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# Outlook for the Philippine Economy and Agro-Industry to 2030: The Role of Productivity Growth

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# Outlook for the Philippine Economy and Agro-industry to 2030:
# The Role of Productivity Growth

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**Abstract**

The main driver of long run economic growth is total factor productivity. Among the basic sectors, namely agriculture, industry, and services, inclusiveness of economic growth depends most importantly on agriculture. This study provides growth projections for the Philippine agriculture based on growth in productivity differentiated by basic sector, using a computable general equilibrium (CGE) model.

Scenario analysis finds that the current policy thrust for agriculture of subsidizing capital cost slightly accelerates growth of agriculture, but slows down overall growth by reducing capital formation. Meanwhile, maintaining productivity growth for industry-service at trend, notwithstanding weak growth of agriculture, suffices to reach government plan targets. Productivity growth of agriculture impacts strongly on agriculture itself, but not on the industry-services sectors; conversely, productivity growth in the latter strongly impacts on itself and GDP, but not on agriculture.

The study suggests that policies emphasize the acceleration of productivity growth in the long run across all sectors, but especially in agriculture. Currently, forward and backward linkages of agriculture matter little to economic growth; increasing growth interactions across the basic sectors.

*Key words*: Philippine economy, agriculture, agro-industry, computable general equilibrium, total factor productivity, growth projections

## 1. INTRODUCTION

According to the Philippine Development Plan (PDP), the Philippines aims at becoming an upper middle income country by 2022, with an income of $5,000 (NEDA, 2017). This represents a 41 percent jump over its 2015 level of $3,550. Overall poverty is seen to decline from 21.6 percent in 2015, to only 14.0 percent in 2022.

The basic sectors of an economy are agriculture, industry, and services. Among the basic sectors, agriculture plays an important role in reducing poverty. Up to two-thirds of all poor workers in the country are agricultural workers (Briones, 2016). In 2016, its share in GDP was down to down to 8.8 percent, while employing as much as 29 percent of all workers; hence labor productivity in agriculture is low compared with the other basic sectors. A more inclusive set of policies are needed to secure the participation of agriculture-dependent households in the economic mainstream.

Growth in agriculture has significantly lagged that of the other basic sectors. The average growth in agriculture over the period 2011 to 2016 was just 2 percent, while that of industry and services was 7 percent. Agricultural wages have also been depressed, growing by only 0.2 percent annually from 2002 to 2012 in real terms. Poor performance of agriculture is worrisome in view of rising food needs of a growing population, the precarious state of the country's natural resource base, and the adverse impacts of climate change (Thomas et al. 2015).

In the short run, macroeconomic aggregates related to demand, the fiscal balance, and the balance of payments, are important drivers of gross domestic product (GDP). As the economy maintains its sound macroeconomic fundamentals i.e. a manageable fiscal deficit, low inflation, and stable balance of payments, the attention of policymakers naturally turns to the supply side of the economy. In the long run, economic growth ultimately depends on supply factors.

Expansion of supply involves increases in primary inputs (labor and capital), and technological progress, as measured by growth in total factor productivity (TFP). Labor supply depends on population growth (labor force participation being constant), while capital accumulation depends savings out of current income. On the other hand, growth in TFP depends on innovation, adoption of new technologies and systems, and closure of technical efficiency gaps. As a source of overall growth in the long run, growth in TFP shows greater potential than growth in factors of production.

However, policy support, especially to agriculture, appears biased towards raising private returns to capital, rather than in boosting TFP. In 2012 – 14, agricultural price support and input subsidy was estimated to be as large as 25% of the value of agricultural production. General support for public goods (more closely associated with productivity enhancement) accounted just 4 percent (OECD, 2017). Current budgetary priorities continue to emphasize input subsidies for credit, and farm machinery, as well as irrigation services, agricultural insurance, and seeds.

This study aims to implement an updated set of projections for the Philippine agriculture in the context of growth of the economy and of agro-industry, based on direct and indirect impacts of TFP growth. The latter is applied differentially to agriculture, industry, and services. The following key questions are posed:

- What productivity trends underlie the expected trajectory of economic growth of the country? To what extent does growth depend on current policy priorities, i.e. subsidies?
- What are the implications of acceleration and slowdown of productivity growth in agriculture for output, consumption, and wages?
- What are the implications of acceleration productivity growth in industry and services for output, consumption, and wages?

The issues will be investigated using a computable general equilibrium (CGE) model, of a standard structure. Data is derived from a social accounting matrix (SAM) of the Philippine economy, reflecting most recent available information on inter-industry flows and national accounts. Of special interest in the study is the indirect impact across sectors, for which the SAM is especially suited. If indirect impacts are found to be strong, then industry, services, and agriculture are already in well-integrated value chains; growth in one basic sector will contribute significantly to growth in the other basic sectors. However, if indirect impacts are found to be weak, then the current structure of the economy implies little role for forward and backward linkages in future economic growth. This may highlight the need closer integration of agriculture with other basic sectors through an agricultural value chain approach.

## 2. THE MODEL

### Overview of AMPLE-CGE

For this study, the Agricultural Model for PoLicy Evaluation (AMPLE), described in Briones (2014), was extended into an economywide version, called AMPLE – CGE. The agricultural sectors of AMPLE-CGE are drawn from those of AMPLE. To this is added the industry and service sectors (Table 1); the latter are referred to jointly as industry-service.

The AMPLE-CGE follows a conventional structure for computable general equilibrium models, such as described in Lofgren, Harris, and Robinson (2002), which in turn draws from Dervis, de Melo, and Robinson (1982); see also Robichaud et al (2012). The model is coded and solved in Generalized Algebraic Modeling System (GAMS) using the CONOPT3 Solver.

The institutions of the AMPLE-CGE are: i) households, divided into rural and urban; ii) business firms; iii) government; and iv) rest of the world. Final demands are, respectively: consumption; investment; government consumption; and exports. Imports are subtracted to net out purchased goods not produced domestically.

Factors of production are agricultural labor, industry-service labor, and capital. The types of labor are segmented into their own factor markets; hence wages are set independently across the labor categories. Capital is malleable across sectors and allocated to equalize value of marginal product with the price (i.e. rental cost) of capital.

Consumption is modeled as a linear expenditure system (LES), as in Robichaud et al (2012). Calibration is implemented with assumed values of elasticities for income and own-price. Total investment demand equals total savings, allocated across sectors based on fixed expenditure shares. Total government consumption is exogenous, and is likewise allocated across sectors according to fixed expenditure shares. Intermediate demand among sectors is modeled as a fixed proportions (Leontieff) system. Demand is allocated between domestically-produced goods and imports following an Armington-type allocation, from which is inferred the import demand. World prices are fixed; government collects import tariffs.

