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The Effects of Domestic Rice Market Interventions Outside Business-As-Usual Conditions For Imported Rice Prices

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Abstract

The Philippine government intervenes in the domestic rice market through the imposition of import tariffs and the provision of producer and consumer subsidies. While policy makers are aware that these programs come with allocative efficiency costs, they justify the programs on the grounds that they insulate the domestic economy from unexpected price spikes in the international rice market. An interesting matter for policy evaluation is to quantify the insulation benefit that the programs provide in circumstances of sudden severe import price spikes. To examine this question, we undertake a dynamic CGE simulation in which the Philippines is subject to an external rice price shock. We find that the insulation benefit of the support programs under a 2008-like event is worth approximately 0.10 per cent of real consumption. However the cost of insuring against these price spikes is significant. We estimate the annual cost of the rice market interventions at approximately 0.40 per cent of real consumption.

JEL classifications: C68, Q18, H12, H21

Keywords: Food security, food subsidies, rice tariff, rice market, price insulation

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1. Introduction

The Philippine government intervenes in the domestic rice market through the imposition of import tariffs and the provision of producer and consumer subsidies. Local policy makers are aware that these programs carry allocative efficiency costs. Trade analysts such as Magno and Yanagida (2000), Salehezadeh and Henneberry (2002), Dawe (2006), Briones (2013) and Layaoen (2014) have argued for reductions in tariff and non-tariff trade barriers on both the rice sector and the broader Philippine agricultural sector to promote economic efficiency. Similarly, there have been many proposals for the abolition or re-design of the Philippine government's rice/paddy subsidy programs, on the grounds that they promote allocative inefficiency, are poorly targeted, and have high budgetary costs (see Sombilla *et al*., 2006; Jha and Mehta, 2008; Cororaton and Corong, 2009; Intal *et al*., 2010; Briones and Parel, 2011). Despite the substantial body of policy analytic work favouring reductions in Philippine rice market support, the continued maintenance of the programs has been justified by government on food security grounds (Department of Agriculture, 2012:8).[3] However, under business-as-usual conditions, the food security benefits of the Philippine's programs look small. For example, Mariano and Giesecke (2014) find that Philippines producer and consumer rice subsidy programs have only a small positive effect on domestic food security, as calculated by comparing the effects of removing the programs on food security indices, relative to a business as usual baseline in which

[3] The Philippines is not alone in equating support for domestic rice production with food security. As Alavi *et al.* (2012) note, the position is held widely in Southeast Asia.

the programs are retained. However, in examining the public justifications for maintaining these programs, it is apparent that Philippine policy concern for food security is motivated in part by fears of events *beyond* business-as-usual conditions (Department of Agriculture, 2012). For example, in 2008 global rice prices spiked upwards. For the Philippines, the c.i.f price of imported rice increased by approximately 60 per cent relative to trend (Figure 1).

The causes of recent volatility in world food markets have been examined by Naylor and Falcon (2010), Timmer (2010), Headey *et al*. (2010), and Gorter *et al*. (2013), among others. An important strand of recent research has been the examination of the volatility amplifying role played by endogenous changes in agricultural interventions. For example, Martin and Anderson (2011) and Anderson and Nelgen (2012) examine how efforts by individual countries to insulate their economies from spikes in world prices for food staples, through the varying of existing barriers to agricultural trade in response to price movements, may have contributed to the severity of these price events. Such adjustments to support measures in the face of volatile food prices by a single country might augment the local insulation benefits provided by its existing interventions, notwithstanding simultaneous activity in this regard might be amplifying for global price movements. However, the maintenance of a given level of pre-existing support for domestic food production will also provide baseline insulation of the economy from spikes in world prices. An interesting matter for policy evaluation is quantification of the insulation benefit provided by maintenance of *in situ* rice interventions in circumstances of sudden severe import price spikes. There is some evidence that considerations of this type are in the minds of policy makers when making the food security case for maintenance of rice market interventions. For example, in providing counterarguments to the efficiency case for liberalisation, Department of Agriculture (2012) expresses concern that concentration and thinness in the global trade for rice contribute to the vulnerability of world rice prices to speculation and panic. Similar policy concerns are expressed in SEPO (2010), which notes that disruptions to world rice markets in the late 2000s led the Arroyo government to direct the Department of Agriculture to increase domestic rice self-sufficiency, an instruction re-affirmed by the new Aquino administration. These policy concerns are not unique to the Philippines. Volatility in world rice prices, caused in part by the thinness of trade, has led many rice importing countries to seek to insulate their economies from this volatility through protection of their domestic rice producers and consumers (Intal *et al.*, 2012).

To our knowledge, the insulating effect played by existing pre-event interventions has not been examined. In this paper, we examine the question for the Philippines using a dynamic economy-wide model with detailed treatment of agricultural activity, land use, and food security measures. We undertake a simulation in which the Philippines is subject to an external rice price shock of a magnitude similar to that experienced in 2008. We run this scenario against two alternative baselines: one in which current rice market interventions are in place (the "with support" case), and one in which they have been removed (the "without support" case). Broadly, we find that the rice market interventions provide insulation benefits in the event of a spike in the imported price of rice. However, these insulation benefits come at the cost of the economic gains that are foregone by retaining ongoing distortions in the rice market. In the paper's final section, we quantify this cost by examining the economic benefit of removal of the rice market interventions.

2. The CGE model, macroeconomic closure and database

2.1. Key features of PHAGE – an applied general equilibrium model of the Philippines

Our simulations are undertaken with a dynamic computable general equilibrium (CGE) model of the Philippines (hereafter PHAGE)[4] with a high level of sectoral and user disaggregation.[5] The core structure of PHAGE begins with the model of Dixon and Rimmer (2002), but extends this with a number of additions to better reflect the characteristics of the Philippine agricultural sector. In particular, PHAGE has a detailed treatment of agricultural activities, land use, and food security measures.

The PHAGE model comprises 52 industries and 52 commodities. The agricultural sector is represented by 22 industries, while the manufacturing and service sectors are comprised of 19 and 11 industries respectively. Three primary factors are identified in the model, namely: labour, capital and land. Labour is further distinguished by skill, and land is differentiated based on agricultural use. The model carries the assumptions of constant returns to scale (CRS) production functions, utility-maximising households and price-responsive export demands. Industries and households make decisions based on optimising behaviour. Given input prices, each industry minimises costs subject to a CRS production function. Households maximise utility, which is described by a nested Klein-Rubin utility function. Capital is industry-specific, with new units of capital allocated to industries on the basis of expected rates of return. New units of capital are formed from local and imported goods in a cost-minimising way, subject to CRS capital production functions. The model recognises imperfect substitutability between domestic and

[4] PHAGE – Philippines Applied General Equilibrium model

[5] The model is solved using the GEMPACK economic modelling software (Harrison and Pearson, 1996).

imported goods via the Armington CES assumption. Aside from domestic use, local goods are also demanded by foreign agents. The export demand for each Philippine-made product is inversely related to its foreign currency export price. PHAGE recognises the consumption of commodities by the government, and contains detailed treatment of direct and indirect taxes. The model carries the assumptions that all sectors are competitive, and that zero pure profit conditions hold in all commodity markets. The purchasers' price of a given commodity is equal to its basic price plus the value of any associated indirect taxes and margin services.

Four types of dynamic adjustment are implemented in the model. The first three follow Dixon and Rimmer (2002), and the fourth is a dynamic structure for land use change. First, net investment in year *t* is installed as physical capital in year *t*+1. Second, changes in the net liability positions of the public and private sectors are determined by the investment/savings imbalances of these sectors. Third, the labour market follows a lagged adjustment path, allowing a transition from a short-run environment in which wages are sticky and employment adjusts, to a long-run environment in which employment is given and wages are fully flexible.

As detailed in Mariano and Giesecke (2014), we combine within PHAGE two approaches to modelling land supply: Horridge and Ferreira (2014) and Giesecke *et al.* (2013). With these approaches implemented in PHAGE, the land allocation process is divided into a two-tier problem. The first tier models the gradual adjustment of land across seven broad land types: paddy, annual crops, perennial crops, animal farming, aquaculture, forestry and unused agricultural land. Following Horridge and Ferreira (2014), land can gradually move between these alternative types from one year to the next. These movements are governed by a land transition matrix, the elements of which describe the annual proportion of land type *i* in year *t* that becomes land type *j* in year *t*+1.[6] The changes in these proportions are positively related to changes in relative land rental rates. Once year-to-year changes in broad land types have been determined in the first tier, we follow Giesecke *et al.* (2013) in allowing optimisation problems in the second tier, specific to each of the seven broad land types, to allocate land within each year across 22 competing agricultural users according to relative land rental rates.[7]

Lastly, PHAGE adopts a nested structure for modelling food demand. At the top level, household utility is Klein-Rubin in 5 broad food bundles, and 29 disaggregated non-food commodities. Each of the broad food types are modelled as CRESH composites of disaggregated food types.[8] For example, the staples bundle is a CRESH composite of rice, unmilled corn, milled corn, and legumes, tubers and root vegetables.[9]

2.2. Macroeconomic environment

We outline in this section the important features of the model's macroeconomic closure as they relate to our rice price spike simulation. First, our modeling of the labour market follows the wage theory of Dixon and Rimmer (2002). Under this approach, short run real wages are sticky, with short run labour market pressures largely expressed as movements in employment. Over the

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[6] We base our estimates of these proportions on the study of Mataia and Francisco (2010), the Census of Philippine Agriculture of NSO (2002), and land data from BAS (2012).

[7] For detailed description of land modelling in PHAGE, see Mariano and Giesecke (2014).

[8] CRESH: Constant ratios of elasticities of substitution, homothetic (Hanoch 1971). Modelling of each disaggregated food type follows the Armington assumption of CES aggregation over imported and domestic varieties.

[9] The remaining broad groups are modelled as follows. Fruits and vegetables is a CRESH composite of vegetables, pineapple, other annual crops, coconut, banana, mango, citrus and other perennial crops. Meat and fish is a CRESH composite of hog, poultry, other livestock, fish, and processed meat and fish. Other foods is a CRESH composite of sugar, coffee and other processed foods.

medium to long run, wage flexibility returns employment to its baseline level. The rate of gradual wage adjustment is set such that the employment effects of exogenous shocks are largely eliminated after about five years.[10]

Second, we assume that nominal economy-wide (private plus public) consumption spending is a fixed proportion of nominal gross national disposable income (GNDI). The ratio of real private to real public consumption spending is assumed to be exogenous. The model's GNDI calculation tracks annual movements in net foreign liabilities and the net interest payments thereon. Aggregate economy-wide investment is determined as the sum of industry-specific investment.

Third, the values of all technology variables are held at their baseline forecast levels. That is, primary-factor technical change and various types of input-saving technical change in intermediate use, capital creation and provision of margin services are not affected by the rice price spike.

2.3. Database

Construction of the model's database begins with the latest input-output (IO) data for the Philippines published by the National Statistics Coordination Board (NSCB, 2000). Before using this IO data as an initial solution to our CGE model, we first subject it to two types of adjustment, using the method described in Horridge (2004). The first set of adjustments updates the data to a recent year (2010). These adjustments update expenditure and income-side macro

[10] This is consistent with the macroeconometric model of the Central Bank of the Philippines, in which changes in employment under various simulations are largely eliminated after five to seven years (see Majuca, 2011).

aggregates, and selected industry and commodity variables, particularly those relating to the paddy and rice markets.

The second set of database adjustments puts in place the 2010 database values for relevant subsidies and taxes in the rice market. The many policy interventions in the Philippines rice market include subsidies on prices received by farmers for paddy, subsidies on the consumer price of rice, and tariffs on rice imports. More broadly, public financing of agricultural R&D, irrigation infrastructure and agricultural extension services also benefits paddy agriculture (Balisacan and Ravago, 2003). In adjusting our database, we use data from Bureau of Agricultural Statistics (BAS), the Philippine Rice Research Institute (PRRI) and the National Food Authority (NFA) to calculate the values for the four largest direct interventions in the rice market: a subsidy on prices paid by rice consumers, a subsidy on prices received by paddy farmers, a subsidy on prices paid for seeds by paddy farmers, and a tariff on rice imports. We estimate the 2010 value of the subsidy on retail purchases of rice at 6.7 billion pesos, the value of the seed subsidy at 1.2 billion pesos, and the value of the subsidy on paddy purchases at 1.1 billion pesos. These are recorded in the 2010 database as subsidies on sales by rice milling to households, sales of paddy to paddy agriculture, and sales of paddy to rice milling, respectively. The 2010 database value of tariff revenue from rice imports was adjusted to reflect the rice tariff rate of 50 per cent (Philippine Tariff Commission, 2010).

