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Impact assessment of national and regional policies using the Philippine Regional General Equilibrium Model

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For the Philippines, a quantitative analysis is more useful for policy if it incorporates regional differences in welfare and economic structure. However, owing to the absence of key regional data, existing computable general equilibrium (CGE) models offer limited analysis of regional effects or national impacts of region-specific interventions. This study formulates a regional CGE model that overcomes these limitations. The applications of the model showed the following: (1) completion of the tariff reform program in agriculture will contract some import-competing sectors in lagging regions, but will improve welfare across all regions; (2) productivity growth in agriculture can more than offset these contractionary effects; (3) investments in marketing infrastructure promise significant pay-offs, though with a trade-off between the size and spread of welfare gains across regions; and (4) combining trade reform with marketing infrastructure investments slightly mitigates some of the contractionary effects from the former.

JEL classification: C68, M390, Q180, R130, R580
Keywords: computable general equilibrium, regional economics, agricultural development, marketing infrastructure, trade liberalization, welfare impact

1. Introduction

In the Philippines, as in many other countries, a regional perspective is essential to the formulation of a national development policy. The eradication of mass poverty remains the paramount policy goal, as poverty incidence in the country stood at 25 percent in 2012. Among the three main island groups, poverty incidence reaches 41 percent in Mindanao and 39 percent in Visayas. In contrast, poverty incidence in Luzon, which hosts the national capital, is only 25 percent [Philippine Statistics Authority 2014].

As noted in the current Philippine Development Plan, economic activity is uneven across space, with some regions lagging in development: 62 percent of the country's GDP is produced in the National Capital Region and two adjacent regions; these regions also host the provinces with the lowest poverty incidence [NEDA 2013]. Moreover, regions differ in economic structure: the share of agriculture in GDP is 30 percent in Mindanao, 16 percent in Visayas, and only 7 percent in Luzon [Philippine Statistics Authority 2014].

These economic differences are due to the country's geography and uneven historical patterns of development. The Philippines is an archipelago of over 7,000 islands and mostly mountainous topography. Forming linkages across locations separated by seas and rough terrain is difficult. The country's limited logistics infrastructure remains a barrier to achieving market efficiency. Poor roads, inadequate transportation systems, and insufficient storage and warehousing facilities lead to damage, shrinkage, and deterioration in the quality of farm products, as well as higher agricultural prices [Intal and Ranit 2004]. In contrast, regions with a better stock of infrastructure tend to have faster regional GDP growth [Llanto 2007].

Regional development seeks to address disparities in living standards across regions as well as differences in welfare outcomes of various economy-wide policies. What are the regional differences in impacts for economy-wide policies? What are the economy-wide and regional implications of region-specific development policies? These questions may be asked, singly or in combination, for policy and investment options.

Impact analysis for various sectoral or economy-wide policies has been conducted for the Philippines using computable general equilibrium (CGE) models. Applications range from agricultural policy reforms [Habito 1986] to the environmental impacts of tax and trade policies (Coxhead [1995]; Inocencio et al. [2001]). More recent work involves World Trade Organization reforms (Cororaton et al. [2006]; Cororaton and Cockburn [2006]). However, regionally disaggregated analysis is typically done *ad hoc*, if at all. Therefore, the research questions in the preceding paragraph cannot be satisfactorily addressed by the existing models.

This study presents a regional CGE model that can address these research questions. The model, called Philippine Regional General Equilibrium Model (PRGEM), is the first bottom-up regional CGE that adopts standard features of Philippine CGEs. PRGEM is applied to policy experiments involving tariff reform and to region-specific investments in logistics and marketing infrastructure.

The rest of this paper is structured as follows. Section 2 reviews the literature covering the major policy and modeling approaches. Section 3 discusses PRGEM. Section 4 discusses PRGEM data and calibration. Section 5 applies the model and discusses implications for the country's regional and national development policy. Section 6 summarizes findings and concludes with directions for future work on regional CGE modeling.

2. Policy and modeling issues

2.1. The regional dimension of Philippine development

The three main island groups are divided into 16 administrative regions, which also exhibit differences in welfare and economic structure (Table 1). Income per capita in the National Capital Region is close to triple the national average; the other regions are near or far below the national average. The National Capital Region is also the least poor region. In general, there is a tendency for regions with lower GDP per capita to display a higher incidence of poverty. Regions with lower GDP per capita also tend to produce a greater share of regional output from agriculture.

TABLE 1. Selected regional indicators for the Philippines

Region	Per capita relative GDP, 2012 (National = 100)	Poverty incidence, 2012 (%)	Agriculture share in GDP, 2012 (%)
NCR	283	3	0
CAR	115	18	10
Region I - Ilocos	61	14	28
Region II - Cagayan Valley	51	17	43
Region III - Central Luzon	82	10	17
Region IVA - CALABARZON	120	8	6
Region IVB - MIMAROPA	57	24	25
Region V - Bicol	35	32	24
Region VI - Western Visayas	52	23	26
Region VII - Central Visayas	86	26	8
Region VIII - Eastern Visayas	49	37	22
Region IX - Western Mindanao	56	34	26
Region X - Northern Mindanao	83	33	27
Region XI - Southern Mindanao	83	25	23
Region XII - Central Mindanao	63	37	38
Caraga	44	32	23
ARMM	25	49	65

Source: Philippine Statistics Authority - National Statistical Coordination Board

Postwar economic policy was dominated by industrialization based on import substitution, imposing an implicit tax burden on agriculture [Intal and Power 1991]. The emphasis on heavy industries inadvertently promoted capital-intensive manufacturing located in cities. Pernia, Paderanga, and Hermoso [1983] found that the sectors that tended to concentrate around the national capital were associated with higher effective protection rates. From the 1980s onward, this protectionist stance was dismantled through a series of structural adjustment programs. In foreign trade, major reforms have been the elimination of export taxes, the repeal

of most quantitative restrictions, and tariff reduction. Subsequently, in the 1990s, manufacturing became less concentrated in the National Capital Region, though the relocation mostly favored the regions adjacent to the capital [Tecson 2007].

Even as industry protection declined during the reform period, the relative protection of agriculture rose, particularly after the World Trade Organization accession in 1995 [David 2003]. There remains a strong political resistance towards further trade liberalization in agriculture. Opponents are wont to cite the potentially adverse impact on foreign competition on small farmers and the rural poor, as well as the inadequacy of government support for building a globally competitive agricultural sector. More recently, Cororaton et al. [2006] found that tariff reduction improves overall welfare but worsens poverty.

As earlier stated, geographic barriers matter in agriculture. Since commodities are more mobile than production factors, there is every reason to suspect that geographic barriers are even more formidable for factor movement, especially of labor. One may model the different regions as having different labor markets, each with its distinctive features, such as rate of adjustment to equilibrium [Montalvo 2006]. Adjustment problems in the geographically disadvantaged regions may be one factor behind the failure of the economy to respond to market reforms.

National policy, expressed in recent economic plans, has highlighted the need to reduce development disparities between the regions. Decentralization is seen not only as the end; it is also the means towards economic development. Since 1991, the government has largely devolved various government functions to local governments. Within this set-up, the regions provide the natural zone of convergence between regional and national government development strategies. Several mechanisms, such as the Regional Development Councils, are in place to promote coordination.

Moreover, national policy recognizes modernization of agriculture as a precursor of regional development. Agricultural modernization entails an effective system of technology transfer, capital assistance, and agricultural marketing services to the agriculture-dependent regions. Also essential would be public investments in irrigation and postharvest facilities, requiring large budgetary outlays for quality transport infrastructure, including roads and shipping facilities, as well as regulatory reforms in transport services [Intal and Ranit 2004].

Quantitative simulations using an explicit regional model are useful when the regions differ in household welfare and dependence on agriculture. National-to-subnational analysis will focus on disaggregating the regional impact of economy-wide reforms, such as trade liberalization in agriculture. Meanwhile subnational-to-national analysis will help formulate regional priorities for public investments in market infrastructure to improve economic linkages between regions. These issues will guide our later formulation of the scenarios for quantitative analysis (section 5).

2.2. Regional CGE models

Most CGEs invoke a disaggregation between the domestic national economy of interest and the rest of the world. This structure provides a useful benchmark for classifying regional CGEs. We follow the classification scheme of Rodriguez [2007].