Value added is a fixed proportion of gross output. Production of value added uses capital and labor; the latter is divided into agricultural labor and industry-services labor. The labor types are viewed as distinct and non-substitutable. The production function mapping value added to capital and labor combinations adopts a constant elasticity of substitution (CES) form. Calibration of production function parameters involves estimates of elasticities of substitution, based to some extent on past studies. Government collects indirect taxes based on value added.

Rural and urban households pay income taxes as a fixed proportion of factor income. Household savings is a fixed proportion of disposable income. Government savings is the residual of tax revenue and government consumption. Foreign savings equals the balance of payments, i.e. net capital inflow, assumed to be at equilibrium at the baseline. Model equilibrium entails: factor demand equals factor endowments; and demand for home production, equals domestic production destined for home demand. Finally, owing to non-uniqueness of the equilibrium price vector, the model solution is found by minimizing the weighted sum of squared difference between the current and baseline price vector.

The details of the model are given in the following. Note that the term “constants” refer to both exogenous variables and equation parameters.

**Table 1: Sectors of the AMPLE-CGE**

| Sector | GAMS label |
|---|---|
| **Agricultural sectors** | |
| *Palay* | C_Palay |
| *Corn* | C_Corn |
| *Coconut* | C_Coconut |
| *Sugarcane* | C_Sugarcane |
| *Banana* | C_Banana |
| *Mango* | C_Mango |
| *Other fruit* | C_Otfruit |
| *Other crops* | C_Otcrop |
| *Root crops* | C_Rootcrop |
| *Vegetables* | C_Veg |
| *Hogs* | C_Hog |
| *Other livestock* | C_Otlivestock |
| *Poultry* | C_Poultry |
| *Agricultural services* | C_AgServ |
| *Forestry* | C_Forest |
| *Capture fisheries* | C_Captur |
| *Aquaculture* | C_Aquacult |
| | |
| **Industrial sectors** | C_Mining |
| *Mining* | C_Rice |
| *Rice* | C_Meat |
| *Meat* | C_Procfish |
| *Processed fish* | C_Sugar |
| *Sugar* | C_Otfoodmanuf |
| *Other food manufacturing* | C_Bev |
| *Beverage manufacturing* | C_Pest |
| *Pesticide manufacturing* | C_Otagrimanuf |
| *Other agricultural manufacturing* | C_Feeds |
| *Feed manufacturing* | C_Otmanuf |
| Other manufacturing | C_Manufagmachin |
| *Manufacturing of agricultural machinery* | C_Otindustry |
| Other industry | |
| | C_Transpo |
| **Service sectors** | C_Stor |
| Transport services | C_Wholesale |
| Storage services | C_Finance |
| Wholesale services | C_Otprivserv |
| Finance services | C_Pubserv |
| Other private services | |
| Public services | |

Note: Labels in italics denote agro-industry sectors. Agro-industry within Industry is called “agri-related industry”.

**Sets**

Sets of the AMPLE-CGE are shown in Table 2, in alphabetical order for ease of reference. *Act, Factor, FactorC, samacct,* and *smallsam*, are used for the SAM; *G*, *GM*, etc. are used in the model proper. The set *t* is used for multi-period, comparative static analysis from 2013 to 2030.

**Table 2: Sets definitions in the AMPLE-CGE**

| Label | Definition | Relationship |
|---|---|---|
| *Act* | Activities | $Act \subset samacct$ |
| *AgFd* | Industry sectors related to agriculture and food | $AgFd \subset G$ |
| *Ag* | Agriculture sector | $Ag \subset AgFd$ |
| *Factor* | Factors of production | $Factor \subset samacct$ |
| *FactorC* | Capital Factors | $FactorC \subset Factor$ |
| *G* | Goods, commodities | $G \subset samacct$ |
| *GM* | Imported goods | $GM \subset G$ |
| *GMN* | Goods not imported | $GMN \subset G$ |
| *GX* | All exported goods except non-exported goods | $GX \subset G$ |
| *GXN* | Non-exported goods (hog, agricultural services, and capture fisheries) | $GXN \subset G$ |
| *H* | Households—rural, urban | $H \subset samacct$ |
| *Ind* | Industry sector | $Ind \subset IS$ |
| *IS* | Industry and Services sector | $IS \subset G$ |
| *Labor* | Labor accounts | $Labor \subset Factor$ |
| *samacct* | All SAM accounts | |
| *Serv* | Service sector | $Serv \subset IS$ |
| *smallsam* | SAM accounts except tariff and ROW | $smallsam \subset samacct$ |
| *t* | Time period | |

**Consumption block**

The first block of the model is the consumption block (Table 3). The first two equations pertain to per capita expenditures and consumption. Equation C1 determines household consumption using an LES formulation; it can also be written as:

$$PC_G \cdot QC_{G,H} = PC_G \cdot qc\min_{G,H} + \beta_{G,H} \cdot \left( XPD_H - XPD\min_H \right).$$

The term $XPD_H - XPD\min_H$ is total expenditure net of subsistence expenditure, also known as *supernumerary expenditure*. Hence, expenditures on *G* equal minimum expenditures on *G*, plus a fixed share of supernumerary expenditures. Equation C2 obtains total subsistence expenditure; C3 converts per capita consumption to total consumption.

**Table 3: Variables, constants, and equations of the consumption block**

| | |
|---|---|
| **Variables** | |
| $QC_{G,H}$ | Household consumption per capita |
| $QDC_G$ | Total household consumption |
| $PD_G$ | Commodity price |
| $XPD_H$ | Household expenditure per capita |
| $XPD\min_H$ | Subsistence expenditure per capita |
| **Constants** | |
| $qcmin_{G,H}$ | Minimum household consumption per capita of G (subsistence) |
| $\beta_{G,H}$ | Coefficient term in LES |
| $pop_H$ | Population |
| $io_{G,GG}$ | Matrix of technical coefficients |
| **Equations** | |
| C1. | $QC_{G,H} = qcmin_{G,H} + \left[ \frac{\beta_{G,H}}{PC_G} \cdot \left( XPD_H - XPDmin_H \right) \right]$ |
| C2. | $XPD\min_H = \sum_G PD_G \cdot qc\min_{G,H}$ |

| | |
|---|---|
| C3. | $QDC_G = \sum_H QC_{G,H} \cdot pop_H$ |

To obtain constants $\beta_{G,H}$ and $qcmin_{G,H}$, denote preliminary estimates of income and own price elasticity as $\eta_{G,H}$ and $\varepsilon_{G,H}$, respectively; expenditure shares are denoted $w_{G,H}$. The following relations hold under the LES:

$$\eta_{G,H} = \beta_{G,H} / w_{G,H}\,; \ \sum_G \beta_{G,H} = 1; \tag{1}$$

$$\varepsilon_{G,H} = \frac{qcmin_{G,H}}{QC_{G,H}} \cdot \left(1 - \beta_{G,H}\right) - 1\,. \tag{2}$$

There is no guarantee however that the $\beta_{G,H}$ and $qcmin_{G,H}$ from (1) and (2) are consistent with C2 and C1 at the baseline. Using GAMS Solver, the calibration entails imposition of baseline data on C2 and C1 while minimizing the squared deviation of implied $\eta_{G,H}$ and $\varepsilon_{G,H}$ from initial estimates.