3. Simulation design

3.1. Simulation shocks

Our aim is to examine the economic and food security implications of a temporary spike in the price of imported rice of a magnitude similar to that experienced by the Philippines in

2008. In Figure 1, the 2008 c.i.f. foreign currency price of imported rice to the Philippines is approximately 60 per cent above the trend line. Hence we adopt 60 per cent as the value for our temporary rice price shock. PHAGE is dynamic, tracking annual values from the model's initial solution for 2010 through to a 2025 forecast. Consistent with the approach outlined in Dixon and Rimmer (2002) we report the effects of the price shock in terms of percentage deviations in results for key variables in the presence of the price shock away from baseline forecast values. Recall that our aim is to quantify the effect of domestic food security policies on the economic and food security implications of a temporary rise in the c.i.f. foreign currency price of imported rice. To do this, we require two alternative baselines:

(1) one in which the four interventions supporting the domestic rice market discussed in Section 2.3 (a consumer rice price subsidy, a producer paddy price subsidy, a farmer seed subsidy, and a rice import tariff) remain at their initial levels throughout the baseline forecast (hereafter, referred to as "with support" scenario), and

(2) one in which the four rice market interventions are permanently removed in 2013 of the baseline forecast (hereafter, referred to as "without support" scenario).

We undertake two counterfactual simulations. These counterfactual simulations are identical to simulations (1) and (2) above in all respects other than that a once-off temporary spike in the c.i.f. foreign currency price of imported rice is imposed in 2016.[11] We report the outcomes under the two counterfactual simulations in terms of percentage deviations in results

[11] In the "without support" scenario, rice market support policies are removed in 2013. By imposing the temporary rice price spike shock in 2016, we have allowed the rice market three years to adjust resource allocation in response to the permanent removal of the rice market support policies.

away from baseline forecast values. We examine how the same price shock has different impacts on the economy depending on whether the price support mechanisms are in place (baseline 1) or have been removed three years prior to the price shock (baseline 2). In this way, we elucidate the insulation effects of the rice market interventions in the face of a 2008-like spike in imported rice prices. Then in Section 5, we undertake a simulation in which we examine the economic benefits of removing the four support mechanisms. This allows us to make comparisons between the insulation benefits that the programs provide, and the costs of the programs in terms of the foregone potential gains from their removal.

3.2. Analytical framework

Following Dixon and Rimmer (2002:243), we make use of a simple back-of-the-envelope (BOTE) model (Table 1) to guide us in explaining the main routes of causation via which the price shock affects the macro economy.

Equation (E1) describes the GDP expenditure-side identity in constant price terms, consisting of real private and public consumption, real investment, export volumes and import volumes. (E2) is a constant returns to scale production function, linking real GDP to effective units of labour, capital and land inputs. (E3) defines real GNDI equal to real GDP multiplied by a positive function of the terms of trade less interest payments on foreign debt plus overseas income transfers to household and government. In (E4), total consumption (C+G) is determined by GNDI via a given propensity to consume (APC). Equation (E5) defines real public consumption as a fixed proportion (RCG) of real private consumption. In (E6), import volumes are positively related to the level of domestic production (proxied by GDP) and the real exchange rate (proxied by the terms of trade). (E7) relates export prices to export volumes via a downward sloping export demand schedule. In (E8), the terms of trade is defined by the ratio of export prices to import prices. Because (E2) is constant returns to scale, the marginal products of labour and capital (MPL and MPK) are functions of the capital–labour ratio. This accounts for (E9) and (E10) which are based on the profit maximising first-order conditions for the use of labour and capital inputs. (E11) indicates that investment expenditure is positively related to rates of return on capital. Lastly, (E12) relates the start-of-year capital stock to investment in the previous year plus the depreciated value of existing capital.

4. Simulation results of the rice price spike shock

In interpreting the simulation results, we first describe the direction of policy effects on each economic variable and then compare the magnitude of results between the two baseline scenarios. A general observation is that the economy responds similarly to the rice price shock under both baselines, but we shall find the economy is more exposed to the economic consequences of the price spike under the "without support" case. We expand on these results below.

4.1 Macroeconomic results

As discussed in Section 3, the shock is a temporary increase in the imported price of rice, rising by 60% relative to trend in 2008, before returning to trend in 2009. In terms of BOTE, this can be represented by an increase in the average price of imports (P_M). Via (E8), this causes the terms of trade to decline relative to baseline. This is confirmed by the PHAGE results: in Figure 2, under both baselines, we see that the rise in the price of imported rice causes a significant deterioration in the terms of trade. The negative deviation in the terms of trade is greater under the “without support” baseline because the share of rice imports in total imports is higher under this scenario relative to the “with support” case.

In Figure 3, we see that there is no deviation in the 2016 capital stock. This is because deviations in year *t* capital stocks depend on deviations in year *t*-1 investment (BOTE equation 12). With the capital stock unchanged in 2016, and with the real wage sticky (represented by exogenous RW in BOTE), the decline in the terms of trade causes employment to fall via BOTE equation E10 (see Figure 4). Consistent with the terms of trade decline being greater under the “without support” case, the 2016 negative employment deviation is larger under the “without support” case (Figure 4).

Via (E9), with no change in the 2016 capital stock, the decline in the terms of trade, together with the decline in employment, causes a temporary negative deviation in the rate of return on capital (Figure 3). In turn this leads to a negative deviation in 2016 real investment via (E11) (see Figure 3). Consistent with both the negative 2016 terms of trade and employment deviations being larger under the “without support” case relative to the “with support” case, we find in Figure 3 that the 2016 negative deviations in both the rate of return and investment are larger under the “without support” case. Note in Figure 3 that the 2016 negative investment deviations are manifested in 2017 as negative deviations in capital supply. However, the rice price spike is temporary. Imported rice prices return to their trend levels from 2017 onwards, and so too does the terms of trade deviation (Figure 2). This leaves the post-2016 capital stock too low with the terms of trade relatively close to the baseline level in 2017. As the capital stock gradually recovers in the long-run, the rate of return increases requiring the investment deviation to turn positive from 2018 onwards (Figure 3). By the end of the simulation period, the positive investment deviation returns the level of the capital stock to close to its baseline value.

In Figure 5 we see that the price spike induces a temporary reallocation of agricultural land across competing uses. The rise in the price of imported rice induces substitution on the part of rice consumers towards the relatively cheaper competing domestic variety. This encourages domestic rice production. The increase in local rice production increases the demand for land in paddy agriculture. This causes the rental price of land used in paddy production to rise relative to other land uses. As illustrated in Figure 5, this induces transformation in land use towards paddy agriculture, generating a sharp positive deviation in the supply of land to paddy agriculture. The increase in land allocation to paddy agriculture generates a concomitant reduction in land supply to other agriculture (Figure 5). Note that in Figure 5 we also report rental-weighted aggregate land supply. This declines relative to baseline in both scenarios, notwithstanding that the total available agricultural land area cannot deviate from its baseline value. This is explained by the relative land rental rates in the baseline data: that is, the rental value of non-paddy land is higher than that of paddy land. As the rice price spike shifts land out of agricultural land uses with higher land rental rates than paddy agriculture, rental-weighted aggregate land supply experiences a negative deviation relative to baseline. In the long-run, the quantity of land supplied to non-paddy agriculture returns to baseline because the rice price spike is temporary. As such, the rental-weighted value of aggregate land supply also gradually returns to baseline.

As discussed above, in Figures 4 and 5 we find negative deviations in 2016 employment and rental-weighted land supply. Via BOTE equation (E2) these negative deviations in primary factor use causes a negative deviation in real GDP. The negative deviation in primary factor use is larger under the “without support” case relative to the “with support” case. Hence, we would expect the negative deviation in real GDP to be larger under the “without support” scenario. However, in Figure 6, it is clear that the negative deviation in real GDP is 0.05 percentage points larger under the “with support” scenario relative to the “without support” scenario. This is due to a rise in allocative inefficiency in the “with support” case as the spike in the rice price generates an expansion in activity of subsidised rice production. To make this more concrete, we begin by following Mariano and Giesecke (2014) in defining the value of the allocative efficiency effect as:

$$ae^{(t)} = y^{(t)} - \sum_{f=1}^{3} factcont_f^{(t)} \tag{C.1}$$

where

$ae^{(t)}$ is the contribution to the real GDP deviation made by price-spike-induced changes in allocative efficiency in year *t*;

$y^{(t)}$ is a Laspeyres index for the percentage deviation in real GDP at market prices in year *t*; and

$factcont_f^{(t)}$ is the contribution to the real GDP deviation made by the deviation in employment of factor *f* (labour, capital and land) in year *t*.

The contribution of changes in factor employment to real GDP, $factcont_f^{(t)}$, is defined as:

$$factcont_f^{(t)} = 100 \frac{VFAC_f^{(B)(t)}}{VGDP^{(B)(t)}} \left[\frac{XF_f^{(P)(t)} - XF_f^{(B)(t)}}{XF_f^{(B)(t)}} \right] \tag{C.2}$$

where

$VFAC_f^{(B)(t)}$ is the baseline forecast value of payments to factor *f* in year *t*;

$VGDP^{(B)(t)}$ is the baseline forecast value of GDP at market prices in year *t;*

$XF_f^{(k)(t)}$ is the quantity of factor f employed in year t in the baseline (k = B) and price spike scenario (k = P).

The allocative efficiency, $ae^{(t)}$, is defined as:[12]

$$\begin{aligned}\frac{ae^{(t)}}{100} &= \sum_{c=1}^{52}\sum_{s=1}^{2}\sum_{i=1}^{52}\sum_{j=1}^{2}\frac{VTAX_{c,s,i,j}^{(B)(t)}}{VGDP^{(B)(t)}}\left[\frac{X_{c,s,i,j}^{(P)(t)}-X_{c,s,i,j}^{(B)(t)}}{X_{c,s,i,j}^{(B)(t)}}\right] \\ &+\sum_{i=1}^{52}\frac{VTAX_{i}^{(B)(t)}}{VGDP^{(B)(t)}}\left[\frac{X_{i}^{(P)(t)}-X_{i}^{(B)(t)}}{X_{i}^{(B)(t)}}\right]+\sum_{c=1}^{52}\sum_{h=1}^{2}\frac{VTAX_{c,h}^{(B)(t)}}{VGDP^{(B)(t)}}\left[\frac{X_{c,h}^{(P)(t)}-X_{c,h}^{(B)(t)}}{X_{c,h}^{(B)(t)}}\right] \\ &+\sum_{c=1}^{52}\sum_{s=1}^{2}\sum_{v=1}^{2}\frac{VTAX_{c,s,v}^{(B)(t)}}{VGDP^{(B)(t)}}\left[\frac{X_{c,s,v}^{(P)(t)}-X_{c,s,v}^{(B)(t)}}{X_{c,s,v}^{(B)(t)}}\right]\end{aligned} \tag{C.3}$$

where

$VTAX_{c,s,i,j}^{(B)(t)}$ is the year t baseline value of indirect taxes paid by industry i on purchases of commodity c from domestic (s=1) and imported (s=2) sources for use in current production (j=1) and capital formation (j=2);

$VTAX_{i}^{(B)(t)}$ is the year t baseline value of production taxes paid by industry i;

[12] As described in Mariano and Giesecke (2014) the right hand side of (C.3) measures the contributions to the deviation in real GDP at market prices of changes in activity across tax bases carrying different rates of indirect taxation. Ignoring the division by VGDP (which simply rebases all terms as a proportion of GDP), a typical right-hand-side element of (C.3) is [VTAX/XB]*(XP – XB), where VTAX is the baseline value of indirect tax collections on the relevant activity, and XP and XB are quantities of the relevant activity in the policy case and baseline respectively. [VTAX/XB] measures the per-unit gap between the market price and the basic price of the activity in question, and (XP-XB) measures the policy-induced change in activity. Movements in (XP-XB) affect real GDP at market prices by reallocating resources across activities for which there are gaps between marginal willingness to pay for the activity, and the basic price of the activity.

$VTAX_{c,h}^{(B)(t)}$ is the year t baseline value of indirect taxes paid on exports (h=1) and imports (h=2) of commodity c;

$VTAX_{c,s,v}^{(B)(t)}$ is the year t baseline value of indirect taxes paid on purchases of commodity c from source s by households (v=1) and government (v=2);

$X_{c,s,i,j}^{(k)(t)}$ is the baseline (k = B) and price spike (k = P) year t quantity of input c from source s used by industry i for current production (j=1) and capital formation (j=2);

$X_{i}^{(k)(t)}$ is output of industry i in year t of the baseline (k = B) and price spike (k = P);

$X_{c,h}^{(k)(t)}$ is the baseline (k = B) and price spike (k = P) year t volume of exports (h=1) and imports (h=2) of commodity c; and,

$X_{c,s,v}^{(k)(t)}$ is the baseline (k = B) and price spike (k = P) year t volume of purchases of commodity c from source s by households (v=1) and government (v=2).