The first type is the **region-specific CGE**. This type of CGE isolates a sub-national economy and groups the rest of the national economy together with the foreign sector under "rest of the world". For instance, Liu and Chen [2004] construct a CGE model of Southern Taiwan; the remainder of Taiwan and the foreign sector are lumped together. Rodriguez provides additional examples since the 1990s.

A second type, according to Rodriguez, is the **partial regional CGE**. This type of CGE groups together sub-national regions into a national economy that is kept distinct from the foreign sector. Equilibrium is, however, determined at the national level, with no feedback from distinct regional markets.

A common technique is to go "top-down", i.e., solve the national CGE first, and then feed the results into a regional module, which can disaggregate households, the production side, or both. Top-down models are the most common type of regional CGE for the Philippines. Among these models, regional disaggregation is more frequently applied to households. Examples include Bautista [1987] and Gaspay [1993]. Regional disaggregation that covers the production side is found in Clarete and Warr [1994] for the APEX model. This is also found in Innocencio et al. [2001], which disaggregates labor and operating surplus by urban and rural regions, as well as in Horridge et al. [2001] for the TARFCOM model, which disaggregates the country into 16 administrative regions.

The third type is the **"bottom-up" regional CGE**. This type of CGE models each sub-national economy as a distinct system of markets, though allowing for trade in a single national market.

The top-down approach is clearly simpler, but it misses out on the richness of inter-regional and intra-regional market interactions that can be captured in the bottom-up approach. The reliance on top-down approaches in regional CGEs, particularly for the Philippines, reflects the absence of region-specific data as well as information on inter-regional flows [Yap 2001]. An example of a bottom-up regional CGE is found in Brocker and Schnedier [2002]. For each region of this model, external outputs (both foreign goods and goods from other regions) are collapsed into a single constant elasticity of substitution (CES) pool. Rodriguez provides several more examples from the international literature. An example of a bottom-up regional CGE for the Philippines is an unpublished paper by Dufournaud et al. [2000]. This paper incorporates economic geography approaches and is covered under the next heading.

Introducing the regional dimension leads us inexorably to the realm of geography. Partridge and Rickman [2008] note that most regional CGEs adopt the

framework of trade models. In essence, such models abstract from the physical geography of the regional units. At the frontier of this line of research are models that make the geographic element explicit and fairly detailed, i.e., spatial CGEs that account for distance and transport costs, or CGEs that endogenize the location of economic actors (producers or consumers).

Spatial patterns of economic activity – namely, agglomeration effects – can be modeled in terms of scale economies, whether external to producers or internal to producers (as in the "new economic geography"). For the Philippines, a regional CGE in the mold of scale economies models has been formulated by Dufournaud et al. [2000]. Their model posits a central urban and rural region, where the former corresponds to the national capital, and the latter to the rest of the country. Production sectors are manufacturing and agriculture. Manufacturing in the central urban area is produced under increasing returns to scale. Production elsewhere or in other sectors is subject to constant returns. In the increasing returns sector, the number of firms is endogenous under free entry and exit, and equilibrium is reached at zero profits for each firm. The model introduces transport cost via the "iceberg" assumption. Their experiments, calibrated to 1989 data, show that an elimination of tariffs causes an increase, in all regions, of welfare, exports, and imports.

As for spatial CGE models, a Philippine version has been developed by Mizokami, Itose, and Dakila [2005], and has been extended in Dakila and Mizokami [2006a]. The model aims to analyze the impact of reducing "impedance", a measure of the transport network congestion. Their model has seven sectors: agriculture; industry; other services; air transport services; water transport services; land transport services; and government services. Production and consumption are represented by Cobb-Douglas functions. Imports and exports are exogenous – a nontrivial simplification. The model uses regional Social Accounting Matrices (SAMs) based on 1994 data, which capture intra-regional and inter-regional flows. Construction of the data set is described in Dakila and Dakila [2004] and Dakila and Mizokami [2006b].

For the regional CGE model adopted in this study, we take the bottom-up approach as most appropriate for modeling the policy issues being tackled, i.e., distinct inter- and intra-regional interactions created by cross-regional rigidities in the movement of goods, services, and factors. However, we adhere to the more tractable constant-returns approach typical in trade modeling. Economic flows such as consumption, production, and inter-regional and international trade will all be modeled using price-responsive, conventional functional forms.

3. The Philippine Regional General Equilibrium Model

3.1. Categories

The regions are defined as follows:

- "Metro Luzon" denotes Central Luzon, Southern Tagalog, and NCR;
- "Northern Luzon" denotes Ilocos, CAR, Cagayan Valley;
- "Visayas" denotes Central Philippines, i.e., Bicol region, all the Visayas regions; and
- "Mindanao" denotes all the Mindanao regions.

Because of serious data limitations in the construction of regional SAMs, the model adopts a minimalist classification of sectors while transcending the basic sector subdivision into agriculture, industry, and services. That is, the number of sectors should be kept to a minimum, subject to the following conditions: categories should support the analytical thrusts of the study, namely the focus on agriculture and inter-regional trade; there may be a basic split each for Industry and Services, but more detailed disaggregation for Agriculture; and, as much as possible, the resulting sectors should exhibit product differences across categories, but similarity within one category.

The resulting disaggregation is as follows:

- Cereals;
- Livestock and Poultry;
- Fisheries;
- Other agriculture;
- Agro-processed products, which covers food, beverage, and tobacco manufacturing;
- Other industry;
- Transport, which covers Trade, Transport, and Storage Services; and
- Other services.

Model sets and variables are shown in Table 2. Parameter notation is shown in Table 3, and equations are shown in Table 4. Equations are divided into three blocks, considered in turn.

TABLE 2. Indices and variable definitions

Indices	
G	Production sectors
R or RJ	Regions
H	Households
Variables - institutions	
$QCH_{G,H,R}$	Consumption by sector by household
$QC_{G,R}$	Consumption by sector
$P_{G,R}$	Retail price
$XPEN_{H,R}$	Expenditure
$YD_{H,R}$	Household disposable income
$HHSAV_{H,R}$	Household saving by HH group
$HHSAV_{H,R}$	Household saving
$Y_{H,R}$	Total income
$GDEM_{G,R}$	Government demand for goods
TXR_{R}	Tax revenue by region
$GSAV_{R}$	Government saving by region
$MPRT_{R}$	Total imports by region in foreign currency
$XPRT_{R}$	Total exports by region in foreign currency
$FSAV_{R}$	Foreign saving by region
$RSAV_{R}$	Net trade of region R with other regions
$SAVR_{R}$	Total saving by region
$QINV_{G,R}$	Investment demand
$QINT_{G,R}$	Intermediate input demand
$QDT_{G,R}$	Total demand
$QD_{G,R}$	Internal demand - CES composite of external and home good
$QDRR_{G,R,RJ}$	Demand in region R for product G from region RJ
Variables - production	
$PST_{G,R}$	Price of gross output
$QST_{G,R}$	Gross output
$LAB_{G,R}$	Labor used to produce gross output
$CAP_{G,R}$	Capital services used to produce gross output
WAG_{R}	Factor price of labor
REN_{R}	Factor price of capital services
$PVA_{G,R}$	Price of value added per unit of gross output

Variables - inter-economy trade and closure	
$PD_{G,R}$	Price of internal demand
$PH_{G,R}$	Price of home good
$QDH_{G,R}$	Demand for home good
$PDRF_{G,R}$	Price of external component of internal demand
$QDRF_{G,R}$	Demand for external component of CES composite
$PDR_{G,R}$	Price of aggregate regional good
$QDR_{G,R}$	Quantity of aggregate regional good
PM_{G}	Import price in local currency gross of tariff
$QDF_{G,R}$	Import demand
$PR_{G,R,RJ}$	Price paid by region R for product G from region RJ
PTC_{R}	Price of transaction good
$QTCG_{G,R,RJ}$	Quantity of transaction good in R to import G from RJ
QTC_{R}	Quantity of transaction cost good
$QS_{G,R}$	Net output (CET composite of home-external)
$PS_{G,R}$	Price of output - CET composite
$QSH_{G,R}$	Supply of home good
PX_{G}	Export price in local currency
$QSF_{G,R}$	Supply of export good
$RGDP_{R}$	Regional Gross Domestic Product
CPI_{R}	Price index