**Household block**

The second block of the model is the household block, shown in Table 4. Constants are all calibrated from the SAM. Equation H1 sums up total factor income of households from the value of labor endowment, adjusted by a parameter $\theta$ for entry into employment from underemployed or surplus labor, assumed exogenous. H2 is the capital endowment of each household; H3 obtains disposable income by netting out the direct income tax, while adding transfers from government and rest of the world. H4, H5, and H6, simply derive, respectively: the household income tax, household savings, and per capita household expenditures.

**Table 4: Variables, constants, and equations of the household block**

| **Variables** | |
|---|---|
| $Y_H$ | Total household income |
| $KAPE_H$ | Total household capital endowment |
| $YD_H$ | Household disposable income per capita |
| $SAV$ | Total savings of households |
| $YTAX$ | Total tax on household income |
| $PK$ | Price of capital |
| $PLA$ | Price of agricultural labor |

| | |
|---|---|
| $PLIS$ | Price of industry-service labor |
| **Constants** | |
| $kapst$ | Baseline capital stock |
| $kapsh_H$ | Ownership shares in capital stock |
| $\lambda AG_H$ | Agricultural labor endowment per household per capita |
| $\lambda IS_H$ | Labor endowment per household, industry-service, per capita |
| $\theta$ | Entry into agricultural employment from underemployment |
| $yt_H$ | Direct tax rate on household |
| $s_H$ | Savings rate of household |
| $gtranh_H$ | Government transfers to households |
| $ftranh_H$ | Foreign transfers to households (in USD) |
| **Equations** | |
| H1. | $Y_H = PKAP \cdot KAPE_H + \left[PLA \cdot \lambda AG_H \cdot pop_H\right] \cdot \theta + \left[PLIS \cdot \lambda IS_H\right]$ |
| H2. | $KAPE_H = kapsh_H \cdot kapst$ |
| H3. | $YD_H = Y_H \cdot \left(1 - yt_H\right) + gtranh_H + ftranh_H$ |
| H4. | $YTAX = \sum_H yt_H \cdot Y_H$ |
| H5. | $SAV = \sum_H s_H \cdot YD_H$ |
| H6. | $XPD_H = \dfrac{YD_H \cdot \left(1 - s_H\right)}{pop_H}$ |

**Production block**

The third block is the production block, shown in Table 5. Value added is produced using capital and labor by way of a constant elasticity of substitution (CES) function, with one version for agricultural sectors (P1.1) and another for industry-service sectors (P1.2). The specification adopts the Armington (1969) format. The elasticity of substitution $\sigma VA_G$ is given by:

$\sigma VA_G = \dfrac{1}{1+\rho VA_G} > 0$ ; this implies $\rho VA_G = \dfrac{1-\sigma VA_G}{\sigma VA_G}$. The price of value added (ignoring first the subsidy term) is as follows:

$$PVA_{Ag} = PKAP_{Ag} \cdot KAP_{Ag} + PLA_{Ag} \cdot LA_{Ag}; \quad ;$$

$$PVA_{IS} = PKAP_{IS} \cdot LIS_{IS}.$$

We obtain equations P2, P3, and P4, using cost-minimization on P1.1 and P1.2. In the presence of a subsidy, the price of capital paid by the firm becomes $PKAP \cdot \left(1 - sub_G\right)$ , which substitutes in P2.

**Table 5: Variables, constants, and equations of the production block**

| | |
|---|---|
| **Variables** | |
| $PVA_G$ | Price of value added per good |
| $QVA_G$ | Quantity of value added per good |
| $KAP_G$ | Capital |
| $LAG_{Ag}$ | Agricultural labor |
| $LIS_{IS}$ | Agricultural labor |
| $QS_G$ | Domestic supply |
| $PS_G$ | Price of domestic supply |
| $VATAX$ | Total domestic indirect tax |
| **Constants** | |
| $\alpha KAP_G$ | Capital parameter in CES value added (VA) function |
| $\alpha LA_{Ag}$ | Agricultural labor parameter in CES VA function |
| $\alpha LIS_{IS}$ | Labor-services parameter in CES VA function |
| $\sigma VA_G$ | Elasticity of substitution in CES VA function |

| | |
|---|---|
| $\rho VA_G$ | Parameter in CES VA function |
| $uva_G$ | Value added per unit gross output |
| $vat_G$ | Implicit value added tax (net of subsidies) |
| $sub_G$ | Subsidy per unit capital (in ad valorem terms) |

**Equations**

P1.1 $$QVA_{Ag} = \left(\alpha KAP_{Ag} \cdot KAP_{Ag}^{-\rho VA_{Ag}} + \alpha LA_{Ag} \cdot LA_{Ag}^{-\rho VA_{Ag}}\right)^{\frac{-1}{\rho VA_{Ag}}}$$

P1.2 $$QVA_{IS} = \left(\alpha KAP_{IS} \cdot KAP_{IS}^{-\rho VA_{IS}} + \alpha LIS_{IS} \cdot LIS_{IS}^{-\rho VA_{IS}}\right)^{\frac{-1}{\rho VA_{IS}}}$$

P2. $$KAP_G = QVA_G \cdot \left(\alpha KAP_G \frac{PVA_G}{PKAP \cdot (1 - sub_G)}\right)^{\sigma VA_G}$$

P3. $$LA_{Ag} = QVA_{Ag} \cdot \left(\alpha LA_{Ag} \frac{PVA_G}{PLA}\right)^{\sigma VA_{Ag}}$$

P4. $$LIS_{IS} = QVA_{IS} \cdot \left(\alpha LIS_{IS} \frac{PVA_{IS}}{PLIS}\right)^{\sigma VA_{IS}}$$

P5. $$PS_G = PVA_G \cdot (1 + vat_G) \cdot uva_G + \sum_{GG} \left(io_{GG,G} \cdot PD_{GG}\right)$$

P6. $$uva_G \cdot QS_G = QVA_G$$

P7. $$VATAX = \sum_G vat_G \cdot PVA_G \cdot QVA_G$$

Equation P5 obtains the price of gross output using value added plus the sum of intermediate inputs per unit gross output, valued at the demand price. Value added, in quantity terms, is a fixed share of gross output (P6). Lastly, the indirect domestic tax is assumed to be levied on value added (P7).