Using equation (C.3), Figure 6 shows that the external price shock generates a short-run loss in allocative efficiency (ae) under both baselines, but this negative outcome is 0.08 percentage points greater under the “with support” case relative to the “without support” case. The price-spike-induced wedges between market prices and resource costs in paddy and rice production and consumption activities are greater in the “with support” case than the “without support case”. In terms of (C.3), expansion in paddy and rice production under the price spike scenario generates larger allocative efficiency losses in the “with support” case. To make this clearer, we isolate from the total allocative efficiency ($ae^{(t)}$) a direct effect generated by expansion in paddy and rice production only; and an indirect effect arising from policy-induced movements in tax bases outside the rice and paddy sectors. Specifically, we define the direct allocative efficiency ($dae_{(1)}^{(t)}$) as:

$$\frac{dae_{(1)}^{(t)}}{100} = \sum_{s=1}^{2}\sum_{i=1}^{52}\sum_{j=1}^{2}\frac{VTAX_{Paddy,s,i,j}^{(B)(t)}}{VGDP^{(B)(t)}}\left[\frac{X_{Paddy,s,i,j}^{(P)(t)} - X_{Paddy,s,i,j}^{(B)(t)}}{X_{Paddy,s,i,j}^{(B)(t)}}\right] +$$
$$\sum_{s=1}^{2}\sum_{i=1}^{52}\sum_{j=1}^{2}\frac{VTAX_{Rice,s,i,j}^{(B)(t)}}{VGDP^{(B)(t)}}\left[\frac{X_{Rice,s,i,j}^{(P)(t)} - X_{Rice,s,i,j}^{(B)(t)}}{X_{Rice,s,i,j}^{(B)(t)}}\right] +$$
$$\frac{VTAX_{Paddy}^{(B)(t)}}{VGDP^{(B)(t)}}\left[\frac{X_{Paddy}^{(P)(t)} - X_{Paddy}^{(B)(t)}}{X_{Paddy}^{(B)(t)}}\right] + \frac{VTAX_{Rice}^{(B)(t)}}{VGDP^{(B)(t)}}\left[\frac{X_{Rice}^{(P)(t)} - X_{Rice}^{(B)(t)}}{X_{Rice}^{(B)(t)}}\right] + \qquad (C4)$$
$$\sum_{h=1}^{2}\frac{VTAX_{Paddy,h}^{(B)(t)}}{VGDP^{(B)(t)}}\left[\frac{X_{Paddy,h}^{(P)(t)} - X_{Paddy,h}^{(B)(t)}}{X_{Paddy,h}^{(B)(t)}}\right] + \sum_{h=1}^{2}\frac{VTAX_{Rice,h}^{(B)(t)}}{VGDP^{(B)(t)}}\left[\frac{X_{Rice,h}^{(P)(t)} - X_{Rice,h}^{(B)(t)}}{X_{Rice,h}^{(B)(t)}}\right] +$$
$$\sum_{s=1}^{2}\sum_{v=1}^{2}\frac{VTAX_{Paddy,s,v}^{(B)(t)}}{VGDP^{(B)(t)}}\left[\frac{X_{Paddy,s,v}^{(P)(t)} - X_{Paddy,s,v}^{(B)(t)}}{X_{Paddy,s,v}^{(B)(t)}}\right] + \sum_{s=1}^{2}\sum_{v=1}^{2}\frac{VTAX_{Rice,s,v}^{(B)(t)}}{VGDP^{(B)(t)}}\left[\frac{X_{Rice,s,v}^{(P)(t)} - X_{Rice,s,v}^{(B)(t)}}{X_{Rice,s,v}^{(B)(t)}}\right]$$

where $dae_{(1)}^{(t)}$ is the first of two direct allocative efficiency terms defined in this paper (we define, for another purpose, $dae_{(2)}^{(t)}$ later in the paper). Note that Figure 6 also reports $dae_{(1)}^{(t)}$. It is clear in Figure 6 that $dae_{(1)}^{(2016)}$ accounts for the bulk of the outcome for $ae^{(2016)}$ and that the negative deviation for $dae_{(1)}^{(2016)}$ is significantly larger under the "with support" case, as expected.

Figure 7 plots deviations in real consumption and real GDP. In comparing the GDP and consumption deviations in Figure 7, two outcomes are apparent: (i) the real consumption troughs are deeper than the real GDP troughs; (ii) whereas the GDP deviation under the "with support" baseline lies below the "without support" GDP deviation, this relativity is not carried through to the outcomes for real consumption: the consumption deviation under the "without support" baseline lies below the "with support" case. These results can be explained via BOTE equations (E3) and (E4). (E3) relates real (consumption price deflated) GNDI to real GDP, a function of the terms of trade (f_2), interest payments on net foreign liabilities, and foreign income transfers to households and government. As we shall see, the latter effects exert a trivial influence on real consumption in this simulation.[13] The major influence on the consumption / GDP relativities reported in Figure 7 is f_2. The definition of f_2 is made clearer by exploring the source of (E3):

$$GNDI = (P_{GDP} / P_C) \cdot GDP - NFL \cdot R + FTRNS \tag{C5}$$

where P_{GDP} and P_C are the deflators for GDP and consumption respectively, and all other variables are as defined in Table 1. Equation (C5) makes clear that the term $f_2(TofT)$ in (E3) is P_{GDP} / P_C. Why P_{GDP} / P_C can be said to be a function of the terms of trade is clear when we recall that P_{GDP} includes export prices while P_C includes import prices. The significant negative deviation in the terms of trade under both baselines (see Figure 2) causes the negative deviation in GNDI to be deeper than the negative deviation in real GDP. This explains (via BOTE equation E4) why the real consumption deviation, under either baseline, lies substantially below the corresponding real GDP deviation (outcome (i) above). But recall from our earlier discussion of Figure 2 that the government rice support program insulates the terms of trade from the rice price spike, as demonstrated by the negative deviation in the terms of trade under the "with support" case lying well above the "without support" case (see Figure 2). This explains why the real consumption deviation under the "with support" case lies above the "without support" case (outcome (ii) above).

[13] The percentage deviation in foreign debt interest payments is very small in the impact year (– 0.010 per cent) and tends towards zero in the long-run. The policy effect on foreign income transfers is also small (-0.003 per cent deviation in the impact year).

The determinants of real consumption can be made clearer by substituting (C5) in (E4) and then taking the percentage change form of the resulting equation. The final percentage change expression for the real consumption deviation is then:[14]

$$\begin{aligned} x_C = {} & S_{GDP} x_{GDP} + S_I(p_I - p_C) + S_X(p_X - p_C) - S_M(p_M - p_C) - \\ & S_{INT}(int - p_C - \phi) + S_{FTRNS}(ftrns - p_C) - (G / [C + G]) \cdot APS(p_G - p_C) \end{aligned} \qquad \text{(C6)}$$

where x_{gdp} is the percentage change in real GDP; *int* and *ftrns* are the percentage changes in interest payments on net foreign debt and net foreign income transfers; ϕ is the percentage change in the nominal exchange rate; and p_C, p_G, p_I, p_X and p_M are the percentage changes in the price deflators for private consumption, public consumption, investment, exports and imports. The *S-terms* are the ratios to *GNDI* of *GDP* (S_{GDP}), investment (S_I), domestic savings (S_S), exports (S_X), imports (S_M), foreign debt interest payments (S_{INT}) and foreign income transfers (S_{FTRNS}). For example, $S_{GDP} = GDP / GNDI$. APS is the average propensity to save. All other variables are as previously defined.

Using equation (C6), the real consumption deviation for any given year can be decomposed into six determining factors, corresponding to six right hand side (RHS) terms of (C6). Table 2 presents such a decomposition for the year of the price spike, 2016. Starting at row (8), we see that the 2016 PHAGE result for the real consumption deviation is 0.10 percentage points higher under the "with support" scenario (row 8, column 3). Comparing rows 7 and 8, we see that the decomposition of the real consumption deviation via (C6) is close to the true PHAGE

[14] Equation (C5) is an extension of the real consumption equation (E10) of Giesecke and Tran (2010). The full derivation of equation (C5) is available in Annex 1.

result. Rows (1) to (6) allow us to understand the difference between the “with support” and “without support” values for real consumption in terms of the economic mechanisms described by the RHS terms of (C6). In row (1) we see that the real consumption loss via the negative deviation in real GDP is larger under the “with support” case. As discussed earlier in reference to Figure 6, the negative deviation in 2016 real GDP is deeper under the “with support” case because of allocative efficiency losses caused by expansion of the heavily protected paddy and rice sectors. The deeper real GDP loss under the “with support” case contributes -0.04 percentage points to the difference between the real consumption outcomes under the two scenarios (row 1, column 3). However, as discussed earlier in reference to Figure 2, the terms of trade loss under the “with support” scenario is lower than under the “without support” scenario. In Table 2, we see that differences in the terms of trade outcomes under the two scenarios accounts for +0.10 percentage points of the difference in real consumption outcomes. On their own, the real GDP and terms of trade effects account for +0.06 (= –0.04 + 0.10) percentage points of the difference between the real consumption outcomes under the two scenarios. However the total difference is +0.10 percentage points (row 8, column 3). The bulk of the remainder of the difference (+0.04 percentage points) is explained by the relative investment price effect (row 3).[15]

Earlier in our discussion, we raised the question of why the government maintains the rice tariff and price subsidies when it is well known in Philippine policy circles that removing these interventions can improve economic efficiency. Some insight into the economic arguments

[15] As explained in Giesecke and Tran (2010), this relative price effect arises from the (C6) assumption of a fixed nominal consumption share in GNDI. Under this assumption, *ceteris paribus*, a rise in the investment price relative to the consumption price must raise real consumption and lower real savings.

presented in favour of continuing the support programs is provided in Department of Agriculture (2012: 8-9), who note that certain characteristics of the world rice market (viz. foreign government interferences in its operation, a thin global rice trade relative to the volumes of domestic demands, and vulnerability to speculation and panic driven price swings) might militate against the standard economic efficiency grounds for domestic liberalisation. This argument can be viewed as a willingness on the part of policy makers to incur some allocative efficiency losses in order to secure particular benefits arising from insulating the domestic economy against disturbances in the global rice market. In these terms, the government can be viewed as purchasing insurance (for real consumption) against foreign rice price shocks by maintaining the rice support mechanisms and incurring their associated economic costs. Empirical support for this insurance interpretation of the apparent willingness on the part of policy makers to incur the costs of protection in order to secure insulation benefits is provided by Clarete *et al*. (2013). In our simulation, the government rice support program buys approximately 0.10 per cent of real consumption insulation in the face of a 2008-like rice price spike (Table 2, row 7, column 3). The cost of this insurance is the hypothetical foregone real consumption gain were the government to remove its rice support programs. We model this in Section 5, where we find that this is worth approximately 0.4 percentage points of annual real consumption.

Our discussion so far has focussed on macroeconomic outcomes, particularly as they relate to real consumption. However, food security and the alleviation of poverty are important goals of Philippine's agricultural policy (NEDA, 2011). In the next two sections we investigate distributional and food security outcomes.

4.2. Distributional results

To elucidate the distributional impacts of the external price shock, we add to the PHAGE model a multi-household top-down income/expenditure extension based on data from the 2009 Family Income and Expenditure Survey in the Philippines (NSO, 2009). Following the methodology used in Giesecke and Tran (2010), this extension utilises results for commodity prices, factor prices and factor employment from the CGE model to generate real consumption outcomes for different households groups. The PHAGE model distinguishes seven types of households: rural farming households (RFHH), rural non-farming households (RNFH) and five urban households categorised into expenditure quintiles (UHQ1 – UHQ5).

In explaining the distributional results we present two sets of results: consumption deviations for seven household types under the "with support" scenario (Figure 8), and the difference between the annual consumption deviations under the "with support" and "without support" scenarios (Figure 10). Our discussion of Figure 8 allows us to identify the economic factors determining relative income prospects under the terms of trade shock. These factors do not differ under the two scenarios, so we do not report separate results for the "without support" case. Instead, we report in Figure 10 the difference between the household consumption outcomes under the two scenarios, allowing us to focus our discussion on the effects of rice support on distributional outcomes under an environment in which imported rice prices temporarily rise sharply.

In Figure 8 we see that the spike in the world rice price generates a transitory rise in the real consumption of rural farming households, and transitory falls in the real consumption of urban households and rural non-farming households. The relative consumption outcomes for these households reflect differences in household income and expenditure shares. Starting with the income side of the household budget, data from NSO (2009) show rural farming households derive a high share of their income from agricultural activities, particularly paddy farming. As the world rice price shock generates a positive deviation in output of paddy agriculture (Figure 9) it causes the real wage of agricultural labour and rates of return on paddy land to rise relative to baseline. This increases the incomes of rural farming households relative to baseline. In comparison, households living in urban areas derive relatively larger shares of their income from non-agricultural capital and labour. In Figure 9 we see that the rise in the world rice price causes a transitory contraction in the output of sectors not directly related to agriculture. This leads to a negative deviation in the real wage of non-agriculture labour and rates of return on non-agricultural capital during the year of the rice price spike. These income sources figure prominently in the budgets of urban households, contributing to the negative deviations in real consumption for these households reported in Figure 8. In Figure 8 we also find that rural non-farming households experience a negative deviation in real consumption, but of a magnitude approximately two-thirds that of urban households. This is because, while not as high as rural farming households, wage and capital income from rice agriculture activities represent a higher share of the incomes of rural non-farming households than they do of urban households.

