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Modelling the Distributional Implications of Agricultural Policies in Developing Countries

THE DEVELOPMENT POLICY EVALUATION MODEL (DEVPEM)

Jonathan Brooks,

Mateusz Filipski,

Erik Jonasson,

J. Edward Taylor

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Abstract

Modelling the Distributional Implications of Agricultural Policies in Developing Countries – the Development Policy Evaluation Model (DEVPEM)

by

Jonathan Brooks, OECD
Mateusz Filipski, University of California, Davis
Erik Jonasson, Lund University, Sweden
J. Edward Taylor, University of California, Davis

This paper presents the Development Policy Evaluation Model (DEVPEM), a new simulation model which captures four critical aspects of rural economies in developing countries: (1) the role of the household as both a producer and a consumer of food crops; (2) high transaction costs of participating in markets; (3) market linkages among heterogeneous rural producers and consumers; (4) the imperfect convertibility of land from one use to another. The results of simulations for six country models show that no untargeted agricultural policy intervention is pro-poor within the rural economy. While agricultural policy instruments are less efficient at raising rural incomes than direct payments, the degree of inefficiency of some market interventions, notably input subsidies, is not inevitably as high as observed in developed OECD countries.

Keywords: Agricultural policy, household analysis, welfare, general equilibrium.

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Modelling the distributional implications of agricultural policies in developing countries – the Development Policy Evaluation Model (DEVPEM)

1. Introduction

Governments in developing countries use agricultural policies to address a wide range of objectives, among which combating poverty and food insecurity are often paramount. According to the World Bank, there are approximately 1.3 billion people living on less than USD 1.25 per day – one in six of the world's population, while according to FAO there are about a billion people who are undernourished. Progress on the first Millennium Development Goal (MDG1), which calls for the eradication of extreme poverty and hunger, has been uneven, with many countries – notably in Africa and South Asia – expected to miss the target of halving between 1990 and 2015 the proportion of people living on less than a dollar a day. In the past few years, high food prices are estimated to have plunged millions into poverty and further undermined food security.

Efforts to reduce poverty and hunger need to safeguard and strengthen incomes over the short to medium term, and simultaneously lay the foundations for enduring improvements in the long term. In the short to medium term – which encompasses the timeframe of MDG1 – economic structures are relatively fixed, while over the long term they can adjust and develop. Effective policies therefore involve striking a balance between achieving an impact given current structures, and facilitating an adjustment to structures that are capable of generating fundamentally higher incomes.

The policy advice that OECD has developed for its member countries suggests that, in terms of supporting incomes, these two timeframes call for distinct policy measures. Over the short to medium term, deficient incomes among farmers, or any other section of society, can be addressed through social policies. Agricultural policies in general, and market interventions in particular, are shown to be relatively inefficient at transferring incomes to farmers (OECD, 2001). In the long term, agricultural incomes can be strengthened by measures to improve competitiveness, which can be done by supporting the enabling environment in general, and via an agricultural policy that focuses on the provision of public goods and the correction of market failures (OECD, 2002).

In the case of developing countries, plausible reasons have been advanced for why this distinction may not always be valid. In the first place, effective systems of social protection may not exist and – pending their development – there made be a need to look for short term alternatives, including the use of agricultural policies. When international food prices spiked in 2007-08, a number of governments responded by mitigating the pass-through of price increases to the national level (Demeke *et al.*, 2009; Jones and Kwiecinski, 2010). Input subsidies have also been suggested as a way of achieving a rapid impact on production and incomes, while simultaneously providing a bridge to

higher incomes by enabling farmers to break out of poverty traps (Dorward, 2009). Essentially, market interventions that offset the effects of market failures (for example in credit markets) are seen as a practical alternative to policies that correct them at source.

A key piece of information needed to inform this debate is how effective agricultural policies are at raising incomes in the short to medium term. The finding that they perform poorly in OECD countries is based on results from the OECD's Policy Evaluation Model (PEM), a partial equilibrium model in which output and factor markets are linked, and the effects of policies on farmers' incomes depends on (a) how the policy in question affects the returns to factors; and (b) farmers' ownership of those factors. In the case of developed OECD countries, a large share of the benefits of support that involves market interventions leaks to non-farming landowners and suppliers of purchased inputs (OECD, 2001) When there is a distribution of farm sizes, the benefits retained at the farm level also tend to be concentrated among larger (and wealthier farmers).