### Trade block

The third block is the trade block (Table 6). The domestically produced version of good *G* is called the “home” good; the good demanded is a composite of home and imported goods, based on the Armington (1969) formulation:

$$QD_G = \left(\delta DH_G \cdot QDH_G^{-\rho D_G} + \delta DF_G \cdot QDF_G^{-\rho D_G}\right)^{\frac{-1}{\rho D_G}} .$$

From this we derive the conditional demands for the home good and the imported good, respectively T1 and T2, with the elasticity of substitution obtained given by:

$$\sigma D_G = \frac{1}{1+\rho D_G} .$$

The domestically demanded version of good *G* is also called a home good; the good supplied is a composite of is a composite of home and exported goods, based on the constant elasticity of transformation (CET) function:

$$QS_G = \left(\delta SH_G \cdot QSH_G^{\rho S_G} + \delta SF_G \cdot QSF_G^{\rho S_G}\right)^{\frac{1}{\rho S_G}}$$

From this we derive the conditional supplies for the home good and the exported good, respectively T3 and T4, with the elasticity of transformation given by:

$$\sigma S_G = \frac{1}{1-\rho S_G} .$$

The price of the imported product is given in T5; the world price is converted to Philippine peso using the exchange rate, taking into account an *ad valorem* tariff, and a further wedge due to non-tariff barriers (also assumed to have an *ad valorem* effect). The counterpart for the export price is T6, which far simpler in absence of export taxes and assuming away non-tariff barriers on the supply side. The composite prices on demand side and supply side are given in T7 and T8, respectively. T9 computes the total import taxes collected.

**Table 6: Variables, constants, and equations of the trade block**

| | |
|---|---|
| **Variables** | |
| $QD_G$ | Total domestic demand (domestic absorption) |
| $QDH_G$ | Demand for goods from home supplier |
| $QDF_G$ | Import quantity (demand for goods from foreign supplier) |
| $QSH_G$ | Supply of goods for home market |
| $QSF_G$ | Export quantity (supply of goods for foreign buyer) |
| $PUSD$ | Price of USD in PHP (exchange rate) |
| $PM_G$ | Border price of imported good |
| $PH_G$ | Price of home supplied good for home market |

| | |
|---|---|
| $PX_G$ | Border price of exported good |
| $MTAX$ | Total taxes on imports |

**Constants**

| | |
|---|---|
| $pwm_G$ | World price (in USD) of imported good |
| $pwx_G$ | World price (in USD) of exported good |
| $tar_G$ | Implicit tariff rate |
| $\delta DH_G$ | Coefficient in Armington composite for home source |
| $\delta DF_G$ | Coefficient in Armington composite for imports |
| $\sigma D_G$ | Elasticity of substitution in Armington composite |
| $\delta SH_G$ | Coefficient in CET composite for home destination |
| $\delta SF_G$ | Coefficient in CET composite for foreign destination |
| $\sigma S_G$ | Elasticity of transformation in CET composite |
| $ntb_G$ | Non-tariff barrier effect on price |

**Equations**

T1. $$QDH_G = QD_G \left( \frac{\delta DH_G \cdot PD_G}{PH_G} \right)^{\sigma D_G}$$

T2. $$QDF_{GM} = QD_{GM} \left( \frac{\delta DF_{GM} \cdot PD_{GM}}{PM_{GM}} \right)^{\sigma D_{GM}} ;\ QdF_{GMN} = 0$$

T3. $$QSH_G = QS_G \left( \frac{PH_G}{\delta SH_G \cdot PS_G} \right)^{\sigma S_G}$$

T4. $$QSF_{GX} = QS_{GX} \left( \frac{PX_{GX}}{\delta SF_{GX} \cdot PS_{GX}} \right)^{\sigma S_{GX}} ;\ QSF_{GXN} = 0 .$$

T5. $$PM_G = pwm_G \cdot PUSD \cdot \left(1 + tar_G + ntb_G\right)$$

| | |
|---|---|
| T6. | $PX_G = pwx_G \cdot PUSD$ |
| T7. | $PD_G \cdot QD_G = PH_G \cdot QDH_G + PM_G \cdot QDF_G$ |
| T8. | $PS_G \cdot QS_G = PH_G \cdot QSH_G + PX_G \cdot QSF_G$ |
| T9. | $MTAX = \sum_G tar_G \cdot pwm_G \cdot PUSD \cdot QDF_G$ |

**Other demand**

The fourth block is the other demand block (Table 7). Total intermediate demand is the sum of intermediate demands from the gross outputs based on the appropriate technical coefficients (OD1). Expenditures on investment goods is a fixed share of total savings, based on the capital allocation coefficient (OD2). Similarly, government consumption expenditures is a fixed share of total government expenditures (OD3); note that total government consumption is exogenous.

**Table 7: Variables, constants, and equations of the other demand block**

| | |
|---|---|
| **Variables** | |
| $QDINT_G$ | Intermediate demand |
| $QDINV_G$ | Investment demand |
| $QDGOV_G$ | Government consumption demand |
| $TSAV$ | Total savings |
| **Constants** | |
| $cac_G$ | Capital allocation coefficient |
| $gxpd$ | Total government consumption expenditure |
| $\gamma_G$ | Shares in government consumption |
| $ftrang$ | Foreign transfers to government (in USD) |
| **Equations** | |
| OD1. | $QDINT_G = \sum_{GG} io_{G,GG} \cdot QS_{GG}$ |
| OD2. | $PD_G \cdot QDINV_G = cac_G \cdot TSAV$ |

| | |
|---|---|
| OD3. | $PD_G \cdot QDGOV_G = \gamma_G \cdot gxpd$ |
| OD4. | $QD_G = QDINT_G + QDC_G + QDINV_G + QDGOV_G$ |

**Other institutions block**

The fifth block is the other institutions block (Table 8). Government savings is total revenues (taxes on income, business, and imports, together with transfers from foreign governments), net of expenditures, total transfers to households, and subsidies (OI1). Foreign savings is value of imports in pesos, net of import taxes, less value of exports, and transfers to households and government from rest of the world (OI2); foreign savings is exogenous to the model and posits the identity between base data foreign savings and normal capital inflows, along with an open foreign exchange market. Imposition of (OI2) leads to the equilibrium exchange rate. Total savings sums up savings of households, government, and rest of the world (OI3).

**Table 8: Variables, constants, and equations of the other institutions block**

| | |
|---|---|
| **Variables** | |
| $SAVG$ | Savings of government (from consumption and income) |
| **Constants** | |
| $savf$ | Savings of foreign |
| **Equations** | |
| OI1. | $SAVG = YTAX + VATAX + MTAX + ftrang \cdot PUSD - \left( \sum_G PD_G \cdot QDGOV_G + \sum_H gtranh_H + \sum_G sub_G \cdot PKAP \cdot KAP_G \right)$ |
| OI2. | $savf = \sum_G pwm_G \cdot (1 + ntb_G) \cdot PUSD \cdot QDF_G - \left[ \sum_G PX_G \cdot QSF_G + \left( \sum_H ftranh_H + ftrang \right) \cdot PUSD \right]$ |
| OI3. | $TSAV = SAV + SAVG + savf$ |

**Other closure block**

The final block is the Other closure block (Table 9). Total demand for capital equals the total stock of capital (OC1); likewise the total labor demand equals the total available labor (OC2 and OC3). The demand for domestically produced version of a good equals the domestically supplied version of the good (OC4). Owing to non-uniqueness of the equilibrium price vector, a definition solution is found by minimizing the sum of squared deviation between the solution price and base data price, weighted by the base data shares (OC5).