Our discussion of Figure 8 has so far focussed on household income. However, the rice price spike also affects real consumption through household expenditure. In particular, food items represent higher shares of the household budgets of low income households than they do of high income households. As we shall see, in reference to our discussion of Figure 13, the rise in the imported rice price causes a rise in the general price of food items. Via the expenditure share effect alone, we would expect the rise in food prices to generate the largest negative real consumption deviations for the poorest households (in particular, rural farming households, and quintiles 1 and 2 of the urban households). However, for rural farming households, the expenditure share effect is more than offset by the positive income effect of higher farm incomes. This accounts for the net positive deviation in the real consumption of these households. For urban households, the combined effects of falling household income and increasing food prices cause their real consumption to fall relative to baseline (Figure 8). Across the urban household groups, relative outcomes are influenced by income shares. In particular, while urban quintiles 1 and 2 have, as poor households, relatively high shares of their expenditure accounted for by rice, we nevertheless see in Figure 8 that they experience negative real consumption deviations that are slightly less severe than those experienced by other urban households. Urban quintiles 1 and 2, despite being urban, receive some income from supplying unskilled labour to agriculture.

Figure 10 reports the percentage point difference in household-specific real consumption deviations under the two baseline scenarios. An interesting result is that rural farming households experience a smaller deviation in their real consumption under the "with support" case relative to the "without support" case. This reflects the relative scale of agricultural activity under the two baselines, with the agricultural sector smaller under the "without support" scenario. When rice prices spike, a smaller agricultural sector is thus exposed to the full (i.e. non-tariff mediated) effects of the rise in imported rice prices. This generates a greater percentage increase in farm incomes under the "without support" case relative to the "with support" case.

4.3. Food security results

We include in PHAGE four measures of food security: (i) the household food cover index (HFCI); (ii) the rice self-sufficiency index (RSSI), (iii) the food trade balance index (FTBI), and (iv) the household calorie intake index (HCII). The HFCI is a measure of the ability of households to meet their food expenditure requirements out of current income, calculated as the ratio of total household expenditure to the value of household spending on all food and drink items (Giesecke *et al*. 2013). The RSSI is an indicator used by the Philippine Department of Agriculture to gauge domestic food shortages and surpluses (BAS, 2013). This index measures the share of domestic rice consumption satisfied by domestic rice production. The FTBI is used by the Food and Agriculture Organization (FAO, 2003) for evaluating the food security impacts of trade reforms, particularly in net food importing countries. This index measures the country's financial capacity to secure its domestic food requirements through its export earnings (Ecker *et al.*, 2010). The HCII has been widely used as an indicator of food security at the household level (FNRI, 2010). This index measures the changes in household calorie intake associated with the price-induced changes in the quantity of food consumed by households. Using these measures, Figures 11 and 12 report the impacts on our food security indices of a temporary rise in the rice import price. For each index, a negative deviation indicates deterioration in food security relative to baseline.

The price shock generates negative deviations in the HFCI, with the deviation deepest under the "without support" baseline (Figure 11). The price shock generates a fall in the HFCI numerator (aggregate household consumption) and a rise in the HFCI denominator (household food consumption). In Figure 7 we see that the negative deviation in household consumption is deeper under the "without support" scenario. Ceteris paribus, this contributes to the deeper negative deviation of the HFCI in Figure 11. This is reinforced by the positive deviation in the denominator of the HFCI, which is higher under the “without support” scenario. In Figure 13, we see positive deviations in the aggregate food price, and negative deviations in real food consumption. Food demand is price inelastic, leading to a rise in total food spending as the food price rises. The positive deviation in the price of food is greater under the “without support” scenario, leading to a higher positive deviation in total food expenditure under this scenario relative to the “with support” case.

Figure 12 reports results for the FTBI, which measures the ratio of total export earnings to the food import bill. The rise in the price of imported rice causes a short-run increase in the country’s food import bill, generating a short-run negative deviation in the FTBI. The negative deviation in this index is greater under the “without support” scenario, reflecting the higher rice share in the food import bill relative to the “with support” case.

The price shock generates a reduction in the calorie intake of households as illustrated in Figure 12. In Section 2.1 we described the modelling of household food demand within PHAGE as nested Klein-Rubin / CRESH. Household staples (rice, unmilled corn, milled corn, legumes, tubers and root vegetables) account for 70% of household calorie intake (FNRI, 2010). Hence, in understanding the result for household calorie intake, it is important to examine outcomes within the staples nest of the household consumption system. Figure 14 reports deviations in the quantity of household rice consumption and real (consumption value weighted) consumption of non-rice staple commodities. The spike in the price of imported rice causes a significant reduction in rice consumption (Figure 14). This reduction is greater under the “without support” scenario. The rise in the price of rice relative to other staples generates substitution towards non-rice staples (Figure 14). In parameterising the broad food nests, we were guided by estimates of own-price elasticities for the major food groups from Balisacan (1994) and Lantican *et al*. (2001). In parameterising the staples nest, we were guided by estimates of cross-price elasticities and the own price elasticity for rice from Balisacan (1994). Under this system, substitution possibilities between rice and other staples are higher than other food substitution possibilities outside the food staple bundle. In Figure 14, we see this expressed as a large positive deviation in non-rice staple food demand relative to non-staple food demand as households substitute away from rice. Despite the increase in demand for non-rice foods, with the significant fall in rice consumption, the net impact on calorie intake is negative (Figure 12). The loss in calorie intake is greatest under the "without support" scenario (Figure 12), reflecting the deeper negative deviation in rice consumption under this scenario (Figure 14).

While the results for the HFCI, FTBI and calorie intake indicators all signal a deterioration in food security, this is not the case for the RSSI (Figure 11). The RSSI is measured by the ratio of domestic rice production to domestic rice consumption. As reported in Figure 15, the rice import price shock encourages domestic rice production (the RSSI numerator) while discouraging domestic rice consumption (the RSSI denominator). This accounts for the positive deviation in the RSSI (Figure 11). The production-promoting and consumption-discouraging effects of the price rise are greater in the absence of support (Figure 15) leading to a greater positive deviation in the RSSI under the "without support" scenario relative to the "with support" scenario (Figure 11). As a static indicator of an economy's ability to absorb shocks to food availability, the RSSI may have its uses, but as a deviation measure of food security, we should interpret with caution an index that signals an improvement in food security when food prices rise.

5. The economic cost to the Philippines of rice market protection

By damping adverse real consumption and food security impacts, our discussion in Section 4 suggests that the presence of ongoing support policies for domestic rice production can be beneficial in the event of an unanticipated shock to the imported price of rice. However, the rice support policies also generate ongoing costs to the Philippines. To quantity the economic costs of rice price subsidies and rice import tariffs, we undertake a separate PHAGE simulation in which we remove these support mechanisms in 2013. In Figure 16, we present a decomposition of the real GDP effects of this simulation, using equations (C.1), (C.2), (C.3), (C.7) and (C.8).

The removal of the rice tariff and domestic price subsidies generates a positive deviation in real GDP (Figure 16). In the first year, the positive deviation in real GDP is just over 0.2 per cent, but in the medium to long-run, builds to approximately 0.4 per cent. Approximately three quarters of the long-run real GDP increase is attributed to primary factor inputs. More specifically, the removal of the government rice support mechanisms generates positive deviations in employment in the short-run, and the capital stock in the long-run. By encouraging land to move out of low-rent paddy agriculture and into higher valued uses, land also makes a positive contribution to the real GDP deviation reported in Figure 16. Removal of the price distortions in rice production, rice consumption and rice importation also contributes to the positive deviation in real GDP via an improvement in allocative efficiency. In Figure 16, the gain in allocative efficiency is divided into two components: a direct effect, generated in the markets directly affected by the policy interventions; and an indirect effect, arising from policy-induced movements in tax bases outside the rice and paddy sectors. Specifically, we define the direct allocative efficiency effect, $dae_{(2)}^{(t)}$, from removal of the rice import tariff and domestic price subsidies as:[16]

$$\begin{aligned}\frac{dae_{(2)}^{(t)}}{100} = {} & \frac{VTAX_{paddy,1,paddy,1}^{(B)(t)}}{VGDP^{(B)(t)}}\left[\frac{X_{paddy,1,paddy,1}^{(P)(t)} - X_{paddy,1,paddy,1}^{(B)(t)}}{X_{paddy,1,paddy,1}^{(B)(t)}}\right] \\ & + \frac{VTAX_{paddy,1,rice,1}^{(B)(t)}}{VGDP^{(B)(t)}}\left[\frac{X_{paddy,1,rice,1}^{(P)(t)} - X_{paddy,1,rice,1}^{(B)(t)}}{X_{paddy,1,rice,1}^{(B)(t)}}\right] \\ & + \sum_{s=1}^{2}\frac{VTAX_{rice,s,1}^{(B)(t)}}{VGDP^{(B)(t)}}\left[\frac{X_{rice,s,1}^{(P)(t)} - X_{rice,s,1}^{(B)(t)}}{X_{rice,s,1}^{(B)(t)}}\right] \\ & + \frac{VTAX_{rice,2,i,1}^{(B)(t)}}{VGDP^{(B)(t)}}\left[\frac{X_{rice,2,i,1}^{(P)(t)} - X_{rice,2,i,1}^{(B)(t)}}{X_{rice,2,i,1}^{(B)(t)}}\right] + \frac{VTAX_{rice,2}^{(B)(t)}}{VGDP^{(B)(t)}}\left[\frac{X_{rice,2}^{(P)(t)} - X_{rice,2}^{(B)(t)}}{X_{rice,2}^{(B)(t)}}\right]\end{aligned} \tag{C.7}$$

We define the indirect allocative efficiency effect, $iae^{(t)}$, as:

$$iae^{(t)} = ae^{(t)} - dae_{(2)}^{(t)} \tag{C.8}$$

As is clear from the result for $dae_{(2)}^{(t)}$ reported in Figure 16, the bulk of the allocative efficiency effect arises from the removal of price distortions in the markets for imported and domestically produced rice. Figure 16 also reports the deviation in real consumption. Consistent

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[16] Note that $dae_{(1)}^{(t)}$ and $dae_{(2)}^{(t)}$ differ because they are tailored to measure the allocative efficiency effects of two different simulations. Our first simulation (Section 4) is about the spike in the price of imported rice. This shock affects all rice and paddy transactions (i.e., production, consumption, investment, exports and imports). Hence, the tax bases related to these transactions appear on the right hand side of our calculation of $dae_{(1)}^{(t)}$. Our second simulation (Section 5) is about the removal of four types of tax/subsidy: (1) rice import tariff, (2) rice price subsidy to consumers, (3) paddy price subsidy to producers, and (4) seed input subsidy to paddy farmers. The calculation of $dae_{(2)}^{(t)}$ includes only those tax bases related to these policy-specific transactions, i.e. (1) rice import purchases by households, (2) rice purchases by the household sector, (3) paddy purchases by the rice milling sector, (4) seed purchases by the paddy sector.

with equation (C6), the real consumption deviation broadly tracks the real GDP deviation. On average, over the simulation period, the potential gain in real consumption from removing the support programs is approximately 0.4 per cent of baseline consumption, every year. In comparison, the price insulation benefit of retaining the support programs, in the event of a 2008-like import price spike, is 0.10 per of baseline real consumption, in the event year only (see Figure 7).

6. Conclusion

Philippine policy makers understand that their interventions in the domestic rice market carry economic costs. Despite these costs, food security objectives have been advanced as justification for maintenance of the programs. The degree to which rice market support programs advance Philippine food security under business-as-usual conditions for world rice prices has been examined elsewhere (for example, Mariano and Giesecke 2014). In this paper, we have investigated a different dimension to the food security argument: by examining the insulation effects of maintenance of *in-situ* rice tariffs and production and consumption subsidies when imported rice prices experience a sharp transient rise, we elucidate the food security case for rice market support programs as insurance against price events outside business-as-usual conditions. Support for this interpretation of the Philippine's food security policy motivation for rice market intervention can be found, for example, in SEPO (2010), Intal *et al.* (2012) and Department of Agriculture (2012). Similar policy motivations for ongoing rice market interventions in Indonesia, Japan and other Southeast Asian countries have been noted by Trethewie (2012), Tanaka and Hosoe (2011) and Clarete *et al.* (2013).