There are several reasons why these results may not carry over seamlessly to poorer developing countries. Some specific features of developing country agriculture may result in policies being more effective than in a developed country context, others less.

- One important feature of developing country agriculture is the joint role of the farm household as both a producer and consumer of food crops. This means that the effects of policies such as farm price support depend on what happens on both the supply side and the demand side. While higher prices stimulate production, they also raise the opportunity cost of consuming home-produced food. In many developing countries, an important share of farm households are net buyers of food, so raising farm prices could lower incomes for this group (unless they show a sufficient supply response to be transformed into net sellers).
- A second factor is that many farm households confront high transaction costs when selling output or purchasing inputs. In the extreme, these transaction costs may be so high that the farmer remains cut off from the market altogether, producing only for home consumption (that is, subsistence). Under these circumstances a subsistence farm household may not benefit from higher farm prices, and could in fact lose via induced increases in land rental rates or in the prices paid for purchased inputs.
- A third aspect is that rural households are heterogeneous in terms of their income sources, expenditure patterns and ownership of factors (particularly land), and will therefore be affected diversely by the direct and indirect impacts of policies. A comprehensive model of the agricultural sector in less-developed countries must consider the behaviour of structurally diverse agents, including commercial farms, semi-subsistence and subsistence farms, and landless rural households.

This paper presents a new model, the Development Evaluation Model (DEVPEM), which incorporates the above specificities. DEVPEM is a disaggregated model of the rural economy, which retains some key aspects of PEM, notably the imperfect transferability of land from one activity to another, which is central to the farmer's ability to respond to policy shocks. As with PEM, output and factor markets are linked, and the effects of policies on household incomes are determined by how those policies alter returns to factors that the household owns (land, labour and capital).

DEVPEM models are constructed for six countries, two in Africa (Ghana and Malawi); two in Asia (Bangladesh and Viet Nam); and two in Latin America (Guatemala and Nicaragua). The models are constructed using household level data from the FAO's

Rural Income Generating Activities (RIGA) and market aggregates from the FAOSTAT database. The virtue of the RIGA database is variables have been standardised across countries, which makes it relatively straightforward to build and parameterise DEVPEM models, and helps ensure comparability across countries.

The six DEVPEM models are relatively stylised, and should not be considered as representing the full structural diversity of these countries or the precise way in which their rural economies function. Rather, the aim is a more modest one of shedding light on how basic structural differences among countries may affect agricultural policy outcomes. In particular, the model is used to investigate the impacts of market price support for food and cash crops, input subsidies and direct payments to households, as well as the impact of removing transaction costs which inhibit households' participation in markets. DEVPEM does not incorporate a range of market failures that may be important in low income countries (such as seasonal cash constraints and the absence of credit markets). It is also a static model that is useful for examining the short to medium term impacts of agricultural policy interventions, but not the long-term effects, such as induced effects on investment decisions. These limitations constitute a potential avenue for further research and analysis.

Section 2 presents the main features of DEVPEM, explaining the main building blocks of the model. Section 3 provides background information on the six DEVPEM countries. Section 4 reports the results of DEVPEM policy experiments, while Section 5 provides some policy conclusions.

2. The Development Policy Evaluation Model (DEVPEM)

The Development Policy Evaluation Model (DEVPEM) has been developed in order to analyse the welfare and distributional implications of alternative agricultural policies in developing countries. It is a rural economy model constructed by linking multiple farm household models in a general equilibrium framework, as in Taylor, *et al.* (2005). A detailed motivation for the modelling approach is contained in the OECD working paper "Modelling agricultural trade and policy impacts in less developed countries" (Brooks, Dyer, & Taylor, 2008). A full exposition of the model is available in the report "The Development Policy Evaluation Model (DEVPEM): Technical Documentation" (OECD Food, Agriculture and Fisheries Working Paper N°50). The main features are outlined below.