**Table 9: Variables and equations of the other closure block**

| | |
|---|---|
| **Variables** | |
| $OBJ$ | Arbitrary objective variable |
| **Constants** | |
| $PD0_G$ | Price of demand good at the base data |
| $wcpi_G$ | Consumption share of G at the baseline |
| **Equations** | |
| OC1. | $\sum_{G} KAP_G = \sum_{H} KAPE_H$ |
| OC2. | $\sum_{Ag} LA_{Ag} = \sum_{H} \lambda AG_H \cdot pop_H \theta$ |
| OC3. | $\sum_{Ag} LIS_{IS} = \sum_{H} \lambda IS_H \cdot pop_H$ |
| OC4. | $QSH_G = QDH_G$ |
| OC4. | $OBJ = \sum_{G} wcpi_G \cdot \left(PD0_G - PD_G\right)^2$ |

**Implementation**

The base data of the model is compiled for 2013. The latest input-output table for the Philippines is for 2006 in 240 sectors; the table is recomputed into the SAM accounts in Table 1. An input-output table for 2013 is constructed by applying growth rates of gross value added (GVA) of the consolidated accounts categories (in current prices) from 2006 to 2013, along with intermediate inputs and final demands. Other national accounts data are incorporated into the preliminary SAM based on the updated input-output table. A modified RAS method is used to balance the updated SAM, with final balance obtained by adjustment of individual cell entries.

Capital stock is obtained using investment accumulation technique using the 1946 – 2010 and then 2011 – 2013 real investment time series, based on 7% discount rate. The differential between agriculture and industry-service wage is based on 2013 Decent Work Statistics of PSA. The resulting SAM is reasonably close to actual national accounts data for 2013. In the

SAM, agriculture accounts for 11 percent of GDP, while agro-industry accounts for 21.2%. Investment as a share in GDP is 20 percent. The capital stock is nearly double (196%) of GDP, while the industry-service wage is 226% larger than the agriculture wage.

Calibration applies the usual method using initial estimates of expenditure elasticities, own-price elasticities, and elasticities of substitution and transformation; Section 3 describes the method for fine-tuning the elasticity estimates. Details of the code, compilation of the SAM, and projections, are provided in a separate User's Guide.

## 3. FRAMING THE SCENARIOS

Annual projections for the Philippine economy are computed from the base period to 2030, the timeline set for the Sustainable Development Goals (SDGs). The scenarios are distinguished by assumptions on productivity growth in the production of value added using a shift term $\alpha$ inserted as follows:

$$QVA = \left(\alpha\delta_{KAP} KAP^{-\rho} + \alpha\delta_{LAB} LAB^{-\rho}\right)^{-\frac{1}{\rho}}.$$

This can be rewritten as:

$$QVA = \alpha^{-1/\rho}\left(\alpha\delta_{KAP} KAP^{-\rho} + \alpha\delta_{LAB} LAB^{-\rho}\right)^{-1/\rho}$$

The elasticity of value added with respect to the shift term is given as follows:

$$\frac{\%\Delta QVA}{\%\Delta\alpha} = \frac{\partial \ln QVA}{\partial\alpha} = \frac{-1}{\rho}.$$

Hence if there is a target percentage change in output due to technical progress, *ceteris paribus*, then the following expression yields the required percentage change in the shift parameter:

$$\%\Delta\alpha = \%\Delta QVA * \sigma / (\sigma - 1)$$

The scenarios to be analyzed are as follows:

- **Reference**: identifying the productivity trends that will sustain the growth patterns observed since 2010, which reflect targets set in the current PDP. Owing to slow growth of agriculture over this period, this will likely entail weaker growth of agricultural productivity relative to industry and services.
- **Productive agriculture**: the same as Reference scenario, except productivity in agriculture accelerates, to match that of industry and services.
- **Climate change**: the same as Reference scenario, except agricultural productivity remains flat owing to worsening impacts of climate change and other resource constraints.
- **Productive industry-services**: the same as Reference scenario, except productivity in industry and services accelerates by half a percentage point per year.

Assumptions for productivity growth in the Reference scenario are aligned with recent estimates in the literature, namely University of Groeningen and University of Davis (2017); and Aba, Maglanoc, and Garoy (2015). Aside from the productivity growth projections, replication of 2014 – 2016 data and expected trends in the Reference case is also used to tune the parameters for: expenditure elasticity; own-price elasticity; elasticities of substitution and transformation (production and trade blocks); and rate of depreciation of the capital stock.

The assumed growth rates for the Reference scenario are shown in Table 10. Productivity growth in agriculture is negative in 2014 – 2016 owing to climate shocks, intensified by the El Nino of 2014-2015; in 2017, agriculture is expected to recover its productivity to at least 2015 level. However, trend growth in agricultural productivity is only one percent per annum.

Meanwhile productivity growth in industry and services accelerates from 2014 to 2016, after which it remains at trend to 2030.

**Table 10: Assumed productivity growth for the basic sectors, Reference scenario (%)**

| | 2014 | 2015 | 2016 | 2017 | 2018-2030 |
|---|---|---|---|---|---|
| Agricultural sectors | -2.00 | -2.00 | -2.75 | 2.75 | 1.00 |
| Industry sectors | 1.50 | 2.00 | 2.50 | 2.50 | 2.50 |
| Service sectors | 2.00 | 2.20 | 2.50 | 2.50 | 2.50 |

Note: From 2016 onward, resource-based sectors, namely C_AgriServ, C_Forest, and C_Captur, exhibit zero productivity growth across all scenarios.

Source: Author's model.

Finally, other exogenous variables for which growth trends have been imposed are:

- Population growth is 1.6 percent annually for both urban and rural households, based on PSA population projections;
- Government transfers to households, and government consumption: respectively, 2 percent reduction annually, and 5 percent expansion annually;
- Tariffs on rice in 2017 decline by 58.6 percent (reaching a final tariff rate of 35 percent); quantitative restrictions on rice decline rapidly by 20% per year to 2030;
- Surplus labor in agriculture leads to exogenous entry into agricultural employment by 2 percent per year (starting 2016).

The resulting sectoral GVA growth rates for the Reference scenario are shown in Table 11. Official data on growth of GDP is closely replicated by the Reference scenario; the expected growth of GDP over the period 2017 – 2030 is 6.91 percent, which continues the GDP growth of 2016, which exceeds the average for 2010 – 2016, and is within range of the government's target of 7 – 8 percent.