TABLE 3. Parameters and exogenous variables

Institutions	
$\beta_{G,H,R}$	Expenditure share parameter in linear expenditure system equation
$\gamma_{G,H,R}$	Subsistence consumption
$aps_{H,R}$	Average propensity to save
$labe_{H,R}$	Labor endowment
$cape_{H,R}$	Capital endowment
$txy_{H,R}$	Income tax rate
$gtrh_{H,R}$	Net government transfers to households
$ftrh_{G,R}$	Net foreign transfers to households in dollars
$gbudn$	Total government spending budget - national
$shgb_{G,R}$	Share allocation of government budget
pwm_{G}	Import price in world market, in dollars
pwx_{G}	Export price in the world market, in dollars
$txb_{G,R}$	Indirect tax rate
$txm_{G,R}$	Tariff rate
$usir_{G,R}$	Proportion of regional saving allocated to regional investment
$ftrg_{R}$	Net foreign transfers to government in foreign currency

Production	
$sig_{G,R}$	Elasticity of substitution in CES production
$rho_{G,R}$	Parameter of elasticity of substitution in CES production
$\delta L_{G,R}$	Share parameter of labor in CES production
$\delta K_{G,R}$	Share parameter of capital in CES production
$\lambda_{G,R}$	Productivity parameter in CES production
$io_{G,R}$	Input-output coefficient
Inter-economy and closure	
$\sigma D_{G,R}$	Elasticity of substitution in CES composite
$\delta DRF_{G,R}$	External good parameter in CES composite
$\delta H_{G,R}$	Home good parameter in CES composite
$\sigma DRF_{G,R}$	Elasticity of substitution in outside good composite - demand
$\delta DR_{G,R}$	Regional aggregate parameter in outside good composite
$\delta DF_{G,R}$	Import parameter in outside good composite - demand
$\sigma DR_{G,R}$	Elasticity of substitution of components of regional aggregate - demand
$\delta DRR_{G,R,RJ}$	Regional component parameter in regional aggregate - demand
$tc_{G,R,RJ}$	Unit transaction cost in R for purchasing G from RJ
$\sigma S_{G,R}$	Elasticity of substitution in CET composite
$\delta SF_{G,R}$	Export parameter in outside good composite - supply
$\delta SH_{G,R}$	Home good parameter in CET composite
$fsavn$	Equilibrium level of foreign saving
$rsh_{G,R}$	Share of consumption spending on G at the regional level, baseline
$shr(R)$	Consumption share of region, baseline
$cpib$	Consumer price index, baseline

TABLE 4. Equations of the model

Institutions	
$QCH_{G,H,R} = \gamma_{G,H,R} + \beta_{G,H,R} / P_{G,R} \ (XPEN_{H,R} - \Sigma_G P_{G,R} \cdot \gamma_{G,H,R})$	(1)
$QC_R = \sum_H QCH_{H,R}$	(2)
$XPEN_{H,R} = YD_{H,R} - HSAVH_{H,R}$	(3)
$HSAVH_{H,R} = aps_{H,R} \cdot YD_{H,R}$	(4)
$HSAV_H = \sum_H HSAVH_{H,R}$	(5)
$YD_{H,R} = Y_{H,R} \cdot (1 - txy_{H,R}) + ftrh_{H,R} \cdot ER + gtrh_{H,R})$	(6)
$Y_{H,R} = WAG_R \cdot labe_{H,R} + REN_R \cdot cape_{H,R}$	(7)
$P_{G,R} \cdot GDEM_{G,R} = gbudn \cdot shgb_{G,R}$	(8)
$TXR_R = \sum_R \sum_H txy_{H,R} \cdot Y_{H,R} + \sum_G txb_{G,R} \cdot PD_{G,R} \cdot QDT_{G,R} + \sum_H gtrh_{H,R}$	(9)
$GSAV_R = TXR_R + ftrg_R \cdot ER - \sum_G P_{G,R} \cdot GDEM_{G,R} - \sum_H gtrh_{H,R}$	(10)
$MPRT_R = \sum_G pwm_G \cdot QDF_{G,R}$	(11)
$XPRT_R = \sum_G pwx_G \cdot QSF_{G,R}$	(12)
$FSAV_R = \left(MPRT_R - XPRT_R - \sum_H ftrh_{H,R} - ftrh_R\right) \cdot ER$	(13)
$RSAV_R = \sum_G P_{G,RJ} \cdot QDRR_{G,R,RJ} - \sum_G P_{G,R} \cdot QDRR_{G,RJ,R}$	(14)
$SAVR_R = HSAV_R + GSAV_R + FSAV_R + RSAV_R$	(15)
$QD_{G,R} = QC_{G,R} + QINV_{G,R} + GDEM_{G,R} + QINT_{G,R}; G \neq Trans$	(16)
$QD_{G,R} = QC_{G,R} + QINV_{G,R} + GDEM_{G,R} + QINT_{G,R} + QTC_R; G = Trans$	(17)
$QINV_{G,R} = usir_R \cdot SAVR_R$	(18)
$QDT_{G,R} = QD_{G,R} + \sum_{RJ} QDRR_{G,RJ,R}$	(19)
Production	
$QST_{G,R} = \lambda_{G,R} \cdot \left(\delta L_{G,R} LAB_{G,R}^{\rho S_{G,R}} + \delta K_{G,R} CAP_{G,R}^{\rho S_{G,R}}\right)^{\frac{-1}{\rho S_{G,R}}}$	(20)
$LAB_{G,R} = \lambda_{G,R}^{\sigma S_{G,R}-1} \cdot QST_{G,R} \cdot (\delta L \cdot PVA_{G,R} / WAG_R)^{\sigma S_{G,R}}$	(21)
$CAP_{G,R} = \lambda_{G,R}^{\sigma S_{G,R}-1} \cdot QST_{G,R} \cdot (\delta K \cdot PVA_{G,R} / REN_R)^{\sigma S_{G,R}}$	(22)
$PVA_{G,R} = PST_{G,R} - \sum_{GJ} io_{GJ,G,R} \cdot P_{GJ,R}$	(23)
$QINT_{G,R} = \sum_{GJ} io_{G,GJ,R} \cdot QST_{GJ,R}$	(24)

Inter-economy and closure

$$PD_{G,R} \cdot QD_{G,R} = PH_{G,R} \cdot QDH_{G,R} + PDRF_{G,R} \cdot QDRF_{G,R} \quad (25)$$

$$QDRF_{G,R} = QD_{G,R} \cdot (\delta DRF_{G,R} \cdot PD_{G,R} / PDRF_{G,R})^{\sigma D_{G,R}} \quad (26)$$

$$QDH_{G,R} = QD_{G,R} \cdot (\delta DH_{G,R} \cdot PD_{G,R} / PH_{G,R})^{\sigma D_{G,R}} \quad (27)$$

$$PDRF_{G,R} \cdot QDRF_{G,R} = PDR_{G,R} \cdot QDR_{G,R} + PM_{G} \cdot QDF_{G,R} \quad (28)$$

$$QDR_{G,R} = QDRF_{G,R} \cdot (\delta DR_{G,R} \cdot PDRF_{G,R} / PDR_{G,R})^{\sigma DRF_{G,R}} \quad (29)$$

$$QDF_{G,R} = QDRF_{G,R} \cdot (\delta DR_{G,R} \cdot PDRF_{G,R} / PM_{G})^{\sigma DRF_{G,R}} \quad (30)$$

$$PM_{G} = pwm_{G} \cdot (1 + txm_{G}) \cdot ER \quad (31)$$

$$QDRR_{G,R,RJ} = QDR_{G,R} \cdot (\delta DRR_{G,R,RJ} \cdot PDR_{G,R} / PD_{G,R,RJ})^{\sigma DR_{G,R}} \quad (32)$$

$$PDR_{G,R} \cdot QDR_{G,R} = \sum_{RJ} PR_{G,R,RJ} \cdot QDRR_{G,R,RJ} \quad (33)$$