Farm households

The basic building block of DEVPEM is the agricultural household model, in which production, consumption and labour allocation decisions may be interdependent (Singh *et al.*, 1986). The household maximises its utility, which comes from consumption of home-produced goods, purchased goods, and leisure, subject to constraints on cash income, family time, endowments of fixed productive assets, and production technology. The household's consumption is constrained by its farm profits and income from marketed factors of production, such that the total value of goods consumed (from own production or purchased), evaluated at market prices, is equal to the sum of all profits and the total market value of all endowments (the "full income" of the household). If all prices are exogenous, then the household can effectively make its production and consumption decisions sequentially, first maximising its profit as a producer, given prices of outputs and inputs, and then using those profits to maximise utility, given prices of

consumption goods. For each good the difference between profit-maximising production and utility-maximising consumption is equal to net sales.

When prices are exogenous, the farm household's supply response is the same as that of a pure agricultural firm (as is implicitly the case in the PEM). On the demand side, however, the household may decrease or increase its consumption, depending on the relative strength of income and substitution effects. In economies in which farm households consume a large part of their output, market and welfare outcomes can differ widely from those predicted by an agricultural firm model. An increase in the price of an agricultural commodity may lead to an increase in production almost fully absorbed by a similar increase in consumption.

Transaction costs and missing markets

In developing countries, long distances to markets, a lack of infrastructure and imperfect information can result in high transaction costs, leading some households to remain in autarky. In DEVPEM, transaction costs are captured via a price band, with households in remote areas selling on the market (or alternatively buying from the market) only if the difference between the market price and the self-sufficiency shadow price exceeds the associated transaction cost. When a household faces transaction costs for buying and selling a good, there will be an interval of prices (a price band) within which it uses its own subjective value of the good (i.e. the shadow price) to determine its optimal production and consumption levels. For prices within this band, separability between production and consumption decisions no longer holds.

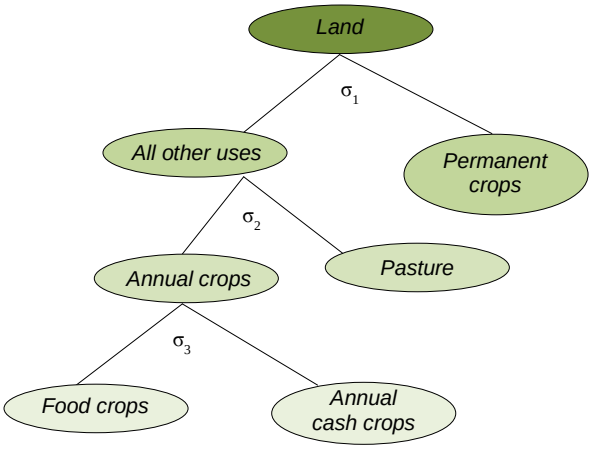
DEVPEM explicitly models the effects of transaction costs and endogenous market participation. It is assumed that households located remotely from markets face proportional (or multiplicative) transaction costs when participating in markets. As buyers of consumption goods and inputs these households face an effective buying price that is higher than the market price, reducing their consumption possibilities. As producers, they face an effective selling price that is lower than the market price, creating a wedge between market and farm gate price.

Additional constraints, such as poorly functioning factor markets and seasonal liquidity constraints, may also impede the responses of households to market price changes. These constraints are not captured directly by DEVPEM. However, we assume fixed endowments, i.e. missing markets, for two factors of production: land and physical capital. These assumptions capture, indirectly, credit constraints that farmers may face, as well as the lack of well-functioning, formalised, land markets in the rural areas of many developing countries. When some factor markets are missing, the factor endowments of the household fundamentally determine its ability to produce and earn its living.

Imperfect land transferability

Many agricultural household models assume that land is a fixed input in each production activity. This assumption may be appropriate in the very short run, or when policies, customs or other considerations impede the smooth functioning of local land markets, as often is the case in developing countries. In the medium term, however, some land re-allocation of household land endowments across activities is likely to occur in response to policy changes. DEVPEM, like PEM, recognises that land may be transformable from one use to another, albeit imperfectly.