**Table 11: Growth rates of the basic sectors, official data and Reference scenario (%)**

| | Official data | | | | Reference scenario | | | | Subsidy |
|---|---|---|---|---|---|---|---|---|---|
| | 2014 | 2015 | 2016 | 2010-16 | 2014 | 2015 | 2016 | 2017-30 | 2017-30 |
| Agriculture | 1.7 | 0.1 | -1.3 | 1.0 | 1.9 | 0.2 | -0.7 | 1.98 | 2.32 |
| Industry | 7.8 | 6.4 | 8.4 | 7.5 | 8.6 | 5.3 | 8.4 | 8.18 | 8.16 |
| Services | 6.0 | 6.9 | 7.4 | 6.7 | 5.5 | 7.6 | 6.9 | 6.73 | 6.73 |
| GDP | 6.1 | 6.1 | 6.9 | 6.3 | 6.1 | 6.1 | 6.6 | 6.91 | 6.90 |

Source: Author's model.

Official data on growth of agriculture GVA is closely replicated by the Reference scenario, except it understates the contraction of agriculture in 2016. Growth is about 2 percent annually; though pessimistic, the projection is above the six-year average for the basic sector. Productivity growth of about one percent annually translates to GDP increase of double that pace. Industry and services are somewhat replicated (with deviations below one percentage point); expected growth in Industry GVA and Services GVA is 8.2 percent and 6.7 percent, respectively. In contrast to agriculture, relatively modest productivity increases (less than 3 percent) drives a rapid pace of sector value added.

The Reference scenario incorporates a zero subsidy. To test the growth implications of a subsidy on capital in agriculture, an alternative Reference scenario is posited with a capital subsidy for agriculture equal to 5% off the cost of capital, except for rice, where the subsidy is increased to 10% (in view of self-sufficiency targets). The subsidy is applied from 2018 onward.

The resulting growth rates are shown in the last column of Table 11. Growth of agriculture accelerates moderately to 2.2 percent per year. Spending on subsidy begins at P47 billion in 2018, rising to P50 billion in 2030; these figures are within the range of annual budget estimates of DA for subsidized credit during the Duterte administration.[1]

These expanded outlays slow down the rate of capital formation, hence the other sectors suffer a mild growth slowdown. However, due to the far bigger share of these sectors in the economy, overall GDP growth falls slightly. As expected, subsidies are of dubious value in terms of promoting growth, and are set to zero in all of the scenarios.

Assumptions for productivity growth for the remaining scenarios are shown in Table 12. Under Productive agriculture, technical progress in agriculture is matched to that of industry-services; under Climate change scenario, productivity growth is driven down to zero. Meanwhile for Productive industry-services, technical progress in industry and services sectors is given a half-percentage point boost.

**Table 12: Assumed productivity growth rates for the basic sectors, by scenario (%)**

| | Productive agriculture | Climate change | Productive industry-services |
|---|---|---|---|
| Agricultural sectors | 2.5 | 0 | 1.0 |
| Industry sectors | 2.5 | 2.5 | 3.0 |
| Service sectors | 2.5 | 2.5 | 3.0 |

Source: Author's model.

[1] http://www.philstar.com/business/2017/06/25/1713306/farmers-now-get-easy-access-credit-da.

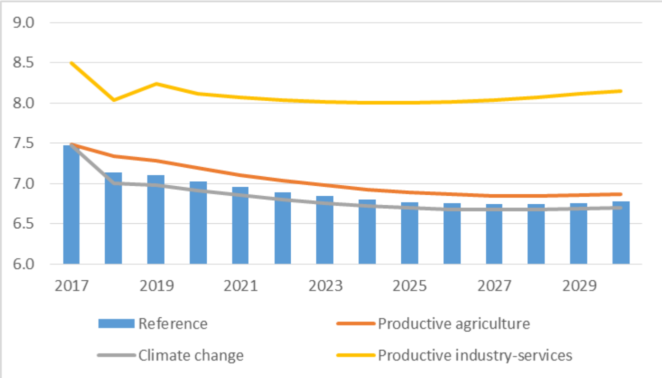
## 4. RESULTS

### Economywide growth

*Official growth targets are achievable under trend rates of GDP growth.*

Projections for GDP growth by scenario are shown in Figure 1. Given TFP growth rates posited in Table 9, the reference scenario finds a TFP growth of about 7.5% initially, slowing down slightly to 6.8% by 2030. This is somewhat below the 7-8% band, but well within the neighborhood of the official growth target.

**Figure 1: Scenarios for growth in GDP (%)**




Source: Author's model.

*A small increment in TFP growth for industry-services leads to large increment in GDP growth, contrasting with the impact of TFP growth in agriculture.*

The economywide growth trajectory is largely unaffected by TFP trends in agriculture, even by the climate change scenario. However, GDP growth is sharply elevated by faster TFP growth in industry-services, peaking at 8.5% in 2017, but maintaining an 8.0 to 8.5% band over the scenario horizon.

### Agriculture

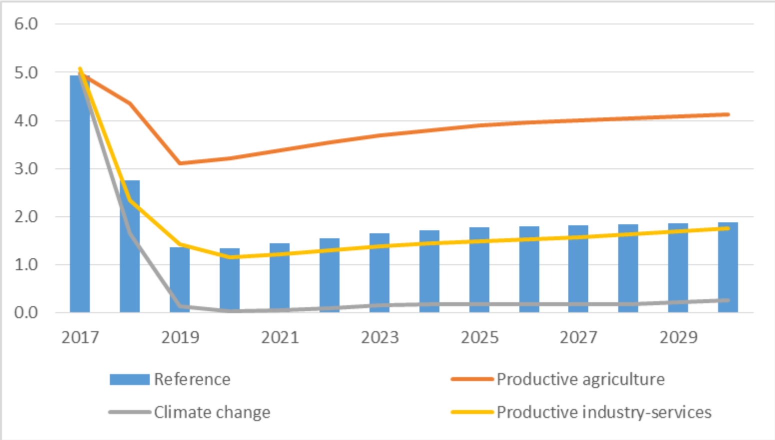
*Overall growth in agriculture resembles the trend in agricultural TFP growth.*

Extrapolating forward from TFP trends inferred from 2010 – 2016, weak growth in agricultural GVA is attributable to low TFP growth. Hence if trend TFP growth continues, we may expect agricultural GVA growth to remain in the 1 – 2 percent growth range.

*Faster TFP growth in industry and services has no significant impact on the growth trajectory of agriculture.*

Somewhat surprisingly, changes in TFP growth trends in industry-services has no significant impact on trends for agricultural growth. In fact, higher TFP growth in industry-services slightly decreases that of agricultural GVA (about 0.20 percentage points) – due to re-allocation of resources (labor and capital) from agriculture to industry-services.

**Figure 2: Scenarios for growth in agricultural GVA (%)**




Source: Author's model.