$$PR_{G,R,RJ} = P_{G,RJ} + tc_{G,R,RJ} \cdot PTC_{R} \quad (34)$$

$$QTCG_{G,R,RJ} = tc_{G,R,RJ} \cdot QDRR_{G,R,RJ} \quad (35)$$

$$QTC_{R} = \sum_{RJ} \sum_{G} QTCG_{G,R,RJ} \quad (36)$$

$$PTC_{R} = P_{G,R}; G = Trans \quad (37)$$

$$QSH_{G,R} = QS_{G,R} \cdot (\delta SH_{G,R} \cdot PS_{G,R} / PH_{G,R})^{\sigma S_{G,R}} \quad (38)$$

$$QSF_{G,R} = QS_{G,R} \cdot (\delta SF_{G,R} \cdot PS_{G,R} / PX_{G})^{\sigma S_{G,R}} \quad (39)$$

$$PS_{G,R} \cdot QS_{G,R} = PH_{G,R} \cdot QSH_{G,R} + PX_{G,R} \cdot QSF_{G,R} \quad (40)$$

$$PST_{G,R} \cdot QST_{G,R} = PS_{G,R} \cdot QS_{G,R} + \sum_{RJ} PD_{G,R} \cdot QDRR_{G,RJ,R} \quad (41)$$

$$QS_{G,R} = QST_{G,R} - \sum_{RJ} QDRR_{G,RJ,R} \quad (42)$$

$$PX_{G} = pwx_{G} \cdot ER \quad (43)$$

$$P_{G,R} = PD_{G,R} \cdot (1 + txb_{G,R}) \quad (44)$$

$$\sum_{G} LAB_{G,R} = labe_{R} \quad (45)$$

$$\sum_{G} CAP_{G,R} = cape_{R} \quad (46)$$

$$QDH_{G,R} = QSH_{G,R} \quad (47)$$

$$\sum_{R} FSAV_{R} = fsavn \quad (48)$$

$$CPI_{R} = \sum_{R} rsh_{G,R} \cdot P_{G,R} \quad (49)$$

$$\sum_{R} shr_{R} \cdot CPI_{R} = cpib \quad (50)$$

$$RGDP_{R} = \sum_{H} Y_{H,R} + \sum_{G} txb_{G,R} \cdot PD_{G,R} \cdot QDT_{G,R} \quad (51)$$

3.2. The institutions block

The components of domestic demand are household consumption, government consumption, and investment demand. In each region and sector, household consumption is characterized by a linear expenditure system (Equation 1). Total consumption per region sums up household consumption (Equation 2). Household expenditure is the residual of disposable income and saving (Equation 3). Household saving is a fixed proportion of disposable income (Equation 4); this sums up total household saving by region (Equation 5). Disposable income is factor income after tax, plus net transfers to households (Equation 6). Factor income is earned from the fixed labor and capital endowment by region (Equation 7), i.e., factor immobility is imposed.

Government consumption is a fixed share of an exogenous national budget, i.e., public sector demand is Cobb-Douglas (Equation 8). Tax revenues are collected directly from factor owners and indirectly from businesses and importation (Equation 9). Revenues plus government transfer receipts, less total spending inclusive of exogenous transfer payments, yields government saving (Equation 10). Equations for total imports and exports (Equations 11 and 12) lead to foreign saving (Equation 13). The counterpart expression for net trade with other regions is shown in Equation 14. Total saving sum up the saving from various sources (Equation 15).

Demand by institutions within a region or internal demand (Equations 16 and 17) consists of final and intermediate demand. Computation of demand for sector Trans has an extra term, signifying the marketing input from Trans to conduct inter-regional trade. Investment demand by sector and region is a fixed proportion of regional saving (Equation 18). Internal demand plus demand from other regions yields total demand (Equation 19).

3.3. Production block

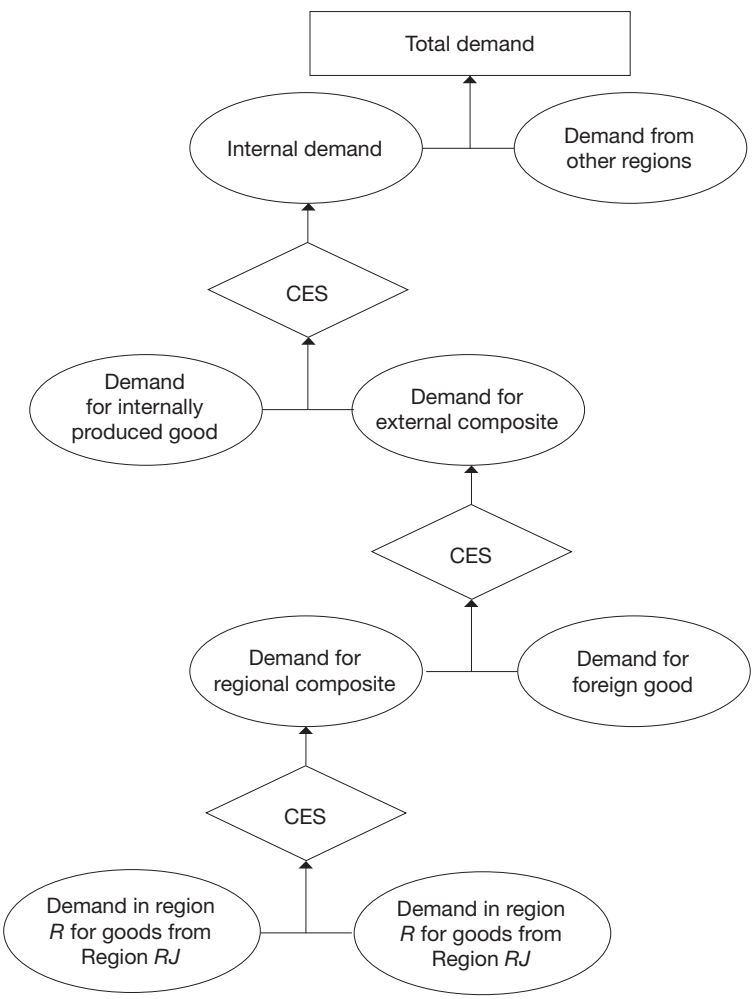
Production follows a CES technology combining primary factors labor and capital with factor demand derived from cost minimization (Equations 20 to 22). We include a productivity parameter λ set to 1 at the baseline. A higher value of λ allows more output to be produced with the same quantity of primary factors. Demand for intermediate inputs is derived from Leontief technology: price of value added is computed from gross output price by subtracting unit intermediate inputs (Equation 23). Unit intermediate inputs multiplied by gross output levels is equal to total intermediate demand (Equation 24).

3.4. Inter-economy and closure block

The inter-economy structure of the model is schematically represented in Figures 1 and 2. The former represents the demand side, which is a nested CES

formulation. Total demand is internal demand plus demand *from* other regions, with corresponding price expression (Equation 25). Internal demand is a CES composite, combining demand for goods produced outside the region (Equation 26) and demand for own production, or *home* demand (Equation 27), again with corresponding price expression (Equation 28). External demand is a CES composite of the aggregate regional good (Equation 29) and imports (Equation 30). Assuming the Philippines is a small economy, the import price is taken from the fixed world price, adjusted for tariffs, and valued in pesos (Equation 31). The regional good is a CES composite of goods produced in other regions, which leads to demand for components of the regional aggregate (Equation 32) with corresponding price expression (Equation 33).

FIGURE 1. Schematic for the demand side of the PRGEM

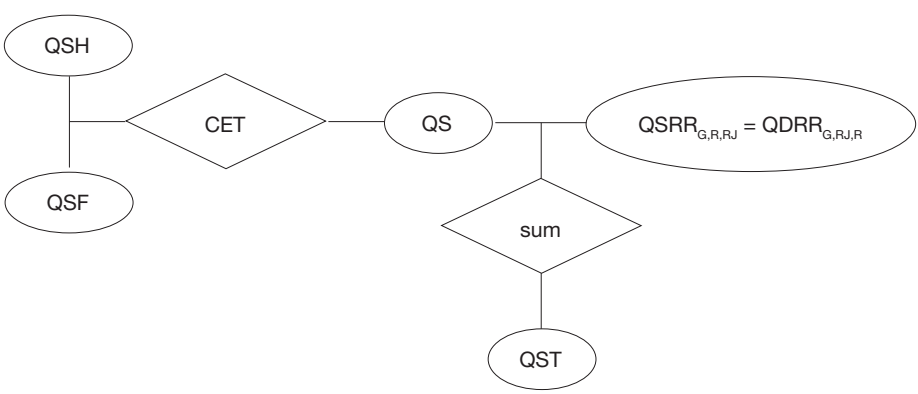


The price of the aggregate regional good is a composite of the demand prices charged by the other regions, with an adjustment for a unit transaction cost (Equation 34). This transaction cost set-up resembles that of the "standard CGE" model of the International Food Policy Research Institute [Lofgren, Harris, and Robinson 2002]. The regional good demands the transaction good based on a fixed coefficient for transaction cost (Equation 35), which sums up to a total transaction good demand by region (Equation 36). The price of the transaction good itself is the consumer price (Equation 37, a special case of Equation 34).