Figure 1. The three levels of land transformability in DEVPEM



Note: The ease of land transformability from one use to another is expressed as the elasticity of transformation, σ. By assumption, $\sigma_1 < \sigma_2 < \sigma_3$, indicating that land re-allocation is easier the more similar any pair of agricultural activities are.

DEVPEM has three levels of land transformability, each with a different elasticity of transformation.[1] Figure 1 illustrates the principle. First, a distinction is made between land used for permanent cash crops and all other uses. Re-allocation of land at this level is assumed to be relatively difficult (indicated by the substitution parameter σ_1). At the second level of transformability, a distinction is made between pasture land and annual crops. Finally, at the third level, a distinction is made between food crops and annual cash crops, between which land is assumed to be relatively easier to re-allocate. Thus, σ_1 is smaller than σ_2, which in turn is smaller than σ_3.

Household heterogeneity

Household heterogeneity is captured by partitioning all rural households into six separate categories, each with specific factor endowments, preferences, and production technologies. The purpose of this classification is to capture heterogeneity in the constraints that households face and their resulting responses to external shocks. The categories are rural non-farm households, large commercial farms, and small and medium sized farm households, with small and medium sized farm households divided into "remote" and "non-remote" groups. "Remote" households confront prohibitive transaction costs, as defined above, which cut them off from food staple markets. Local markets often exist even in the most remote communities, but they operate in isolation from the rest of the world, and the prices on those markets reflect endogenous prices for the whole remote community. In that sense, the remote households in the model are not only representative of households in pure autarky, but also of households which buy and sell on local, isolated markets. They are pure subsistence households in the model baseline, but their market participation status may change.

Because the household distributions differ across countries in terms of land ownership and remoteness to markets, a farmer with, say, one hectare of cultivated land may be

1. The elasticity of transformation is defined as the percentage increase in land use in one activity, given a 1% decrease in land use in the other activity. Land transformability across activities is modelled in DEVPEM with a constant elasticity of transformation (CET) function.

considered small in one country and fairly large in another. Thus rather than defining category cut-off points as particular areas, we defined them as percentiles of the distributions, common for every country. This treatment of household categories has the advantage of providing a basis for cross-country comparison. Access to land was defined not in terms of land ownership but in terms of cultivated land. In some countries, access to land may be granted through traditional rights rather than formal land ownership, such that households cultivating land without a formal title should still be considered "owners" of that plot. Furthermore, access to land is likely to be relatively secure in the short to medium term, which is the relevant timeframe for DEVPEM simulations.

To define remoteness, we computed an index at the community level using distances to basic services or administrative centres (roads, buses, telephones, hospitals, schools, regional capitals, etc., variables depending on availability in each country survey). We considered as remote those households living in the 25% most remote communities according to this measure. Large farmers were not considered to be remote because we assume that their scale and the size of their assets would allow them to overcome transaction costs no matter where they might be located. It is well-established that land ownership is strongly correlated with market participation (Barrett & Dorosh, 1996), therefore it seems reasonable to assume that all large farmers are connected to markets. In DEVPEM, small and medium-sized farms in remote areas are considered to be subsistence producers with respect to food crops in all six countries.

Rural economy linkages

The six representative household groups in DEVPEM constitute the rural economy. The rural economy is, in turn, linked to the urban economy, or "the rest of the world". Opening up for general equilibrium effects implies taking into account the markets for inputs and factors of production, as well as the effects on other goods markets. Thus, maize price support may increase labour demand, inducing a higher wage rate in the rural economy. This might benefit landless households (whose only income source is wage labour) who – if maize is only a small share of their household budget – might ultimately gain more as wage labourers than they lose as maize consumers. While general-equilibrium linkages in DEVPEM are more involved than this, the above example illustrates the potential strength of general equilibrium analysis. Establishing the direction and quantitative impacts of policy shocks cannot be done analytically, but requires a programming approach.