*Per capita consumption of primary agriculture will remain mostly unchanged over time, though per capita consumption of processed food is expected to grow by 3-6% (except for milled rice).*

Growth in agricultural output similar to that of population growth of 1.6 percent (Figure 2). This does not however imply deterioration in per capita consumption of food, even as high income growth raises consumer purchasing power (Table 13).

**Table 13: Growth in per capita consumption, by scenario (%)**

| | Reference | | Agricultural productivity | | Climate change | | Industry-service productivity | |
|---|---|---|---|---|---|---|---|---|
| | Rural | Urban | Rural | Urban | Rural | Urban | Rural | Urban |
| C_Corn | 0.04 | 0.04 | 0.05 | 0.05 | 0.03 | 0.03 | 0.05 | 0.05 |
| C_Coconut | 0.02 | 0.02 | 0.04 | 0.04 | 0.01 | 0.01 | 0.03 | 0.02 |
| C_Sugarcane | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| C_Banana | -0.03 | -0.03 | -0.01 | -0.01 | -0.03 | -0.04 | -0.03 | -0.04 |
| C_Mango | 0.01 | 0.01 | 0.04 | 0.03 | 0.00 | 0.00 | 0.02 | 0.01 |
| C_Otfruit | 0.04 | 0.04 | 0.05 | 0.05 | 0.04 | 0.04 | 0.06 | 0.05 |
| C_Otcrop | 0.06 | 0.06 | 0.06 | 0.06 | 0.06 | 0.06 | 0.08 | 0.08 |
| C_Rootcrop | 0.02 | 0.01 | 0.04 | 0.04 | 0.01 | 0.00 | 0.02 | 0.01 |
| C_Veg | 0.02 | 0.01 | 0.04 | 0.03 | 0.01 | 0.00 | 0.02 | 0.01 |
| C_Aquacult | 0.02 | 0.02 | 0.04 | 0.04 | 0.01 | 0.01 | 0.03 | 0.02 |
| C_Mining | 0.08 | 0.08 | 0.08 | 0.08 | 0.08 | 0.08 | 0.10 | 0.10 |
| C_Rice | 0.73 | 0.74 | 0.78 | 0.79 | 0.70 | 0.71 | 0.90 | 0.90 |
| C_Meat | 3.60 | 3.52 | 4.23 | 4.17 | 3.23 | 3.15 | 4.18 | 4.12 |
| C_Procfish | 3.25 | 3.15 | 3.50 | 3.39 | 3.11 | 3.03 | 3.97 | 3.89 |
| C_Sugar | 3.52 | 3.44 | 4.07 | 4.00 | 3.26 | 3.19 | 4.18 | 4.12 |
| C_Otfoodmanuf | 4.40 | 4.38 | 4.78 | 4.75 | 4.17 | 4.15 | 5.12 | 5.11 |
| C_Bev | 4.91 | 4.92 | 5.08 | 5.07 | 4.80 | 4.83 | 5.75 | 5.76 |

Source: Author's model.

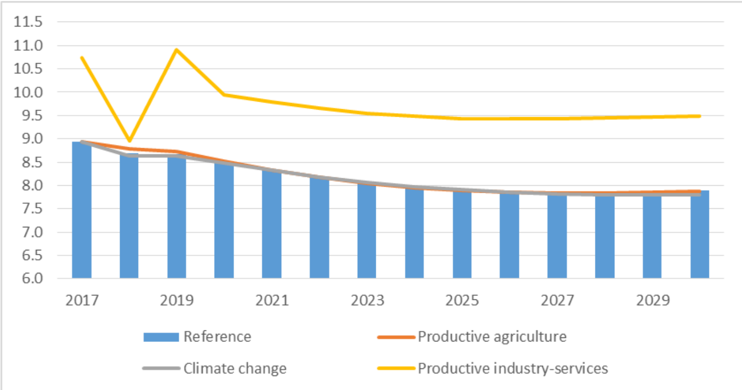
The table makes clear though that the most rapid rates of consumption growth are not for primary agricultural products, but rather for processed agricultural products, other manufacturing, and services. This reflects the imposition of income inelastic demand for primary products, and elasticities at unity or higher for processed food, manufactured products, and services.

### Industry, service, and agro-industry

*Industry will lead in growth performance, with service remaining at average pace. Both sectors largely unaffected by changes in agricultural productivity.*

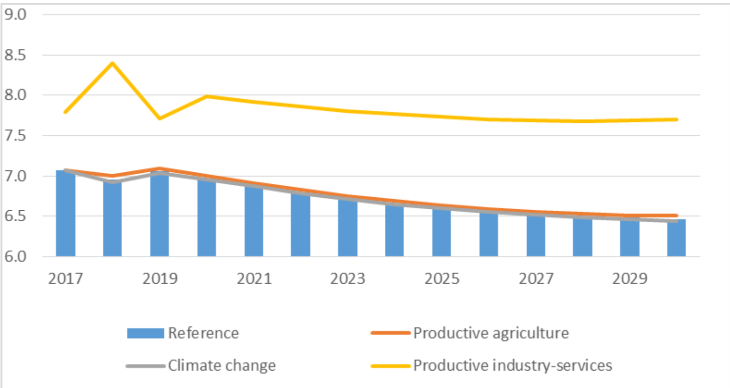
Growth of industry begins at an outstanding 9 percent clip in 2017, but tapering off to around 8 percent average pace in 2025 onward (Figure 3). Meanwhile, growth of services begins at 7 percent, and adjusts slightly down to 6.5 percent in 2030. The trends are mostly unchanged whether there is an acceleration or deceleration of productivity growth in agriculture.

**Figure 3: Scenarios for growth in industry GVA (%)**




Source: Author’s model.

**Figure 4: Scenarios for growth in service GVA (%)**




Source: Author’s model.

*Growth in industry-service GVA rises significantly with small increment in productivity growth.*

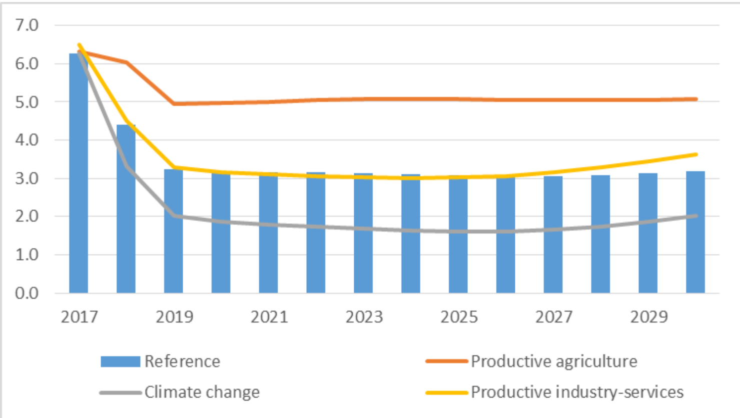
With just a 0.5 percentage point addition in TFP growth, growth of industry GVA rises sharply to 11 percent by 2019, and staying at above 9.5 percent by 2030. Similarly, growth of service GVA accelerates to nearly 8.5 percent, before falling off to about 7.5 percent by 2030.