Net output is a CET composite of home production (Equation 38) and production for exports (Equation 39). These expressions are accompanied by corresponding price functions (Equations 40 and 41). Net supply is derived from total supply less what is supplied to other regions (Equation 42). The introduction of a demand term in the supply side is justified by perfect transformability, with respect to output of the producing region, across the regional market destinations (including that of the producing region). Alternatively, we could have defined a variable, say $QSRR_{G,R,RJ}$, with equilibrium at $QSRR_{G,R,RJ} = QDRR_{G,RJ,R}$. However, the current presentation is more concise.

The counterpart of the import price expression on the supply side leads to Equation 43, with no tax term. Closure is imposed by relating consumer price to demand price (Equation 44), attaining equilibrium in the markets for primary factors by region (Equations 45 and 46), and equating demand and supply for the home good by region (Equation 47). A flexible exchange rate, consistent with the policy regime in the last two decades, is implemented at the supposed equilibrium capital outflow or foreign saving (Equation 48). As system equilibrium is homogenous of degree zero in all prices, normalization is required to obtain a unique solution. This is imposed by setting the consumer price index to its baseline value (Equation 49).

FIGURE 2. Schematic for the supply side of the PRGEM

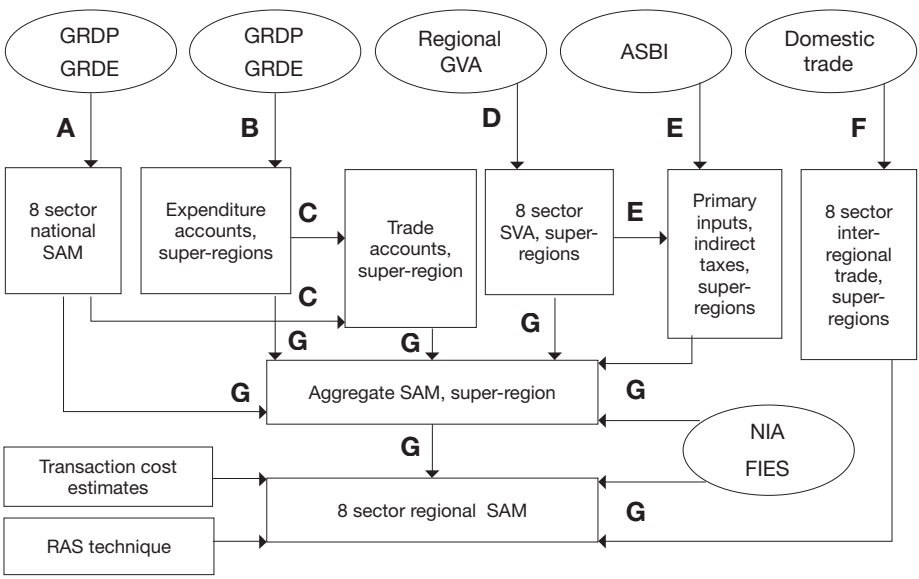


4. Model data and calibration

4.1. Regional SAMs

The biggest challenge in constructing a regional CGE is building the regional SAMs, which comprise the base data set of the CGE. Some of the methods follow Dakila and Dakila [2004]. The regional SAMs are constructed in a series of steps. Figure 3 provides a schematic representation of these steps: oval shapes represent official data sources; rectangles represent processed data; and block arrows represent other sources of information, i.e., literature review and computational procedure.

FIGURE 3. Schematic for the data processing procedure of the PRGEM



4.1.1. Construct a national SAM

First, we build a national SAM based on our eight economic sectors and exclude inter-regional trade. The national SAM is primarily based on the 2000 input-output table. Transfer items are computed from the 2000 national income accounts. We requested estimates of weighted tariff rates from the Tariff Commission based on the 8-sector definition for the year 2000. Finally, saving is computed as a residual to balance the SAM.

4.1.2. Compile regional spending data

Next, we compile regional accounts data from the Gross Regional Domestic Expenditure (GRDE) table and from the Gross Regional Domestic Product (GRDP)

table for 2000. Note that, in principle, GDP should equal the sum of primary factor payments (gross of depreciation) and indirect business taxes. As official data violate this condition, the model data is kept consistent with the levels in the input-output table, with shares in total based on the regional accounts.

4.1.3. Compute regional exports, imports, and tariff revenue by sector

As the regional accounts compute only the net exports, we need to generate our own estimates of exports and imports by region. First, imports are computed by weighting total imports (in the input-output table) by GRDP shares in GDP. The net export account is then added back to recover regional exports. We then disaggregate the trade accounts by sector. Exports and imports are disaggregated using the sector shares in the national SAM on the aggregate regional exports and imports. The tariff rates in the national SAM are applied equally to the regional imports to obtain regional tariff revenues.

4.1.4. Disaggregate gross value added by sector and region

Regional accounts data disaggregates gross value added (GVA) into the three major subdivisions: Agriculture; Industry; and Services. We divide Agriculture into our four sectors – Cereals, Livestock and poultry, Fish, and Other agriculture– using output value shares from official data. Based on national SAM shares, Industry is divided into Agro-processed products and Other industry, and Services is divided into Transport and Other services.

4.1.5. Obtain regional primary inputs and indirect taxes

The next task is to decompose gross value added into labor, capital, and indirect tax, by sector and region. The main data source for this is the Annual Survey of Business and Industry (ASBI) of the Philippine Statistics Authority. Published data from the 2000 ASBI was regrouped into the sectors and regions of the model. Ratios of labor, capital, and indirect tax cost to gross value added were then applied to compute the primary factor and sales tax accounts of the regional SAMs.

4.1.6. Construct the inter-regional trade data set

For inter-regional flows of goods, the main source of information is the domestic trade data of the National Statistics Office. These statistics are derived from cargo declarations, waybills, manifests, and other documents collected in seaports, airports, and railway stations. There are several limitations of this data. First, no data is available on inter-regional trade in goods delivered by road transport. This omission is most relevant for the regions Metro Luzon and Other Luzon. Second, information about the source of transported goods is limited to

its immediate port of origin. We simplify by assuming that the region hosting the port of origin produces the transported goods. Likewise, the region hosting the port of destination is the locus of demand for the transported goods. Third, the domestic trade data is limited to merchandise deliveries. Hence we omit all services from inter-regional trade. Fourth, intra-regional trade is ignored. This explains the discrepancy between our totals and the domestic trade totals.

We rely on the domestic trade summary tables covering directed trade data (oriented by origin-destination) in terms of the following categories:

- Food and live animals (Cereals, Livestock and poultry, Fish, Other agriculture);
- Beverages and tobacco (Agro-processed products);
- Crude materials (Other industry);
- Mineral fuels (Other industry);
- Animal and vegetable oils (Agro-processed products);
- Chemicals (Other industry);
- Manufactured materials (Other industry);
- Machinery and transport equipment (Other industry);
- Miscellaneous manufactures (Other industry); and
- Others not elsewhere classified (Other industry).

The bracketed labels denote the corresponding sectors in our model. The domestic trade summaries have data that are disaggregated by two-digit industry classification, but are aggregated over the regions. The ratios from this table are used to allocate the domestic trade data into our model sectors.

Directed trade summaries by category are available for the island groups of Luzon, Visayas, and Mindanao. We can directly use the data from Visayas and Mindanao. However, we must disaggregate Luzon intra-regional trade into trade between Metro Luzon and Other Luzon, as well as Luzon inter-regional exports and imports to Visayas and Mindanao. We do this using the ratios obtained from the complete directed trade totals by administrative region.