We investigate the effects of given rice market interventions outside of business-as-usual conditions by constructing two baseline simulations with a detailed dynamic CGE model: one in which current rice market interventions remain in place (the “with support” case), and one in which they are permanently removed (the “without support” case). Both baseline simulations are then subject to the same shock: a 2008-like increase in the foreign price of imported rise. We measure the insulation effects of the existing price subsidies and trade protection by comparing the effects of the price spike shock under the two alternative baselines. We find that the economy is more insulated from the price spike under the “with support” case, for example, reducing the real consumption loss from a 2008-like event by approximately 0.10 per cent relative to the “without support” case. Our results also show that under the “with support” case, households are less vulnerable to becoming food insecure in the event of a sudden spike in the imported price of rice. However, the cost of insuring against these price spikes is significant. By leaving these programs in place, we find that the Philippines is foregoing a potential increase in real consumption of approximately 0.4 per cent per annum. While it is ultimately for policy makers to judge, this would appear to be a very high ongoing price to pay for the benefit of mitigating the consumption loss associated with a 2008-magnitude rice price event.

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Figure 1. Prices of imported rice from 2000 to 2012 (BAS, 2012).

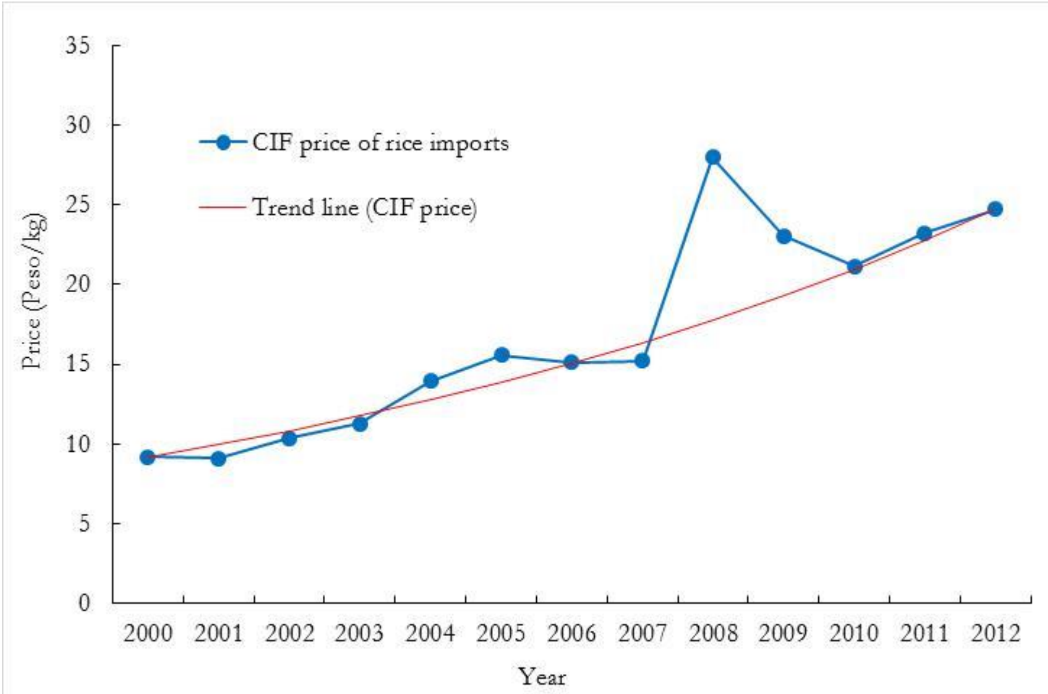

Figure 2. Changes in the country's terms of trade under two baseline scenarios *(percentage deviation from baseline forecast)*

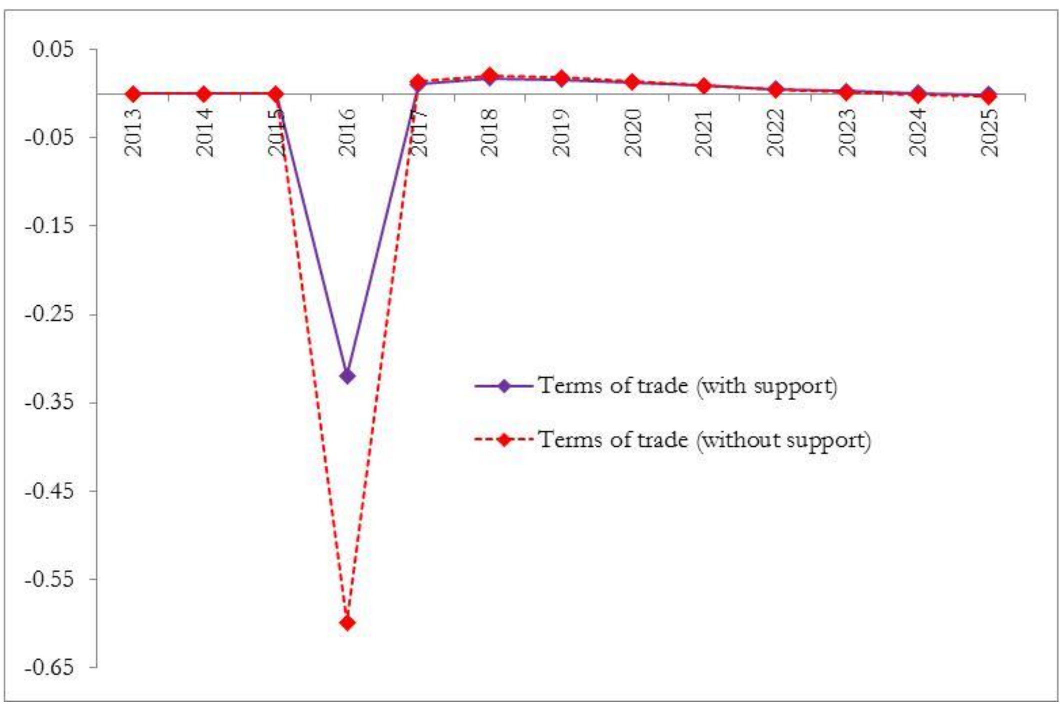

Figure 3. Changes in capital stock, rates of return on capital and real investment under two baseline scenarios *(percentage deviation from baseline forecast)*

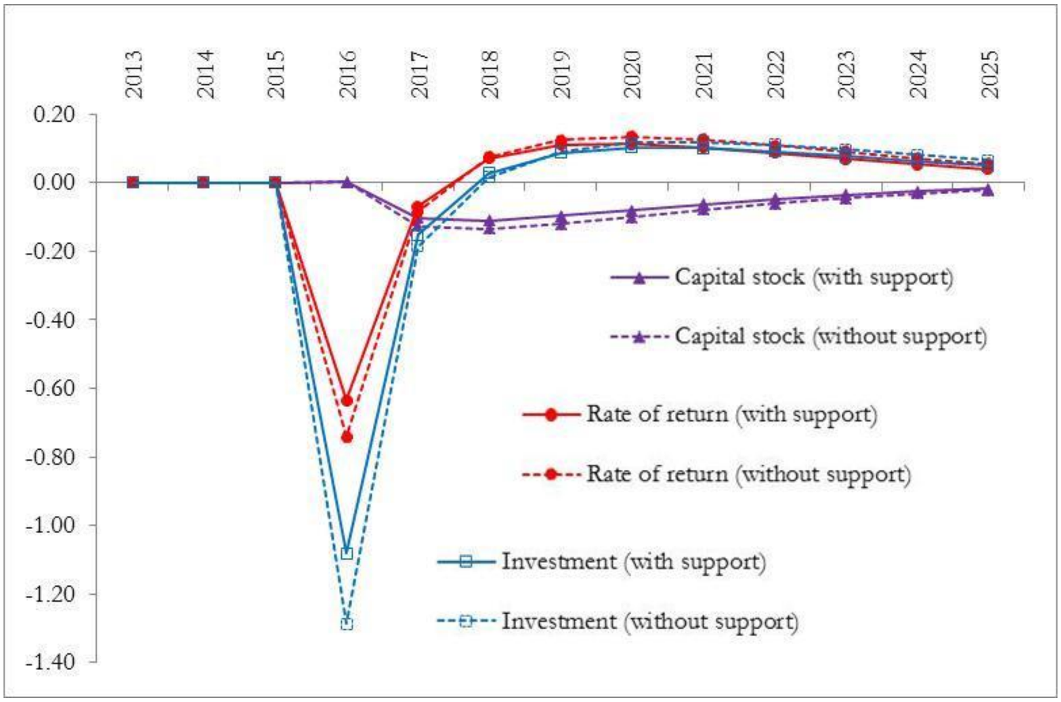

Figure 4. Changes in aggregate employment (wage bill-weighted) and real producer wage under two baseline scenarios *(percentage deviation from baseline forecast)*

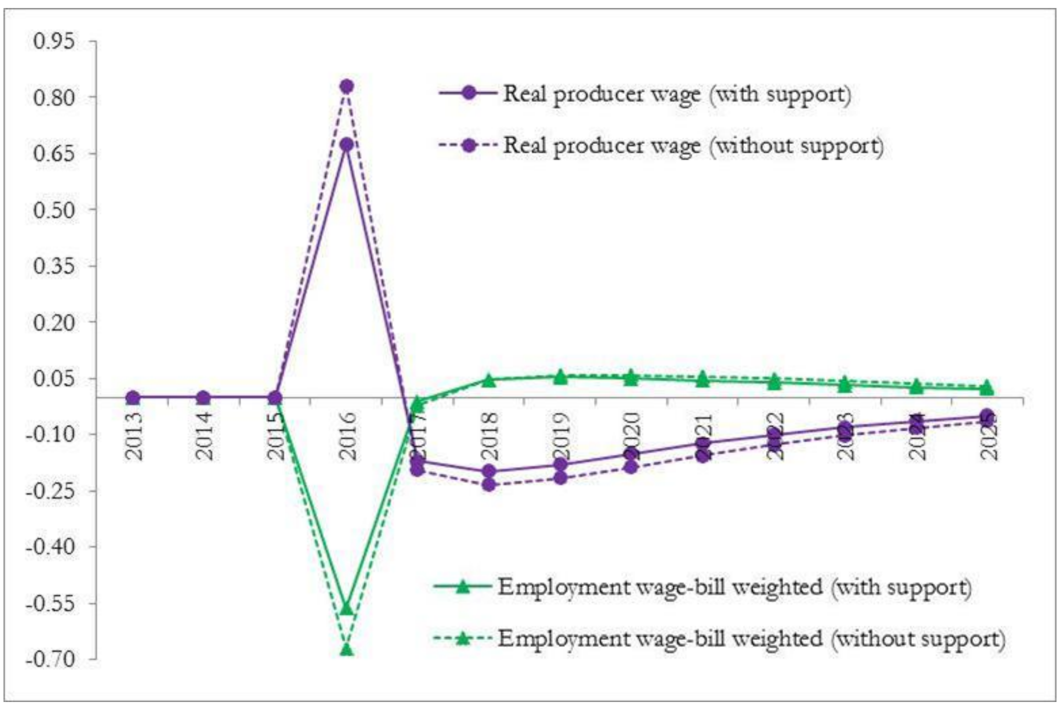

Figure 5. Changes in the supply of paddy land, non-paddy land and aggregated land under two baseline scenarios *(percentage deviation from baseline forecast)*

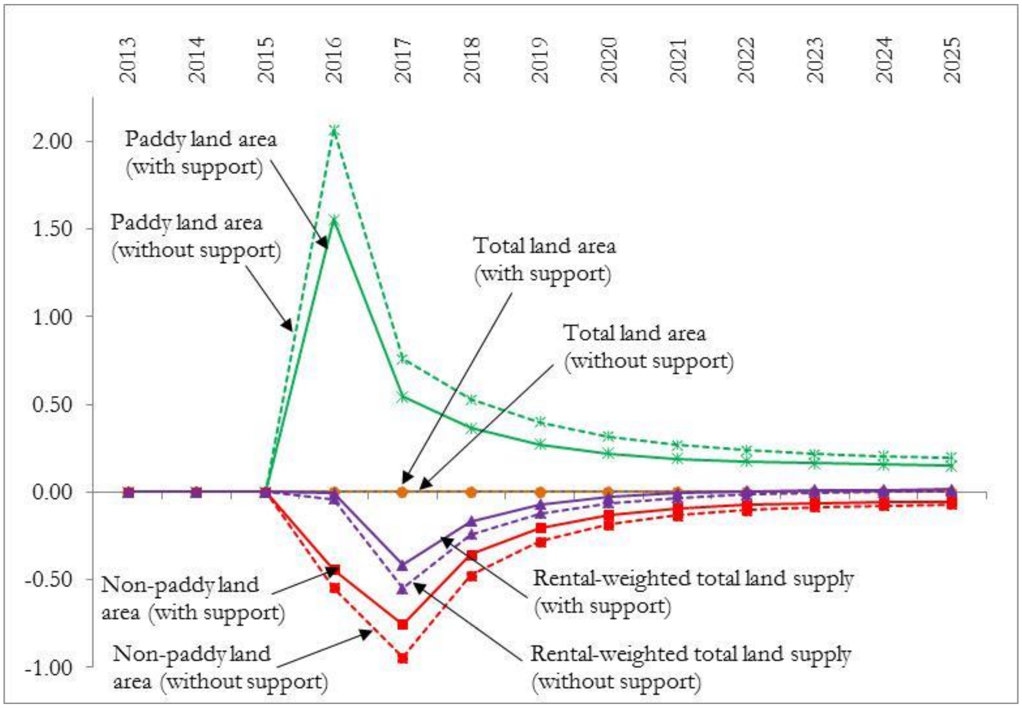

Figure 6. Changes in allocative efficiency and real GDP under two baseline scenarios *(percentage deviation from baseline forecast)*

