policy Research Working Paper 3701, World Bank, Washington D.C. Also in *Putting Development Back into the Doha Agenda: Poverty Impacts of a WTO Agreement*, Eds: T. Hertel and L.A. Winters, forthcoming.

Floros, C. and P. Failler, (2004) Policy analysis for fisheries: A dynamic CGE model, paper presented at the *Input-Output and General Equilibrium Data, Modeling and Policy Analysis Conference*, Brussels, Belgium, 2-4 September.

Garcia-Negro, M., X. Doldan-Garcia, M. Chas-Ami, Y. Zotes-Tarrio, A. Carbello-Penella, E. Nogueira-Moure and S. Villasante-Larramendi, (2004) Application of input-output methods for the study of Galician fishing in 1999, paper presented at the *Input-Output and General Equilibrium Data, Modeling and Policy Analysis Conference*, Brussels, Belgium, 2-4 September.

Gaspay, M., (1993) Getting prices right, how important is it? A CGE modeling approach, *Philippine Review of Economics*, **30**(2): 189-233.

Habito, C., (1984) *Equity and Efficiency Trade-offs in Philippine Tax Policy: A General Equilibrium Approach*, PhD Dissertation, Harvard University, Boston, USA.

Haddad, E. and F. Perobelli, (2005) Trade liberalization and regional inequity: Do transportation costs impose a spatial poverty trap? *EcoMod2005 International Conference on Policy Modeling*, 29 June-1 July.

Haddad, E. and G. Hewings, (2004) *Transportation Costs, Increasing Returns and Regional Growth: An Interregional CGE Analysis*.

Hertel, T. (Ed), (1999) *Global Trade Analysis: Modeling and Applications*, Cambridge University Press.

Holden, S., H. Lofgren and B. Shiferaw, (2005) *Economic Reforms and Soil Degradation in the Ethiopian Highlands: A Micro CGE Model with Transaction Costs*, manuscript, downloadable at http://72.14.203.104/search?q=cache:XXJ3NtK3cywJ: www.ecomod.net/conferences/ecomod2005/ecomod2005_papers/910.pdf+village+cge&hl=tl&gl=ph&ct=clnk&cd=5.

Horridge, M., (1999) *A General Equilibrium Model of Australia's Premier City*, Preliminary Working Paper No. IP-74, Center of Policy Studies, Monash University, Victoria, Australia.

Horridge, M., B. Parmenter, M. Cameron, R. Joubert, A. Suleman, D. de Jongh, (1995) *The Macroeconomic, Industrial, Distributional and Regional Effects of Government Spending Programs in South Africa*, General Paper No. G-109, Center of Policy Studies and the Impact Project, Monash University, Victoria, Australia.

Horridge, M., J. Giesecke, H. Cabalu, M. Mendoza and U. Rodriguez, (2001) *TAFCOM: A CGE Model of the Philippines*, Institute for Research into International Competitiveness (IRIC), Curtin Business School, Curtin University of Technology, Perth, Australia.

Horridge, M., J. Madden and G. Wittwer, (2003) Using a highly disaggregated multi-regional single-country model to analyze the impacts of the 2002-3 drought on Australia, paper presented at the *2003 GTAP Conference*, Netherlands, June.

Hughes, D. and R. Vlosky, (2000) *Economic Implications of Forest Products Sector Industry Development in Northwest Louisiana*, Bulletin No. 874, Louisiana State University AgCenter, USA.

Inocencio, A., C. Dufournaud and U. Rodriguez, (2001) *Impact of Tax Changes on Environmental Emissions: An Applied General Equilibrium Approach for the Philippines*, IMAPE Research Paper No. 7, IMAPE Project, Policy and Development Foundation, Makati, Philippines.

Jean, S. and D. Laborde, (2004) The impact of multilateral liberalization on european regions: A CGE assessment, paper presented at the *Policy Modeling International Conference*, Paris, France, 30 June - 2 July.

Jung, H. and E. Thorbecke, (2001) *The Impact of Public Education Expenditure on Human Capital, Growth and Poverty in Tanzania and Zambia: A General Equilibrium Approach*, Working Paper WP/01/106, International Monetary Fund.

Karl, C., (2004) *How Can the Poor be Affected by Tax Policies and Macroeconomic Shocks? A Quantitative Assessment Using a Computable General Equilibrium Framework for Columbia*, Department of Economics, University of Los Andres, Colombia.

Khan, H., (2004) *Using Macroeconomic Computable General Equilibrium Models for Assessing Poverty Impact of Structural Adjustment Policies*, ADB Institute Discussion Paper No. 12, Asian Development Bank.

King, B., (1981) *What is a SAM? A Layman's Guide to Social Accounting Matrices*, Working Paper No. 463, World Bank, Washington D.C., USA.

Kpodar, K., (2006) *Distributional Effects of Oil Price Changes on Household Expenditures: Evidence from Mali*, IMF Working Paper WP/06/91, International Monetary Fund.

Kuiper, M., and F. van Tongeren, (2004) Growing together or growing apart? A village level study of the impact of the Doha Round on rural China, paper prepared for the *7th Annual Conference on Global Economic Analysis*, Washington D.C., USA, 17-19 June.

Leontief, W., A. Morgan, K. Polensky, D. Simpson and E. Tower, (1965) The economic impact – industrial and regional of an arms cut, *Review of Economics and Statistics*, **XLVII**: 217-241.

Levantis, T., (1998) *A General Equilibrium Model of Papua New Guinea*, Economics Division Working Papers 98/1, National Center for Development Studies, Australian National University, Canberra, Australia.