The magnitude of these linkage effects is limited, however, by the fact that most prices in DEVPEM are assumed to be exogenous to the rural economy. There are seven commodities defined in the model: six agricultural commodities, all produced in the rural economy, and a composite non-agricultural good, representing all consumption goods produced outside the rural economy. There are five factors of production in the model: family labour, hired labour, land, physical capital, and intermediate inputs (such as seeds and fertiliser). All commodity prices are assumed to be exogenous, that is, determined in the urban economy or on the world market. In terms of production factors, the wage rate and the price of intermediate inputs are determined endogenously in the rural economy, although we consider an alternative scenario in which intermediate inputs, such as fertiliser, are supplied exogenously at the world price. Since markets for land and physical capital are assumed to be missing, there are no market prices for those factors. The elements and defining characteristics of the DEVPEM model are summarised in Table 1. For detailed explanation, the reader is referred to the accompanying technical documentation.

Table 1. DEVPEM overview: household groups, production factors, and commodities

Households groups	Defining characteristic or assumption
Non-farm households	Landless rural households, no farm income.
Small remote farm households	Face transaction costs for buying and selling farm goods.
Small non-remote farm households	Small land holdings, no transaction costs.
Medium-sized remote farm households	Face transaction costs for buying and selling farm goods.
Medium-sized non-remote farm households	Medium land holdings, no transaction costs.
Large farm households	Relatively large land holdings, no transaction costs.
Factors of production	**Defining characteristic or assumption**
Family labour	Used on the own farm or supplied on the rural labour market; wage rate determined endogenously.
Hired labour	Wage rate determined endogenously; not all farms hire labour.
Land	Missing market; imperfect transferability from one use to another.
Physical capital	Missing market.
Intermediate inputs (seeds, fertiliser, etc.)	Supplied by the urban economy at an increasing marginal cost.
Commodities*	**Defining characteristic or assumption**
Main cash crop	Produced but not consumed by rural households; price determined exogenously.
Main food staple	Produced and consumed (partly) by rural households; price determined exogenously.
Other food staples	
Other annual crops	
Other cash crops	
Livestock products	
Non-agricultural ("market") goods	Produced by the urban or foreign economy and consumed (partly) by rural households. Price determined exogenously.
* Classification varies somewhat by country model.	

Data sources and model calibration

The basic data platform for DEVPEM consists of disaggregated social accounting matrices, constructed with household survey data compiled by the United Nations Food and Agricultural Organization in its Rural Income Generation Activities (RIGA) database and with data from the FAOSTAT database.[2]

The model consists of a set of variables (for which we have observations) and a set of relationships among variables, defined by equations with parameters (for most of which we do not have observations). In order to make the model operational and tractable, we must calibrate it, that is, find the missing parameter values, using actual production and consumption data for each country for which the model is applied. The aim of calibration procedures is to find parameter values such that the observed data represent a solution to the model. Our calibration procedure is based on a social accounting matrix (SAM) for each of the six countries. A SAM provides a picture of all flows of money and goods in

2. Davis *et al.* (2010) and Winters *et al.* (2009) describe the RIGA database and present detailed insights on asset holdings and income sources among rural households, based on these data. Further information is available at *www.fao.org/economic/riga*.

an economy in matrix form, where rows represent the incomes of economic actors and columns represent expenditures. An advantage of using a SAM is that, by construction, all cash constraints and market clearing conditions are satisfied for all accounts in the matrix, which is consistent with general equilibrium theory. This is why computable general equilibrium (CGE) practitioners often parameterise models using SAMs. Each country SAM has the same structure, even if specific activities and goods differ between countries. Keeping the structure the same for each country facilitates comparability across countries and simplifies extensions of the model, with applications on additional countries.

3. The six DEVPEM countries

We have used DEVPEM to simulate the effects of agricultural policies in six developing countries: Bangladesh, Ghana, Guatemala, Malawi, Nicaragua and Viet Nam. The choice of countries was guided by geographic location (two African, two Asian and two Latin American countries), the possibility of establishing a common data platform, and the scope for exploring the implications of significant structural differences across countries. These countries show differences at both the macro and micro levels. At the macro level, the six countries differ in terms of population size, income levels (and hence poverty levels), industrial composition, and character of the agricultural sector. At the micro (household) level, there are marked differences between the countries in asset ownership, crop mix, and market integration.