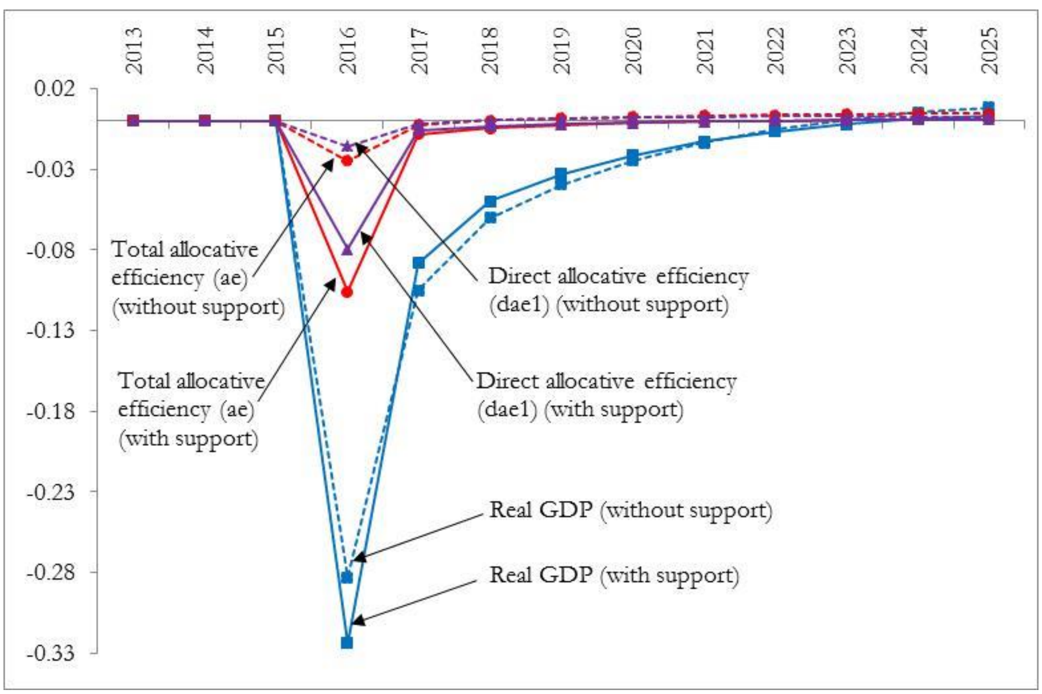

Figure 7. Changes in real household consumption and real GDP under two baseline scenarios *(percentage deviation from baseline forecast)*

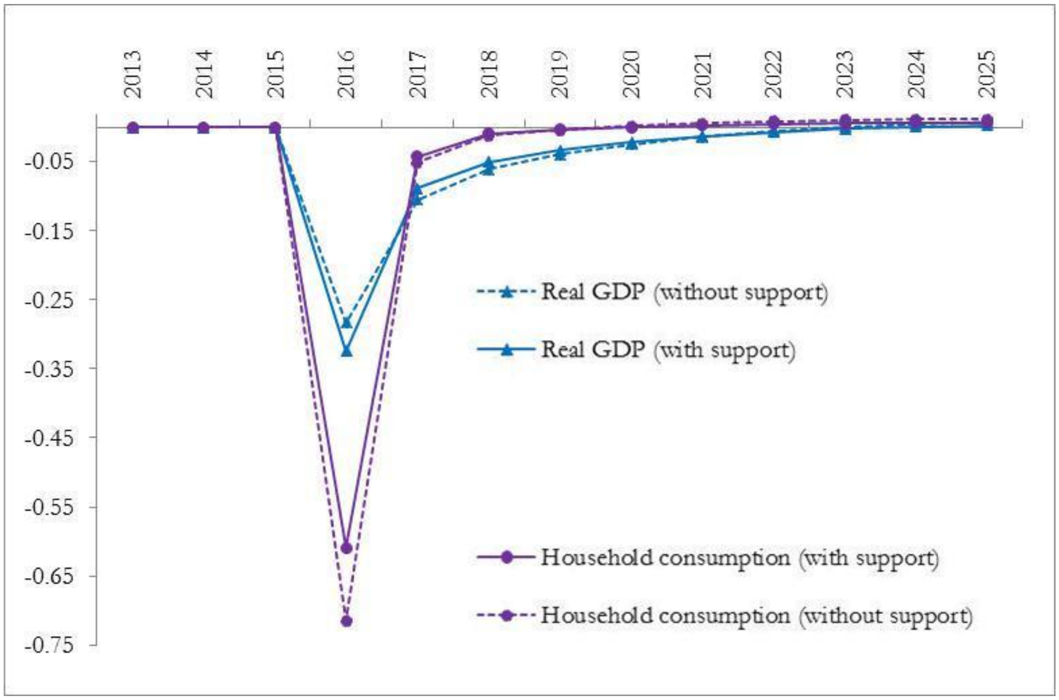

Figure 8. Real consumption of seven household groups ("with support" case) *(percentage deviation from "with support" baseline)*

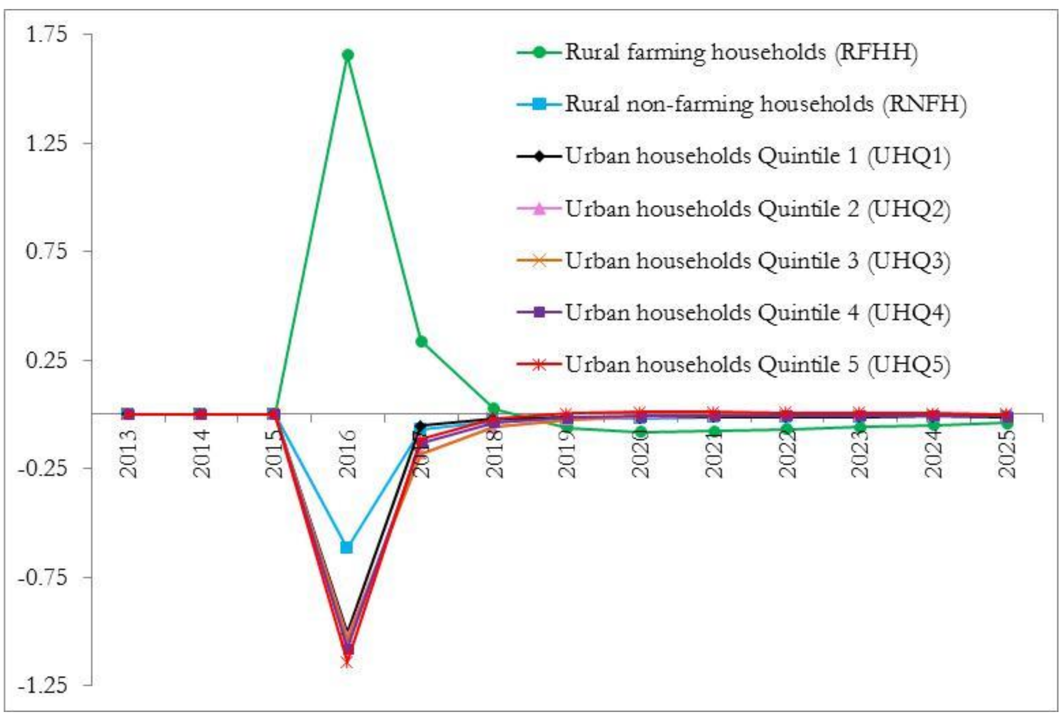

Figure 9. Sectoral output deviations ("with support" case) *(percentage deviation from "with support" baseline)*

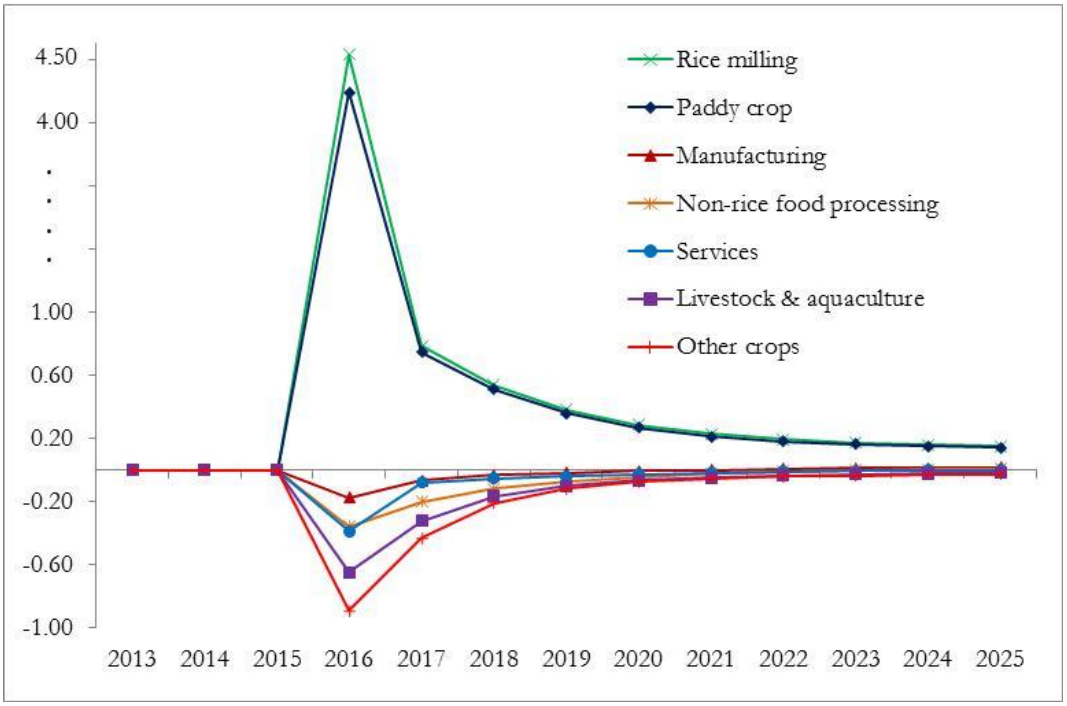

Figure 10. Difference in real consumption deviations under the "with" and "without" support cases *(percentage point difference: "with support" deviation – "without support" deviation)*

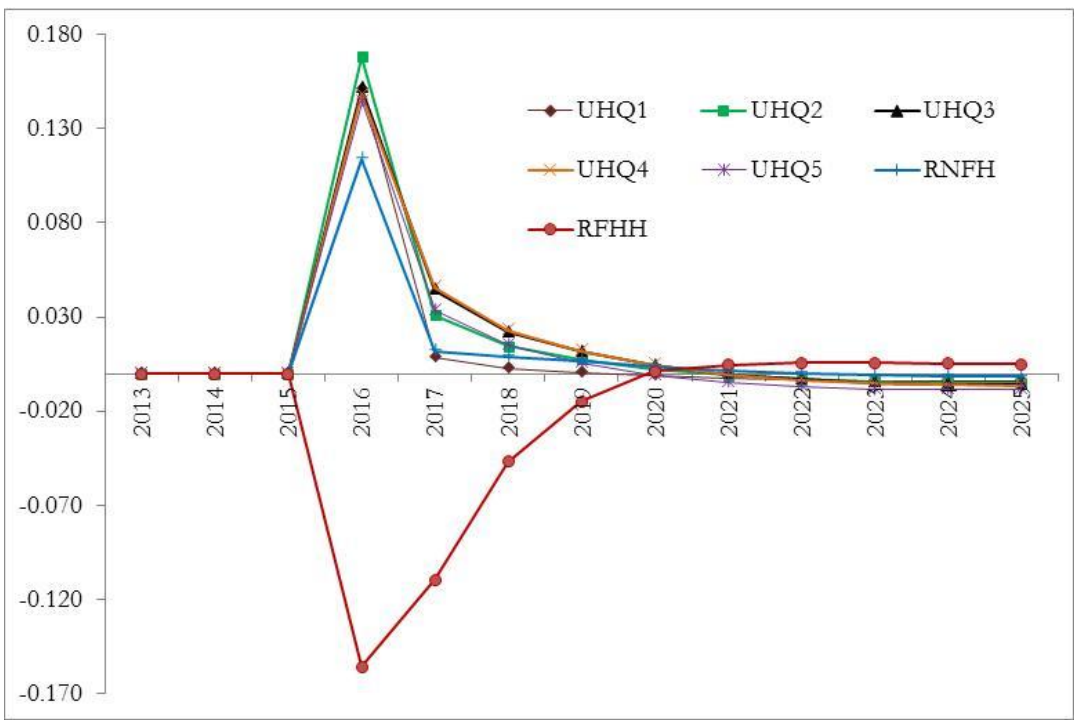

Figure 11. Changes in the household food cover index and rice self-sufficiency index under two baseline scenarios *(percentage deviation from baseline forecast)*