4.1.7. Construct regional SAMs

The final step involves the construction of the regional SAMs. As a preparatory step, we first construct aggregate accounts by region, that is, Activities, Goods, Factors, Households, Government, Saving-Investment, Tax-income, Tax-business, and Foreign, each summed up over the economic sectors. The previous steps all contribute to completing the regional aggregate accounts. Other items, such as transfers, are computed by using the GRDP shares in GDP. The exception is the regional income tax revenue, which is obtained by splitting the national SAM account using regional share data from the Family Income and Expenditure Survey (FIES) of 2000, which is processed from public use data files provided by the National Statistics Office. The saving-investment account is used to achieve a balance in the aggregate accounts.

The regional SAM has all the accounts found in the national SAM and adds the four regions for inter-regional trade, as well as four transaction entries by region (*Mluz-trans*, *OthLuz-trans, Vis-trans,* and *Minda-trans*). Transaction cost is computed from unit transaction cost margins as a ratio of consumer price. These ratios are estimated from transport cost and logistic studies, as summarized in Ordonez et al. [2005] and Intal and Ranit [2004]. Adjustments were made in terms of distance; adjacent regions will tend to have slightly lower unit transaction cost than more remote regions. This applies for the pair *Mluz – OthLuz* and *Vis* – any region. Some of the entries were verified for realism through key person interviews with industry representatives.

The transaction cost assumptions are shown in Table 5. Note that these figures are little more than guesstimates. They should be regarded as useful starting points rather than hard-and-fast numbers for conducting the analysis.

TABLE 5. Unit transaction cost estimates by sector and trade direction

Region	Destination			
	Metro Luzon	Other Luzon	Visayas	Mindanao
Metro Luzon				
Cereals	-	0.200	0.200	0.200
Livestock and poultry	-	0.190	0.200	0.200
Fish	-	0.050	0.060	0.070
Other agriculture	-	0.300	0.300	0.300
Agro-processed products	-	0.230	0.240	0.250
Other industry	-	0.140	0.140	0.150
Other Luzon				
Cereals	0.200	-	0.200	0.200
Livestock and poultry	0.190	-	0.200	0.200
Fish	0.050	-	0.060	0.070
Other agriculture	0.300	-	0.300	0.300
Agro-processed products	0.230	-	0.240	0.250
Other industry	0.100	-	0.140	0.150
Visayas				
Cereals	0.200	0.200	-	0.200
Livestock and poultry	0.190	0.190	-	0.200
Fish	0.060	0.060	-	0.060
Other agriculture	0.300	0.300	-	0.300
Agro-processed products	0.230	0.230	-	0.230
Other industry	0.140	0.140	-	0.150
Mindanao				
Cereals	0.200	0.200	0.189	-
Livestock and poultry	0.200	0.200	0.150	-
Fish	0.070	0.070	0.050	-
Other agriculture	0.300	0.300	0.300	-
Agro-processed products	0.250	0.240	0.230	-
Other industry	0.150	0.140	0.140	-

Source: Author's estimates from various sources

The previous steps have generated the data to fill in the accounts for the following: indirect business tax; labor; capital; imports; tariff revenues; exports; and inter-regional trade. Consumption, government spending, and income taxes are subdivided across sectors based on the shares in the national SAM. Consumption is further subdivided across regions using FIES shares. We provide preliminary figures for investment demand using a similar method. For intermediate demand, we apply the shares in sector value added in the national SAM, applied to the sector value added by region, and adjusted proportionately to equal the total intermediate demand in the aggregated regional SAMs. Other items that do not require disaggregation – such as income tax, transfers, and saving – are copied from the aggregate regional accounts.

This leads to regional SAMs that are everywhere in balance, except for the sector accounts. The sector accounts are balanced using the RAS method on the inter-industry block, subject to the constraint that the intermediate demand by region sums up to the predetermined regional aggregate. The RAS and other disaggregation procedures imply that the regional SAMs will not add up perfectly to our original regional aggregates, although the deviations should be minor. The complete regional SAMs are available from the author upon request.

4.2. Calibration

Calibration involves the base data contained in the regional SAMs, on the assumption that 2000 data represents the Philippine regional economies in a state of equilibrium. Calibration also requires estimates of elasticities of substitution, i.e., the sigmas, to calibrate the parameters of the production and inter-economy equations. Here we arbitrarily set the absolute value of these elasticities to 2. Finally, estimates of expenditure elasticities as well as the Frisch parameter (whose absolute value is the ratio of expenditure to supernumerary expenditure) are needed to calibrate the linear expenditure system (Table 6).

TABLE 6. Household expenditure elasticities by sector and region

	Metro Luzon	Other Luzon	Visayas	Mindanao
Cereals	1.00	1.00	1.00	1.00
Livestock and poultry	0.80	0.80	0.80	0.80
Fish	0.80	0.80	0.80	0.80
Other agriculture	1.20	1.20	1.20	1.20
Agro-processed products	1.00	1.00	1.00	1.00
Other industry	1.20	1.20	1.20	1.20
Transportation	0.80	0.80	0.80	0.80
Other services	1.10	1.04	1.06	1.04

The model is programmed in the Generalized Algebraic Modeling System software. The baseline solution replicates the base data set.

4.3. Welfare

Aside from changes in all the endogenous variables listed in section 3, the model also calculates welfare impact based on equivalent variation. Suppose prices adjust in such a way as to increase the household purchasing power and the household living standard. Equivalent variation measures the amount of additional income the household should receive, at the base prices, to reach the same level of utility given the price adjustment. Hence we expect a positive equivalent variation. In the case of a welfare decline, equivalent variation should be negative. Equivalent variation is calculated at regional level (there being only one household per region). Equivalent variation at the national level is obtained as a simple summation of regional equivalent variations.

There are two important caveats to the scenario analysis. First, there are no inter-regional transfers between households, as we lack the data to trace household transfers from region *R* to region *RJ*. The FIES does contain data on remittances received and transfers paid out, but it has no information about source or destination, respectively. Hence regional welfare changes should be cautiously interpreted owing to this omission. Second, the model imposes factor immobility, ruling out inter-regional arbitrage. Hence the model solution should be associated only with a short-run equilibrium.

5. Experiments

5.1. Scenarios

We base our scenarios on the discussion in section 2.1. For the national-to-subnational analysis, we frame the following scenarios: the *Tariff reduction* scenario; and a *Tariff reduction with agricultural competitiveness* scenario, pertaining to a combination of tariff reduction and improved agricultural productivity. Tariff reduction deals with a significant form of trade protection. However, it does not address non-tariff barriers, a significant form of protection for sensitive agricultural products, such as the quantitative restrictions import regime for rice.

For the subnational-to-national analysis, we frame the scenarios in terms of improved marketing infrastructure. Such improvement leads to a reduction in transaction cost and productivity improvement in the marketing sector. First, we define a *Catch-up* scenario, involving improved marketing infrastructure in all the lagging regions (Other Luzon, Visayas, Mindanao). Then we define a *Concentration* scenario, involving improved marketing infrastructure only in the leading region (Metro Luzon). We than specify Catch-up scenarios for the individual lagging regions in turn.

More specifically, the scenarios are as follows.

Scenario 1: *Tariff reduction.* All tariffs for agricultural products are set uniformly to 5 percent.
Scenario 2: *Tariff reduction with agricultural competitiveness.* The Tariff reform scenario is combined with a 5 percent productivity improvement in the agricultural production sectors.
Scenario 3: *Catch-up investment*. Simultaneous 20 percent reduction in transaction cost for inter-regional exports from lagging regions to other regions is combined with a 5 percent productivity improvement in Transportation production in lagging regions.
Scenario 4: *Concentration investment*. A 20 percent reduction in transaction cost for inter-regional imports from Metro Luzon is combined with a 5 percent productivity improvement in Trans production in Metro Luzon.
Scenario 5a: *Catch-up investment, Other Luzon.* A 20 percent reduction in transaction cost for inter-regional exports from Other Luzon to all other regions is combined with a 5 percent productivity improvement in Transportation production in Other Luzon.
Scenario 5b: *Catch-up investment, Visayas*. A 20 percent reduction in transaction cost for inter-regional exports from Visayas to all other regions is combined with a 5 percent productivity improvement in Transportation production in Visayas.
Scenario 5c: *Catch-up investment, Mindanao*. A 20 percent reduction in transaction cost for inter-regional exports from Mindanao to all other regions is combined with a 5 percent productivity improvement in Transportation production in Mindanao.