*Acceleration in agricultural TFP growth has only modest impact on agri-related industry growth, compared to accelerated I-S TFP growth.*

Under the Reference scenario, the growth rate of agri-related industry GVA averages only 3.52 percent, far slower than the pace of overall industry growth. Beginning from over 6 percent growth in 2017, the industry cluster slows down to just about 3 percent growth in 2019, slightly accelerating to 3.62 percent by 2030 (Figure 5). The share of agri-related industry in GDP is 8.6 percent in 2016, falling to just 4.3 percent in 2030.

Faster productivity growth of agriculture likewise boosts growth of agri-related industry, stabilizing its growth pace at about 5 percent per year. On the other hand, adverse climate change depresses agri-related industry growth down to about 2 percent. There is no sharp change in trajectory with faster industry-service growth, compared to the Reference scenario; though the trajectories begin to diverge at around 2027, when growth rates under the Productive-industry services scenario become noticeable faster.

**Figure 5: Scenarios for growth in agri-related industry GVA (%)**




Source: Author’s model.

## Wages

*Agricultural wages will grow, but will be outpaced by industry-service wages.*

Projections for wages are shown in Table 14 and 15. Growth starts at above 4 percent annually, slowing down to 3 percent by 2030; however, that of industry-service ranges from 4 to 5 percent. Over time therefore wages of agriculture and industry-service will continue to diverge.

*Growth in agricultural wage is significantly affected by productivity growth in agriculture, as well as by productivity growth in industry-service.*

The wage projection for industry-service is mostly unaffected by changes in agricultural productivity; it is only significantly affected by faster productivity growth in industry-service itself. Likewise, agricultural wages are positively and significantly affected by productivity growth in agriculture.

**Table 14: Average annual growth of agricultural wages, by scenario, 2013 – 2030 (%)**

| | 2017-19 | 2020-22 | 2023-25 | 2025-30 | 2013-30 |
|---|---|---|---|---|---|
| Reference | 3.86 | 3.37 | 3.34 | 3.08 | 3.54 |
| Productive agriculture | 4.09 | 3.84 | 3.95 | 3.89 | 4.02 |
| Climate change | 3.69 | 2.95 | 2.71 | 2.10 | 3.02 |
| Productive industry-services | 4.75 | 4.07 | 3.89 | 3.39 | 4.00 |

Source: Author's calculation.

**Table 15: Average annual growth of industry-service wages, by scenario, 2013 – 2030 (%)**

| | 2017-19 | 2020-22 | 2023-25 | 2025-30 | 2013-30 |
|---|---|---|---|---|---|
| Reference | 5.31 | 5.09 | 4.71 | 4.28 | 4.62 |
| Productive agriculture | 5.60 | 5.53 | 5.24 | 4.97 | 5.05 |
| Climate change | 5.11 | 4.71 | 4.16 | 3.38 | 4.14 |
| Productive industry-services | 6.25 | 5.88 | 5.35 | 4.63 | 5.13 |

Source: Author's calculation.

Of interest is the fact that faster productivity growth in industry-service is also associated with faster increases in agricultural wages. This is somewhat puzzling as agricultural output growth is slower under the Productive industry-services scenario; moreover, labor supply is segmented between agriculture and service-industry. The faster wage growth must be occurring through interaction with accumulation of capital stock, which is faster under the Productive industry-service scenario, than under the Reference scenario.

## 5. CONCLUSION

Despite low contribution to GDP and declining contribution to employment, agriculture remains a key sector for inclusive growth and poverty alleviation. This study has developed a CGE model for analyzing long term growth prospects for agriculture within the context of agro-industry and economywide growth. "Long-term" here refers to the base period to 2030, the cut-off year for the SDGs.

The CGE model builds on the author's previous AMPLE supply-demand model for agriculture, with disaggregation for agriculture and agriculture-linked industry. The model adopts a conventional structure based on social accounting matrix compiled for the Philippines for the base period 2013.

The primary engine of long term growth in the analysis is TFP, corresponding to technical progress, broadly defined. The scenarios analyzed are: the reference case (industry-services growing at trend TFP growth rates at the national level, but sharply slower TFP growth for agriculture); faster agricultural TFP growth; slower agricultural TFP growth (reflecting deterioration in outlook due to climate change); and faster TFP growth for industry-service.

One key finding is that subsidies on capital in agriculture (the current policy thrust of Department of Agriculture) slightly accelerates growth of agriculture, but acts as a drag on overall growth by slowing down the rate of capital formation. On the other hand, maintaining productivity growth for industry-services, trend rates suffices to reach PDP growth targets, despite weak TFP growth for agriculture.

As for agriculture, the scenario analysis finds that weak growth performance of agriculture will persist as long as TFP performance does. From the perspective of food security, this does not mean that per capita food consumption will necessarily fall; however, implications for livelihoods and the pace of poverty reduction are unclear, requiring further analysis and development of an equity-sensitive version of AMPLE-CGE. One clue is that agricultural wages are projected rise, but wage disparity vis-à-vis industry-service continues to widen over time.

Meanwhile, varying the rate of TFP growth in agriculture impacts strongly on agriculture itself, but hardly affects growth prospects of the industry-service sectors. Conversely, TFP growth in the latter strongly on itself and overall GDP, but not on agriculture. In short, the scenario analysis finds little support for strong indirect impacts, except for agricultural wages being affected by industry-service growth.

The analysis spotlights the necessity of boosting productivity growth, as opposed to devoting resources towards artificially increasing returns to investments, even in a key sector such as agriculture. Going into the specifics of TFP growth enhance is beyond the scope of this paper; it suffices to say that TFP is generally not increased by price support policies for agriculture, nor by subsidies on private goods, contrary to the current thrust of agricultural policy. Elements for accelerating TFP growth are instead: R&D, innovation, adoption of technology, improved practices and systems, public goods (e.g. transport infrastructure).

If the goal is sustaining rapid, economywide growth, the analysis emphasizes industry-service TFP over that of agriculture. Further research is needed to establish whether equity considerations will justify great focus on agriculture TFP.

Furthermore, the lack of indirect impact from agriculture to industry-service, and vice-versa, seems to invalidate the value chain strategy to agriculture advocated in the latest incarnation of the PDP. However, such a conclusion is premature. The value chain strategy aims at stronger integration between agriculture and industry-service, as well as encouraging agro-industry-specific capital formation. For as long as these subsidies for private goods are avoided, and more cost-effective mechanisms pursued, e.g. cluster-based approach, establishing agricultural value chains may yet be a viable strategy for inclusive growth.

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