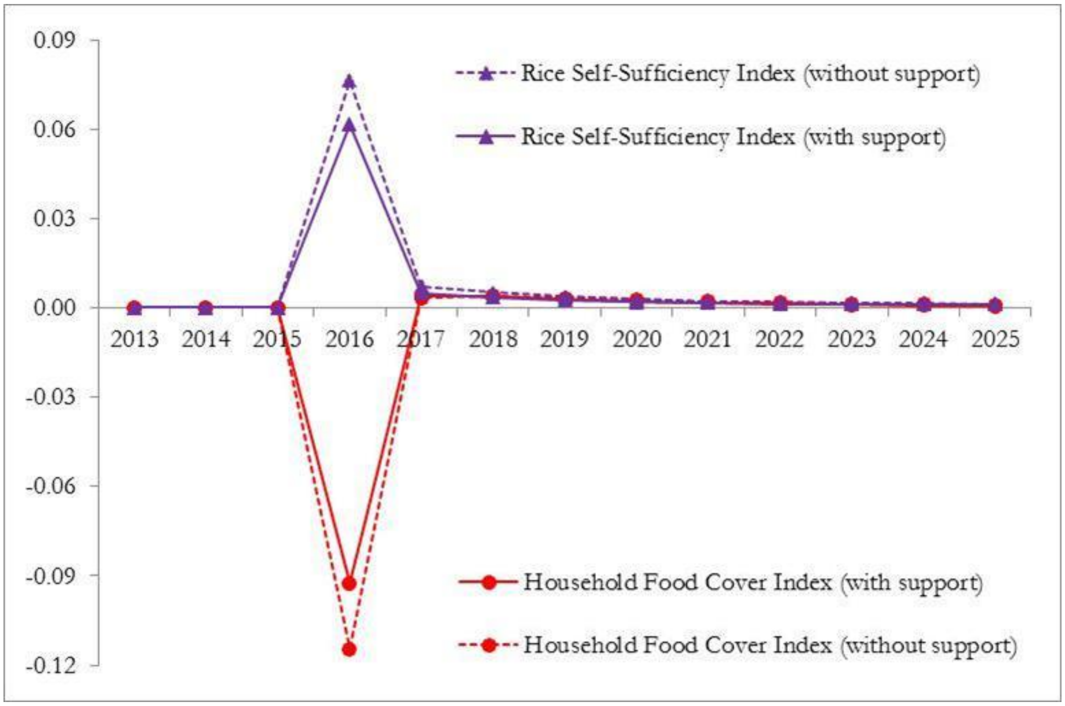

Figure 12. Changes in the food trade balance index and household calorie intake under two baseline scenarios *(percentage deviation from baseline forecast)*

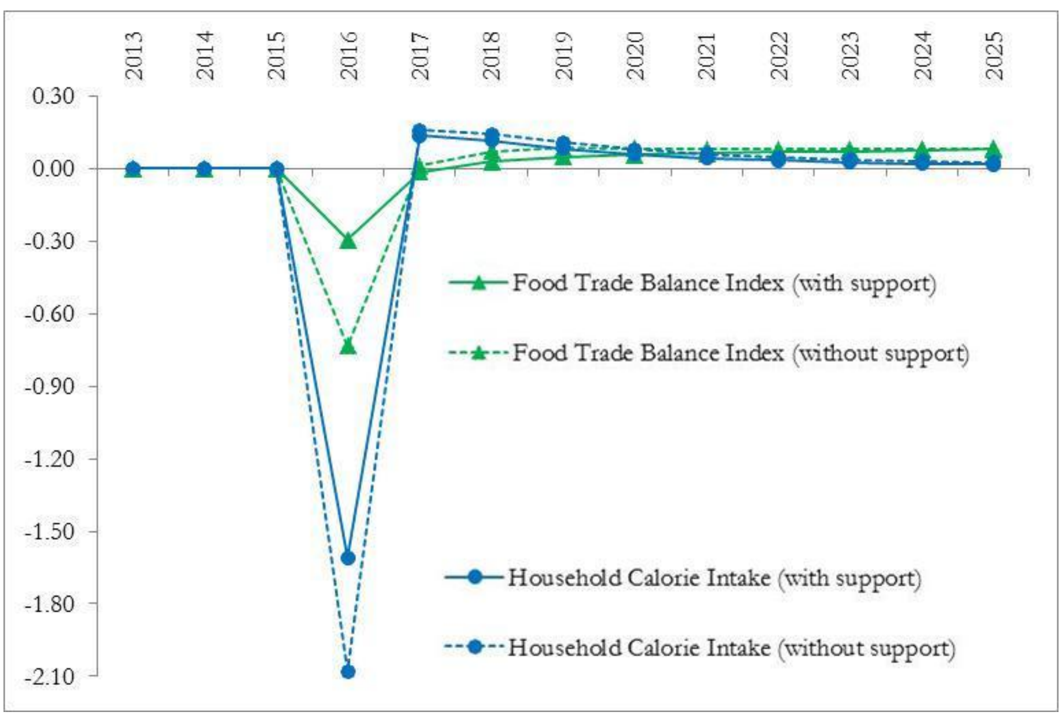

Figure 13. Changes in real rice consumption, real food consumption, rice prices and food prices under two baseline scenarios *(percentage deviation from baseline forecast)*

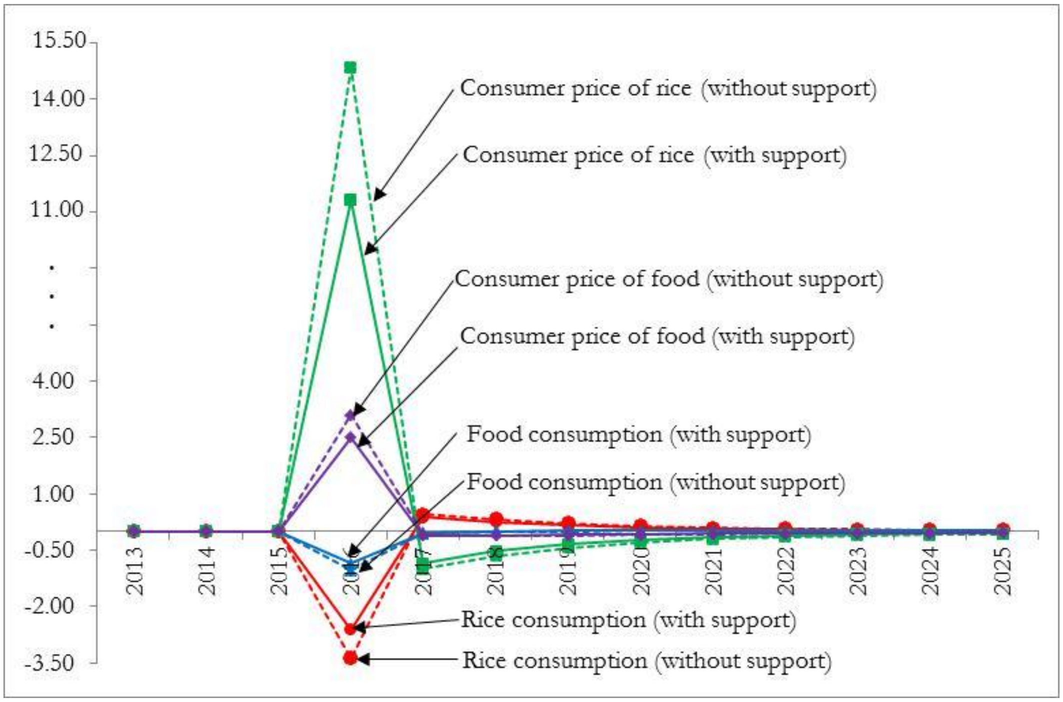

Figure 14. Changes in food consumption (rice, non-rice staple foods, and non-staple foods) under two baseline scenarios *(percentage deviation from baseline forecast)*

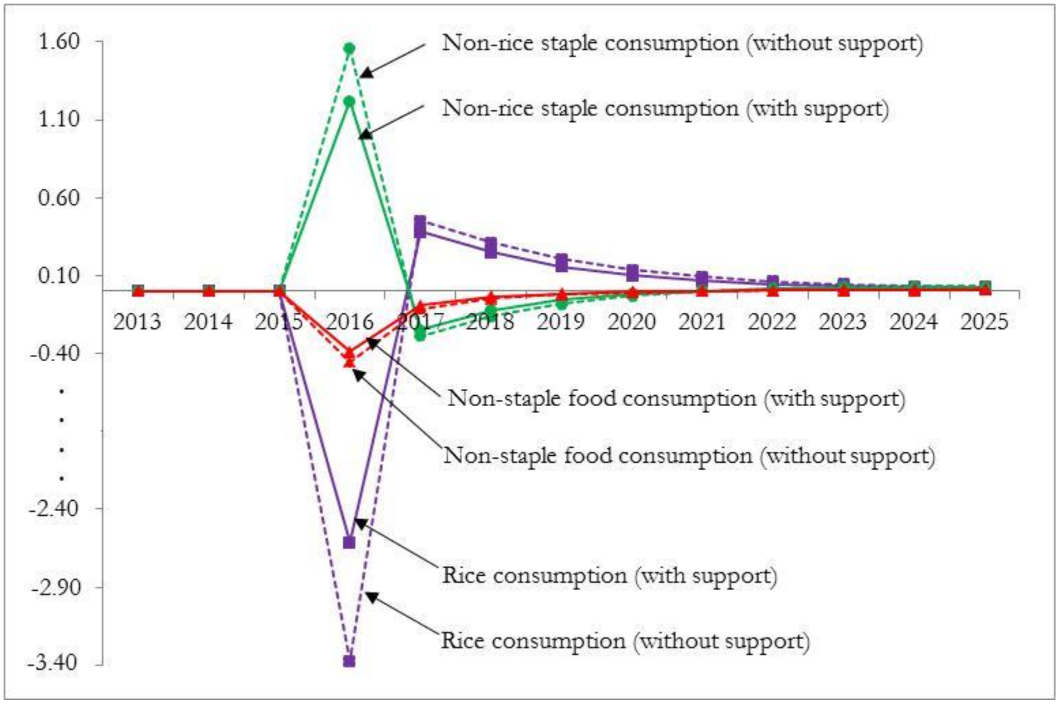

Figure 15. Changes in domestic rice production and domestic rice consumption under two baseline scenarios *(percentage deviation from baseline forecast)*

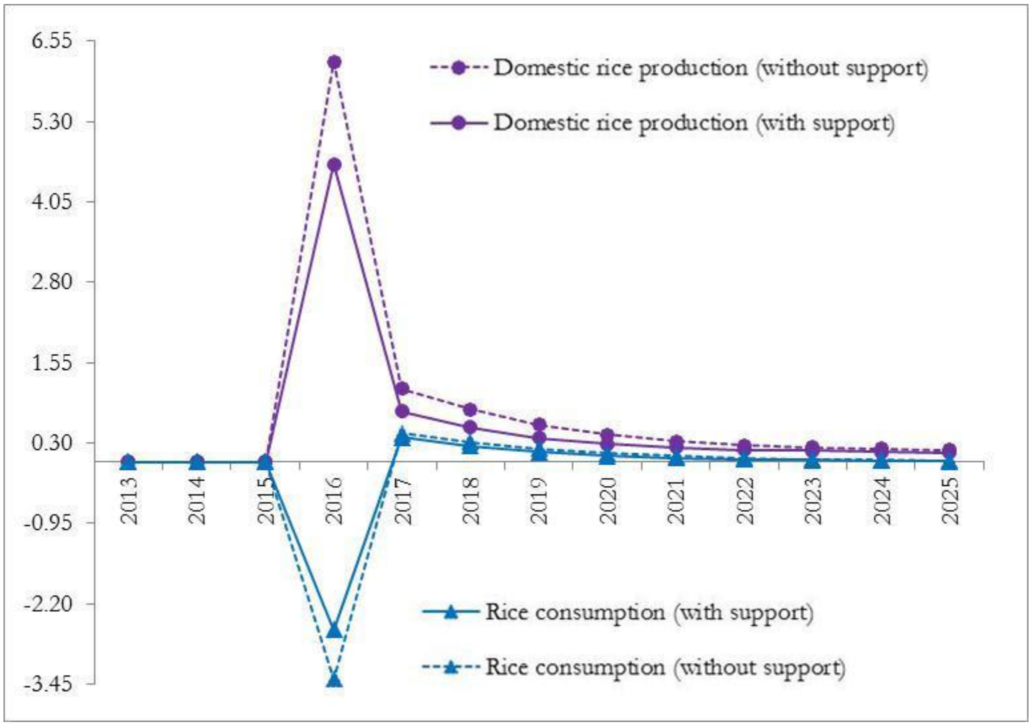

Figure 16. Real GDP decomposition and real consumption deviation *(percentage deviations relative to baseline forecast)*