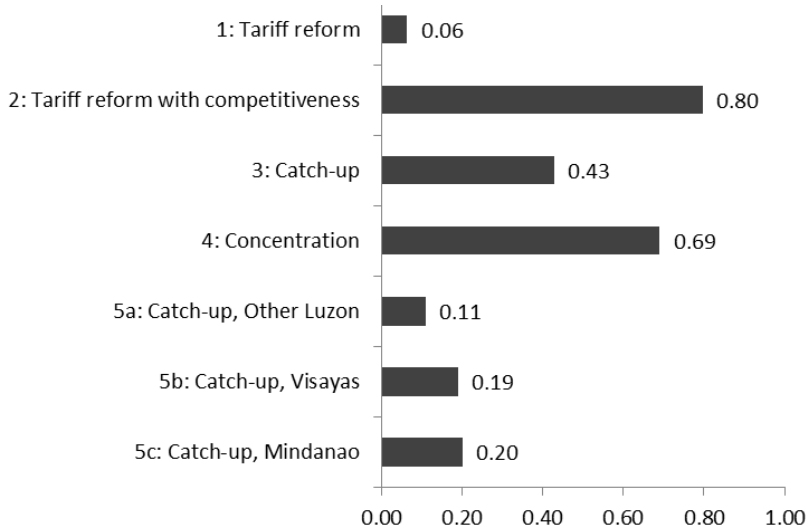
Note that the benefits being calculated are in gross terms. We lack information on the cost of the requisite investment. Hence the following analysis should at best be a partial though informative guide to policy. More disaggregated effects, by sector and by region, are presented to explain the welfare results.

5.2. Results

Figure 4 displays the national welfare changes, based on equivalent variation, expressed as a percentage of baseline expenditure. Consistent with economic theory, all the scenarios increase national welfare. *Tariff reduction* causes the smallest increase. *Tariff reduction with agricultural competitiveness* registers the biggest welfare improvement. In between are the regional investment policies, of which the biggest change is seen in the *Concentration investment* scenario. *Catch-up* for all the lagging regions results in a welfare change smaller than that of the *Concentration investment* scenario. Among the lagging regions, the largest national benefit from individual productivity increase is for Mindanao, followed

closely by that for Visayas. Due to the relatively small size of Other Luzon, the welfare increase for *Catch-up* of this region is smallest.

FIGURE 4. Equivalent variation in percentage of baseline household expenditure, national level



Source: Author's calculations

The regional disaggregation of welfare impact is shown in Table 7. Mirroring national-level impacts, all the regions benefit from each of the scenarios. Even the *Tariff reduction* scenario fails to reduce welfare in the laggard regions where agriculture comprises a bigger share of regional output. However for all regions, the *Tariff reduction* scenario causes the lowest welfare improvement. As noted previously, the scenario addresses only tariff barriers, suggesting that trade reform requires a more comprehensive approach in order to make a more serious impact on national well-being.

TABLE 7. Equivalent variation by scenario and region, percentage of baseline

	Metro Luzon	Other Luzon	Visayas	Mindanao
1. Tariff reform	0.05	0.07	0.08	0.08
2. Tariff reform with competitiveness	0.27	1.62	1.02	1.53
3. Catch-up	0.12	0.59	0.90	0.78
4. Concentration	1.09	0.10	0.32	0.32
5a. Catch-up, Other Luzon	0.01	0.76	0.01	0.01
5b. Catch-up, Visayas	0.02	0.00	0.97	0.08
5c. Catch-up, Mindanao	0.06	-0.02	0.15	0.90

Source: Author's calculations

The most beneficial policy, *Tariff reduction with competitiveness*, also has the greatest positive impact on the lagging regions. Somewhat less beneficial for the lagging regions is *Catch-up*, though even the leading region realizes a welfare benefit in this scenario. In the *Concentration* scenario, the leading region realizes a sizable benefit relative to the other regions. The large national welfare impact of this scenario, shown in Figure 4, is mostly captured by the leading region. In contrast, the benefit for the leading region from the individual *Catch-up* scenarios for the lagging regions is minimal. Among the individual *Catch-up* scenarios, the largest increase in welfare is observed in the region experiencing the productivity improvement, with positive though much lower benefits in the other regions. In one case, however, improved competitiveness in one region (Mindanao) may slightly undermine welfare in a competing laggard region (Other Luzon).

The immediate impact of *Tariff reduction* for each region is obviously on imports (Table 8). Imports rise for the agricultural sectors in all the regions, with surges observed for Cereals as well as Livestock and poultry. However, output contraction is not especially severe for Cereals; the lagging regions experience a slight increase in output of some agricultural sectors.

TABLE 8. Imports and output by sector under the tariff reform scenario, percentage change from baseline

	Metro Luzon	Other Luzon	Visayas	Mindanao
Imports				
Cereals	24.94	29.42	27.98	29.23
Livestock and poultry	39.71	40.10	40.55	40.42
Fish	6.30	6.24	6.66	6.65
Other agriculture	3.44	3.60	3.96	4.03
Agro-processed products	0.39	0.24	0.58	0.52
Other industry	-0.04	-0.04	0.18	0.12
Transportation	0.25	0.20	0.44	0.38
Other services	0.26	0.19	0.38	0.29
Output				
Cereals	-5.10	-0.58	-2.27	-1.15
Livestock and poultry	-0.18	0.08	0.30	0.18
Fish	0.01	0.04	0.24	0.18
Other agriculture	-0.08	-0.02	0.00	0.22
Agro-processed products	0.19	0.08	0.23	0.16
Other industry	0.32	0.50	0.59	0.57
Transportation	-0.04	0.04	0.08	0.09
Other services	-0.04	0.03	-0.10	-0.04

Source: Author's calculations

This increase is accentuated under the Tariff reduction with competitiveness scenario (Table 9). Cereals production expands substantially in the lagging regions, even as imports of cereals expand in all the regions. Substantial increases in agricultural output are also observed in all of the regions.

TABLE 9. Imports and output by sector under the tariff reform with competitiveness scenario, percentage change from baseline

	Metro Luzon	Other Luzon	Visayas	Mindanao
Imports				
Cereals	21.71	27.30	25.34	29.15
Livestock and poultry	35.69	37.57	41.98	41.09
Fish	1.05	5.84	4.90	5.06
Other agriculture	3.17	2.39	1.44	3.81
Agro-processed products	2.14	4.49	5.20	6.81
Other industry	1.63	0.12	0.90	1.56
Transportation	1.81	3.90	3.98	5.16
Other services	1.77	3.84	3.94	4.53
Output				
Cereals	-2.57	2.91	1.87	3.37
Livestock and poultry	1.32	3.33	3.13	4.27
Fish	4.82	2.42	2.84	3.89
Other agriculture	1.46	3.55	5.18	4.93
Agro-processed products	0.73	0.93	1.65	1.30
Other industry	1.06	4.08	3.83	5.09
Transportation	-0.06	0.33	0.32	0.39
Other services	-0.14	0.21	-1.03	-0.82

Source: Author's calculations

For the regional investment scenarios, the most immediate impact is felt by regional exports to other regions, as shown in Table 10. The Transport and Other services accounts are omitted, as there is no inter-regional trade for either. The Tariff reform scenario mostly raises exports to other regions, except for Cereals, where the lagging regions lose exports to other regions as imports surge. The *Catch-up* scenario leads to a greater expansion in inter-regional exports of the lagging regions and the least for the leading region; the reverse holds for the *Concentration* scenario.

The *Catch-up* scenario for individual lagging regions also causes the greatest increase in the inter-regional exports of the regions experiencing the productivity improvement. Among the lagging regions, Mindanao experiences the greatest increase across the board: a simple average of 13 percent, compared to 6 percent for Other Luzon and the same average for Visayas.