Levantis, T., (2004) *AUSTATE: ABARE's National Model of the Australian Economy*, Australian Bureau of Agricultural Research, Australia.

Levantis, T., (2004) *PNGGEM: ABARE's Model of the Economy of Papua New Guinea*, Australian Bureau of Agricultural Research, Australia

Levantis, T., (2006) *AUSREGION Documentation*, downloadable at http://www. abareconomics. com/research/models/ausregion.html.

Lofgren, H. and S. Robinson, (1999) *Spatial Networks in Multi-Region Computable General Equilibrium Models*, TMD Discussion Paper No.35, International Food Policy Research Institute, Washington DC, USA.

McKibbin, W. and J. Sachs, (1989) *The McKibbin-Sachs Global Model: Theory and Specification*, NBER Working Paper No. 3100, National Bureau of Economic Research.

Nakayama, H. and S. Kaneko, (2003) Developing a computable general equilibrium Model: Case studies on Beijing and Shanghai, *Proceedings of the International Workshop on Policy Integration Towards Sustainable Energy Use for Cities in Asia*, East-West Center, Hawaii, USA.

Oktaviani, R., (2005) *AI and Its Impacts on the Indonesian Economy: A CGE Approach*, manuscript, Department of Economics, Bogor Agricultural University, Indonesia, downloadable at http://www.aomevents.com/AARES2006/papers/oktaviani.pdf.

Productivity Commission, (2005) *Modeling Impacts of Infrastructure Change over the 1990s*, Supplement to the Review of National Competition Policy Reforms, Productivity Commission Inquiry Report No. 33, Canberra, Australia.

Rodriguez, U. and R. Briones, (1997) *Economywide Models and the Rural Economy*, report submitted to the Center for Integrative Studies, University of the Philippines, Quezon City, Philippines.

Rodriguez, U., (2000) The effects of trade liberalization on pollution emissions and regional economic activity: An application to the Philippines, presented at the 2000 Taipei Conference on *Policies for Greenhouse Gases Reduction and Pollution Control in Asian-Pacific*, Institute of Economics, Academia Sinica, Taipei, Taiwan, 30 Nov-2 Dec.

Rodriguez, U., (2003) *The Effects of a Commercial Log Ban on Equity, Efficiency and the Environment*, Working Paper No. 03-01, Department of Economics, University of the Philippines Los Baños, Laguna, Philippines.

Rodriguez U. and H. Cabalu, (2006) An assessment of the economywide impact of Philippine tariff changes in the early 2000s, paper prepared for the *Improving Trade Policy in the Philippines: An Assessment of the Economywide Impact of Tariff Reforms and the Implementation of Safeguard Measures under the WTO*, project of the AusAID and Philippine Tariff Commission.

Rodriguez, U. and L. Cabanilla, (2006) *The Impact of a Philippine-US FTA: The Case of Philippine Agriculture*, Discussion Paper Series No. 2006-06, Philippine Institute for Development Studies, Makati, Philippines.

Sadoulet, E. and de Janvry, (1995) *Quantitative Development Policy Analysis*, Johns Hopkins University Press.

Samuelson, P., (1952) The transfer problem: The terms of trade when impediments are absent, *Economic Journal*, **62**: 278-304.

San, N., H. Lofgren and S. Robinson, (2000) *Structural Adjustment, Agriculture and Deforestation in the Sumatera Regional Economy*, TMD Discussion Paper No. 52, International Food Policy Research Institute, Washington D.C., USA.

Shoven, J. and J. Whalley, (1984) Applied general equilibrium models of taxation and international trade: An introduction and survey, *Journal of Economic Literature*, **22**(3): 1007-51.

Shoven, J. and J. Whalley, (1992) *Applying General Equilibrium*, Cambridge University Press.

Srinivasan, T. and J. Whalley, (1986) *General Equilibrium Trade Policy Modeling*, MIT Press.

Statistics New Zealand, (2006) *Population Indicators*, http://www.stats.gov.nz/ tables/ population-indicators.html.

Stroombergen, A. and G. Stuart, (2003) A General Equilibrium Model for Regional Economic Development, paper presented at the *2003 EcoMod Conference*, Istanbul, Turkey, 3-5 July.

Tolentino, B. and A. Balisacan, (1992) *Equity and Efficiency Effects of Fertilizer Subsidy in the Philippines: A Preliminary Application of the APEX Model*, Apex Project, downloadable at http://rspas.anu.edu.au/economics/apex/ papers.php.

van Tongeren, F., H. van Meijl, and Y. Surry, (2001) Global models applied to agricultural and trade policies: A review and assessment, *Agricultural Economics*, **26**: 149-172.

van Tongeren, F., (2005) Model simulations of agri-food trade liberalization, manuscript, Wageningen University PHLO course "*Agricultural Trade, The World Trade Organization and the Doha Round*".

Warr, P. and I. Coxhead, (1992) *Technical Progress, Income Distribution and Economic Policy in Philippine Agriculture*, Apex Project, downloadable at http://rspas.anu.edu.au/ economics/apex/papers.php.

Xiaoping, S., N. Heerink, S. Holden, Q. Futian, (2003) *Off-farm Employment, Factor Market Development and Input Use in Farm Production – A Case Study of a Remote Village in Jianxi Province, China*, Discussion Paper DP-03/05, Department of Economics and Resource Management, Norwegian University of Life Sciences, Norway.

Zakarias, G., O. Fritz, R. Kurzmann and G. Streicher, (2002) Comparing regional structural change: An application of econometric input-output models, paper presented at the *Policy Modeling International Conference*, Brussels, Belgium, 4-6 July.