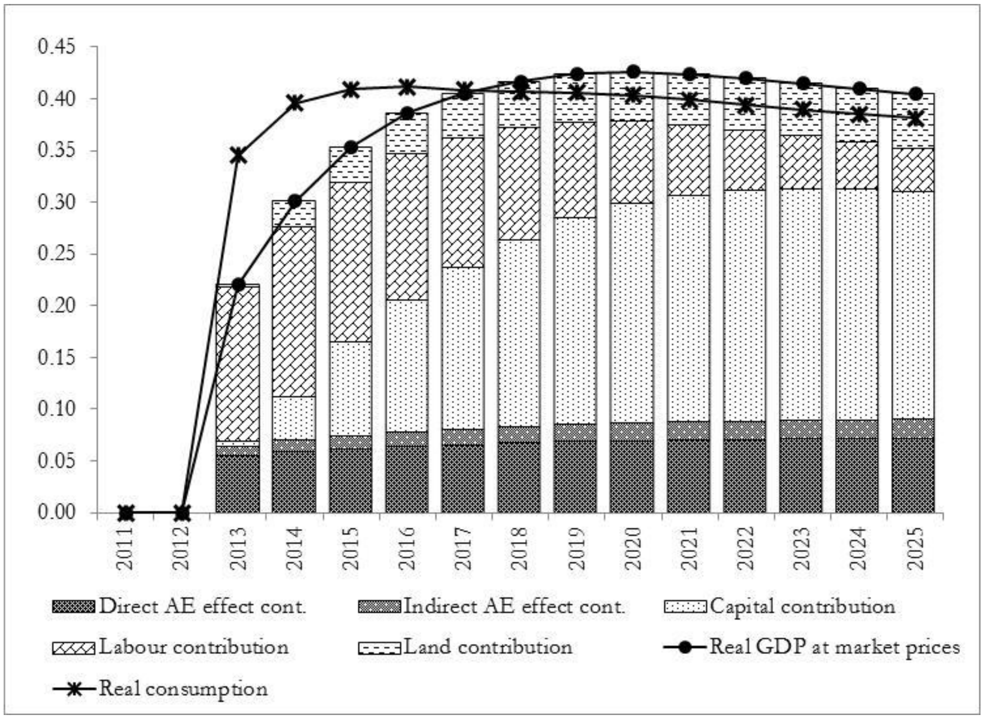

Table 1. A stylised representation of the main macroeconomic relationships in PHAGE model.

Back-of-the-envelope (BOTE) equations	
(E1) GDP = C + I + G + (X – M)	(E7) $P_X = f_4(X)$
(E2) GDP = $\mathbf{A}*f_1(K, L, \mathbf{N})$	(E8) TofT = $f_5(P_X/\mathbf{P_M})$
(E3) GNDI = $GDP*f_2(TofT) - \mathbf{NFL}*\mathbf{R} + \mathbf{FTRNS}$	(E9) ROR=$f_6(K/L, \mathbf{A}, TOT)$
(E4) C+G = **APC***GNDI	(E10) **RW**=$f_7(K/L, \mathbf{A}, TOT)$
(E5) C/G=**RCG**	(E11) I = $f_8(ROR/\mathbf{F_I})$
(E6) M = $f_3(GDP, TofT)$	(E12) K = $\mathbf{K_{t-1}}(1-\mathbf{D}) + \mathbf{I_{t-1}}$

Definition of variables:

A – primary factor augmenting technical change	L – employment (wagebill-weighted)
APC – average propensity to consume	M – real imports
C – real private consumption	**NFL** – real (consumption price deflated) net foreign liabilities
D – depreciation rate	$\mathbf{P_M}$ – foreign currency import price
$\mathbf{F_I}$ – normal rate of return	P_X – foreign currency export price
FTRNS – real (consumption price deflated) foreign income transfers to households and government	**R** – rate of interest on net foreign liabilities
G – real public consumption	**RCG** – ratio of private to public consumption
GDP – real gross domestic product	ROR – rate of return on capital
GNDI – real (consumption price deflated) gross national disposable income	**RW** – real (CPI-deflated) wage
	TOT – terms-of-trade
I, $\mathbf{I_{t-1}}$– real investment in year t and t-1, respectively	X – real exports
K, $\mathbf{K_{t-1}}$ – capital stock in year t and t-1, respectively	**N** – land input (rental-weighted)

Notes: Variables in bold denote exogenous. The BOTE closure relates to the short-run because the rice price spike is temporary. NFL is endogenous in PHAGE, but we suppress the details of its determination in BOTE, and thus represent it as exogenous. RW is also endogenous in PHAGE, but short-run movements in its value are constrained by an assumption of stickiness in the real consumer wage. We suppress the PHAGE sticky wage mechanism in our BOTE description, but represent the mechanism's short-run operation by the exogenous status of RW. Aggregate land supply (area) is exogenous in PHAGE. We represent this by the exogenous status of N in BOTE. However we note that land can move between agricultural uses with different rental weights, providing for the possibility of small movements in the value of N in PHAGE.

Table 2. Decomposition of 2016 real consumption deviation under two baseline scenarios

Consumption factors	Equation (C) RHS term:	Real consumption impacts: (1) With Support	(2) Without support	(3) Difference = (1)-(2)
(1) Real GDP effect	$S_{GDP}*x_{gdp}$	-0.323	-0.282	-0.041
(2) Terms-of-trade effect	$S_x(p_x - p_c) - S_m(p_m - p_c)$	-0.110	-0.212	0.102
(3) Investment price effect	$S_i(p_i - p_c)$	-0.165	-0.204	0.040
(4) Foreign debt effect	$-S_{int}(netdebt - phi - p_c)$	-0.010	-0.012	0.002
(5) Foreign transfer effect	$S_{trn}(transfer - p_c)$	-0.003	-0.004	0.001
(6) Government price effect	$-(G/C+G)APS(p_g - p_c)$	0.000	0.000	0.000
Aggregate real consumption deviation:				
(7) Via equation (C5) = (1)+(2)+(3)+(4)+(5)+(6)		-0.611	-0.714	0.103
(8) 2016 PHAGE model simulation result (see Figure 7)		-0.610	-0.715	0.105
(9) Difference = (8) – (7)		0.001	-0.001	0.002

Annex 1. Derivation of the real consumption decomposition

In the PHAGE model, the nominal economy-wide consumption spending is tied down by the nominal gross national disposable income. In levels form, this relationship is represented in the model as:

$$C + G = APC \cdot GNDI \qquad \text{(I.1)}$$

where *C* is nominal private consumption, *APC* is the average propensity to consume and *GNDI* is the nominal gross national disposable income. The percentage change form of (I.1) is given as:

$$C\left(p_c + x_c\right) + G\left(p_g + x_g\right) = \left[C + G\right]\left(\omega + gndi\right) \qquad \text{(I.2)}$$

where *C* and *G* are the nominal values of private and public consumption, x_c and x_g are the percentage changes in real private and public consumption, p_c and p_g are the percentage changes in private and public consumption deflators, ω is the percentage change in the average propensity to consume and *gndi* is the percentage change in the nominal gross national disposable income. GNDI is determined in the model by the percentage change equation:

$$GNDI \cdot gndi = GDP\left(p_{gdp} + x_{gdp}\right) - INTint + TRNtrn \qquad \text{(I.3)}$$

where the lower-case notations are percentage changes of nominal gross national disposable income(*gndi*) , real GDP (x_{gdp}), price deflator for GDP (p_{gdp}), total interest payments on net foreign debt (*int*), and foreign income transfers (*trn*). Substituting equations (I.3) into (I.2), and noting that APC = (C+G)/GNDI (from equation I.1), we have:

$$C(x_c + p_c) + G(x_g + p_g) = [C+G]\omega + APC\begin{bmatrix} GDP(x_{gdp} + p_{gdp}) \\ -INTint + TRNtrn \end{bmatrix} \qquad \text{(I.4)}$$

In the PHAGE model, the consumer price index (p_c) is set as the numeraire. Hence, we can express equation (I.4) in such a way that all variables are normalised with respect to p_c. To do this, we add the term $-p_c + p_c$ to both sides of the equation. That is,

$$\begin{aligned} &C(x_c + p_c - p_c + p_c) + G(x_g + p_g - p_c + p_c) \\ &\quad = [C+G]\omega + APC\begin{bmatrix} GDP(x_{gdp} + p_{gdp} - p_c + p_c) \\ -INT(int - p_c + p_c) + TRN(trn - p_c + p_c) \end{bmatrix} \end{aligned} \qquad \text{(I.5)}$$

In the policy closure, real public consumption is assume to move with real private consumption via a fixed expenditure ratio. Hence, we can substitute x_g with x_C in the last expression above. With some re-arranging, equation (I.5) becomes:

$$\begin{aligned} [C+G]x_c &= APC\left[GDP(x_{gdp} + p_{gdp} - p_c) - INT(int - p_c) + TRN(trn - p_c)\right] \\ &\quad + [C+G]\omega - G(p_g - p_c) + p_c\left\{APC(GDP - INT + TRN) - C - G\right\} \end{aligned} \qquad \text{(I.6)}$$

From equation (I.1), C+G = APC*GNDI=APC*(GDP-INT+TRN). Hence, equation (I.6) can be simplified into:

$$[C+G]x_c = APC\begin{bmatrix} GDP(x_{gdp} + p_{gdp} - p_c) \\ -INT(int - p_c) + TRN(trn - p_c) \end{bmatrix} - G(p_g - p_c) + [C+G]\omega \qquad \text{(I.7)}$$

The percentage change in *GDP* price deflator p_{gdp} can be expanded into the following form:

$$GDP p_{gdp} = C p_C + I p_I + G p_G + X p_X - M p_M \tag{I.8}$$

where I, X and M are nominal investment, export and import, respectively; and p_I, p_X and p_M are the percentage changes in the price index for investment, exports and imports, respectively

Also, the interest payment variable is defined in the PHAGE model as:

$$INT = \left(NFL \cdot \Re\right) / \Phi \quad \xrightarrow[\text{percentage change form}]{\text{convert to}} \quad int = nfl - \phi \tag{I.9}$$

where NFL is the net foreign liability or debt in foreign currency terms, $\Re$ is the interest rate on that debt and Φ is the nominal exchange rate. Note that $\Re$ is exogenously set in the model so we can drop this variable in the percentage change form of equation (I.9).

Substituting (I.8) and (I.9) into (I.7), and with some re-arranging, we have:

$$\begin{aligned}
[C+G]x_C &= APC \cdot GDP x_{GDP} + APC \cdot I(p_I - p_C) \\
&\quad + APC \cdot \left\{X(p_X - p_C) - M(p_M - p_C)\right\} \\
&\quad - APC \cdot INT(nfl - p_C - \phi) + APC \cdot TRN(trn - p_C) \\
&\quad + APC \cdot G(p_g - p_c) - G(p_g - p_c) + \left[C+G\right]\omega
\end{aligned} \tag{I.10}$$

Note that $APC = (C+G)/GNDI$ (from equation (I.1) and the average propensity to save is defined as $APS = 1\text{-}APC$. Applying these notations in equation (I.10) and then find an expression for x_C, we have:

$$\begin{aligned} x_C &= S_{GDP} x_{GDP} + S_I(p_I - p_C) + S_X(p_X - p_C) - S_M(p_M - p_C) \\ &\quad - S_{INT}(nfl - p_C - \phi) + S_{TRN}(trn - p_C) - \frac{G}{C+G} APS(p_G - p_C) \end{aligned} \tag{I.11}$$

where the *S-terms* are the *GNDI* shares of *GDP* (S_{GDP}), public consumption (S_C), investment (S_I), domestic savings (S_S), exports (S_X), imports (S_I), foreign debt interest payments (S_{INT}) and foreign transfer incomes (S_{TRN}). APS is the average propensity to save. All other variables are as previously defined. We drop ω in our algebra because the percentage change in the average propensity to consume is exogenously fixed in the model.

Using equation (I.11), the real consumption deviation is decomposed into six influencing factors, as shown below:

Real consumption decomposition	Notation in equation (C.11)
(1) Real GDP effect	$S_{GDP}*x_{gdp}$
(2) Terms-of-trade effect	$S_x(p_x - p_c) - S_m(p_m - p_c)$
(3) Investment price effect	$S_i(p_i - p_c)$
(4) Foreign debt interest payment effect	$-S_{int}(netdebt - phi - p_c)$
(5) Foreign income transfer effect	$S_{trn}(transfer - p_c)$
(6) Government price effect	$-(G/C+G)APS(p_g - p_c)$