TABLE 10. Region's exports to all other regions, by scenario, percentage change from baseline

	Metro Luzon	Other Luzon	Visayas	Mindanao
Tariff reform				
Cereals	2.55	-0.61	-0.98	-2.27
Livestock and poultry	0.69	0.60	0.04	0.12
Fish	0.35	0.44	0.03	-0.01
Other agriculture	0.59	0.44	-0.02	-0.06
Agro-processed products	0.34	0.26	0.16	0.16
Other industry	0.19	0.14	0.05	0.10
Tariff reform with competitiveness				
Cereals	4.01	1.63	1.12	-1.56
Livestock and poultry	4.42	5.16	-0.51	1.00
Fish	6.36	1.29	0.17	0.56
Other agriculture	-0.42	1.48	3.65	1.88
Agro-processed products	4.11	-0.09	1.84	-0.77
Other industry	0.60	2.19	1.25	1.26
Catch-up				
Cereals	2.53	8.44	7.07	6.86
Livestock and poultry	1.88	8.17	7.09	7.27
Fish	1.38	3.98	2.28	2.22
Other agriculture	2.82	12.10	10.20	10.00
Agro-processed products	1.77	8.95	9.44	8.86
Other industry	1.09	5.75	6.31	6.37
Concentration				
Cereals	7.07	0.69	1.69	1.39
Livestock and poultry	6.69	0.92	1.65	1.75
Fish	1.81	0.80	1.25	1.26
Other agriculture	9.82	0.53	2.05	1.80
Agro-processed products	7.64	2.07	1.04	1.88
Other industry	4.34	1.34	1.03	1.27
Catch-up, Other Luzon				
Cereals	0.19	6.52	0.16	0.11
Livestock and poultry	0.17	6.33	0.14	0.11
Fish	0.06	2.32	0.06	0.05
Other agriculture	0.20	9.56	0.14	0.09
Agro-processed products	0.09	8.21	0.06	0.07
Other industry	0.07	5.03	0.07	0.06
Catch-up, Visayas				
Cereals	1.28	1.32	6.39	0.57
Livestock and poultry	0.93	1.10	6.38	0.57
Fish	0.74	0.96	1.80	0.38
Other agriculture	1.54	1.70	9.29	0.77

	Metro Luzon	Other Luzon	Visayas	Mindanao
Agro-processed products	0.78	0.31	8.21	0.75
Other industry	0.49	0.38	5.19	0.94
Catch-up, Mindanao				
Cereals	0.15	0.02	-0.58	10.43
Livestock and poultry	-1.76	-1.20	-1.76	11.30
Fish	-1.04	-0.37	-1.18	6.09
Other agriculture	0.61	0.95	-0.69	14.08
Agro-processed products	-0.73	0.75	-1.09	11.90
Other industry	-2.40	1.30	-14.89	23.02

Source: Author's calculations

Fiscal balance is a concern under the *Tariff reduction* scenarios, as lower tariff rates imply reduced government revenue (Table 11). At the baseline, the government is in deficit (negative saving); as expected, Tariff reduction leads to an increase in the deficit (about 18 percent). While substantial, this is within range of the typical fluctuations in the deficit (the coefficient of variation is about 0.6 for the period 1998 to 2009). Hence it is feasible to absorb the loss by borrowing or to replace revenue with domestic taxes or even improvements in collection efficiency.

TABLE 11. Government saving, baseline levels (in millions ₱), and changes by selected scenario (percentage change from baseline)

	Metro Luzon	Other Luzon	Visayas	Mindanao	Total
Baseline	9,756	-6,578	-778	-15,446	-13,046
Changes from baseline					
Scenario 1. Tariff reform	-13.63	3.87	43.43	2.30	17.46
Scenario 2. Tariff reform with agricultural competitiveness	-5.82	-6.54	-64.28	-4.85	-8.52

Source: Author's calculations

Lastly, we highlight the *Concentration* and *Catch-up* scenarios in terms of resulting adjustment in output (Table 12). Under either scenario, the sharpest output increases are observed for the Transportation sector. For *Catch-up*, lagging regions exhibit the largest increases. For *Concentration*, the leading region exhibits the largest increase. Outputs of the other sectors tend to increase (but not always) under either scenario, as well as with the individual *Catch-up* scenarios.

TABLE 12. Output by selected scenario (percentage change from baseline)

	Metro Luzon	Other Luzon	Visayas	Mindanao
Catch-up				
Cereals	-0.55	0.44	-0.23	-0.34
Livestock and poultry	0.25	0.32	0.63	-0.16
Fish	-0.12	0.34	0.64	0.01
Other agriculture	-0.14	0.36	-0.24	-0.17
Agro-processed products	0.16	0.61	0.82	-0.11
Other industry	0.42	0.24	0.58	-0.42
Transportation	-0.21	2.39	2.79	3.22
Other services	-0.12	0.35	-0.16	0.02
Concentration				
Cereals	-0.43	0.15	-0.02	0.20
Livestock and poultry	0.03	0.12	0.73	0.32
Fish	-0.02	0.01	0.42	0.18
Other agriculture	0.16	-0.07	-0.31	0.12
Agro-processed products	-0.02	-0.03	0.15	-0.17
Other industry	-0.36	0.24	1.07	0.62
Transportation	4.91	-0.12	-0.54	-0.68
Other services	-0.13	-0.07	-0.23	-0.10
Catch-up, Other Luzon				
Cereals	0.06	0.41	0.01	0.01
Livestock and poultry	0.07	0.30	0.03	0.02
Fish	0.00	0.34	0.02	0.01
Other agriculture	0.05	0.40	0.00	0.01
Agro-processed products	0.02	0.62	0.01	0.00
Other industry	0.06	0.18	0.04	0.02
Transportation	-0.02	2.43	-0.01	-0.02
Other services	-0.02	0.36	-0.02	-0.02
Catch-up, Visayas				
Cereals	-0.13	0.02	-0.09	0.07
Livestock and poultry	0.08	0.01	0.32	0.12
Fish	-0.04	0.00	0.45	0.06
Other agriculture	-0.03	-0.01	0.00	0.04
Agro-processed products	0.04	-0.01	0.74	-0.10
Other industry	0.09	0.03	0.12	0.17
Transportation	-0.05	-0.02	3.06	-0.24
Other services	-0.05	-0.01	-0.08	-0.01
Catch-up, Mindanao				
Cereals	-0.19	0.04	-0.32	-0.56
Livestock and poultry	0.82	-0.01	0.43	-4.48
Fish	-0.32	-0.02	-0.88	0.73

	Metro Luzon	Other Luzon	Visayas	Mindanao
Other agriculture	0.13	-0.04	0.98	-0.74
Agro-processed products	0.17	-0.01	-0.51	0.78
Other industry	0.54	0.06	-1.68	0.30
Transportation	0.07	-0.04	2.19	-0.44
Other services	-0.26	0.00	-0.48	1.64

Source: Author's calculations

6. Conclusion and future directions

A summary of the salient findings follows. First, tariff reduction is beneficial, for the economy as a whole and even for the lagging regions. Second, the scope for further welfare improvement from agricultural tariff reduction is limited. Much has already been accomplished in this area, despite some policy reversals. Hence the scope for further reduction has narrowed. Third, there is considerable scope for welfare gain from improvements in productivity, whether from agricultural production or marketing. Fourth, the trade-off between size and distribution of welfare gain is certainly an issue to be confronted in targeting infrastructure investments. Our analysis suggests that concentrating improvements in the leading region leads to the greatest welfare gain, but the benefit is concentrated in the leading region.

This study has constructed the first bottom-up regional CGE model for the Philippines. The model can transcend the usual types of analysis performed by CGE models by adding regional disaggregation in the shocks and outcomes, while allowing for economic interactions between the regional sub-economies.

There remains, nevertheless, considerable work to be done to advance the analysis. The more immediate and remediable limitation is the lack of disaggregation of households into income groups and further disaggregation of sectors and regions. Dynamic analysis can also be readily introduced by incorporating time-varying exogenous variables (e.g., growth in productive factors, trends in technology and world prices), as well as gradual adjustment of factor prices due to factor mobility.

Other limitations require more serious investments in data collection. Among the major constraints in building a regional data set are the lack of input-output data at the regional level, as well as information on inter-regional flows of goods (including land transport) and household transfers. Finally, empirical estimation would be the preferred method for quantifying key parameters on transaction cost of inter-regional flows and elasticities of demand and substitution by sector and region.

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