To construct DEVPEM models that generate results that are comparable across countries, a key prerequisite is the availability of data that are fairly comparable across countries. Therefore, countries were chosen that were all part of the Rural Income Generating Activities (RIGA) initiative at the United Nations Food and Agriculture Organization (FAO). The RIGA team has made an effort to clean and homogenise raw household survey data from 18 low- and middle income countries and construct a comprehensive database of household surveys suitable for cross-country comparisons. Many of these are Living Standard Measurement Study (LSMS) surveys, designed by the World Bank.[3] Comparable variables were generated by the RIGA team for income sources, asset holdings, employment forms, and specialisation patterns among rural households. Besides these data from the RIGA database, FAOSTAT was used as a complementary data source for information on aggregate production and consumption of agricultural goods.

3. The household survey data that are used in DEVPEM (either the raw data or data processed by the RIGA team) are from the Bangladeshi Household Income-Expenditure Survey (2000), the Ghanaian Living Standard Survey (1998), the Guatemalan National Survey of Living Conditions (2000), the Second Malawian Integrated Household Survey (2004), the Nicaraguan Living Standard Measurement Survey (2005), and the Vietnamese Household Living Standard Survey (2002).

Macroeconomic differences across the DEVPEM countries

Bangladesh, Ghana and Malawi fall in the category of low-income countries, whereas Guatemala, Nicaragua and Viet Nam are lower middle-income countries, according to the World Bank country classification. Table 2 provides a few economic indicators and other summary statistics for the six countries. Malawi is one of the poorest countries in the world, with a per capita income of USD 774 in 2008 (in 2005 PPP US dollars), placing it 151st out of 160 countries. As a comparison, the average GDP per capita in high-income OECD countries was 34 312 USD in 2008 (in 2005 PPP US dollars). During the past 25 years, Malawi has essentially had zero economic growth and more than 70% of the population fell below the extreme poverty line in 2004. By definition, an even larger share of the population (90%) fell below the 2 dollar-per-day poverty line, defined as non-extreme poverty. Ghana has about double the per capita income of Malawi and its economy has grown quite steadily, although slowly, since the mid-1980s. Yet in absolute terms the rise in income has been meagre. Ghana's headcount ratio of non-extreme poverty was about 54% in 2006, the latest year for which information is available.

Per-capita income is also very low in Bangladesh (USD 1 233), the second poorest country in our study. Viet Nam and Bangladesh had essentially the same levels of per capita income in the early 1980s, but Viet Nam has grown faster since and per capita incomes are now twice those in Bangladesh. Since both countries have a fairly similar distribution of income (in terms of the Gini-coefficient), this underlines the importance of economic growth for poverty reduction. Over 80% of the population in Bangladesh is still poor, compared with 48% in Viet Nam.

Of the two Central-American countries included in the study, Guatemala is the one that has come furthest in terms of economic development. Both countries went through negative macroeconomic shocks in the 1980s and early 1990s that led to substantial falls in aggregate production. While Guatemala was able to recover to the GDP level it had in 1980 by the end of the 1990s, Nicaragua still has a lower income level today, in real terms, that it had three decades ago. The incidence of poverty is substantially lower in Guatemala and Nicaragua (about 25-30%) than in the other four countries. High degrees of income inequality, however, suggest that poverty rates could be lower if the gains from economic growth had been shared more equally.

The six countries have structural differences that are to be expected at these levels of income. With over 80% of its population in rural areas and with a third of the economy consisting of agricultural production, Malawi is a largely agriculture-based country. While Ghana has a lower share of its population in rural areas (50%), it also derives about a third of its GDP from agriculture. In Viet Nam and Bangladesh, about three-quarters of the population live in rural areas, but agriculture plays a smaller role in both countries, constituting about 20% of GDP. Despite their large rural population shares, the economies of both Viet Nam and Bangladesh are dominated by manufacturing and services. The agricultural sector accounts for less than 20% of GDP in Nicaragua and 12% in Guatemala. Figure 2 shows that agriculture has declined as share of GDP in all six countries since the 1980s, while the growth patterns in GDP have been widely different across the countries.

Even if the relative importance of agriculture in GDP declines over time, agricultural production tends to continue to expand in absolute terms. As can be inferred from Figure 3, agricultural production has at least doubled in all six countries since the 1980s. Between 2000 and 2008, agricultural production increased by 20-30% in all countries but

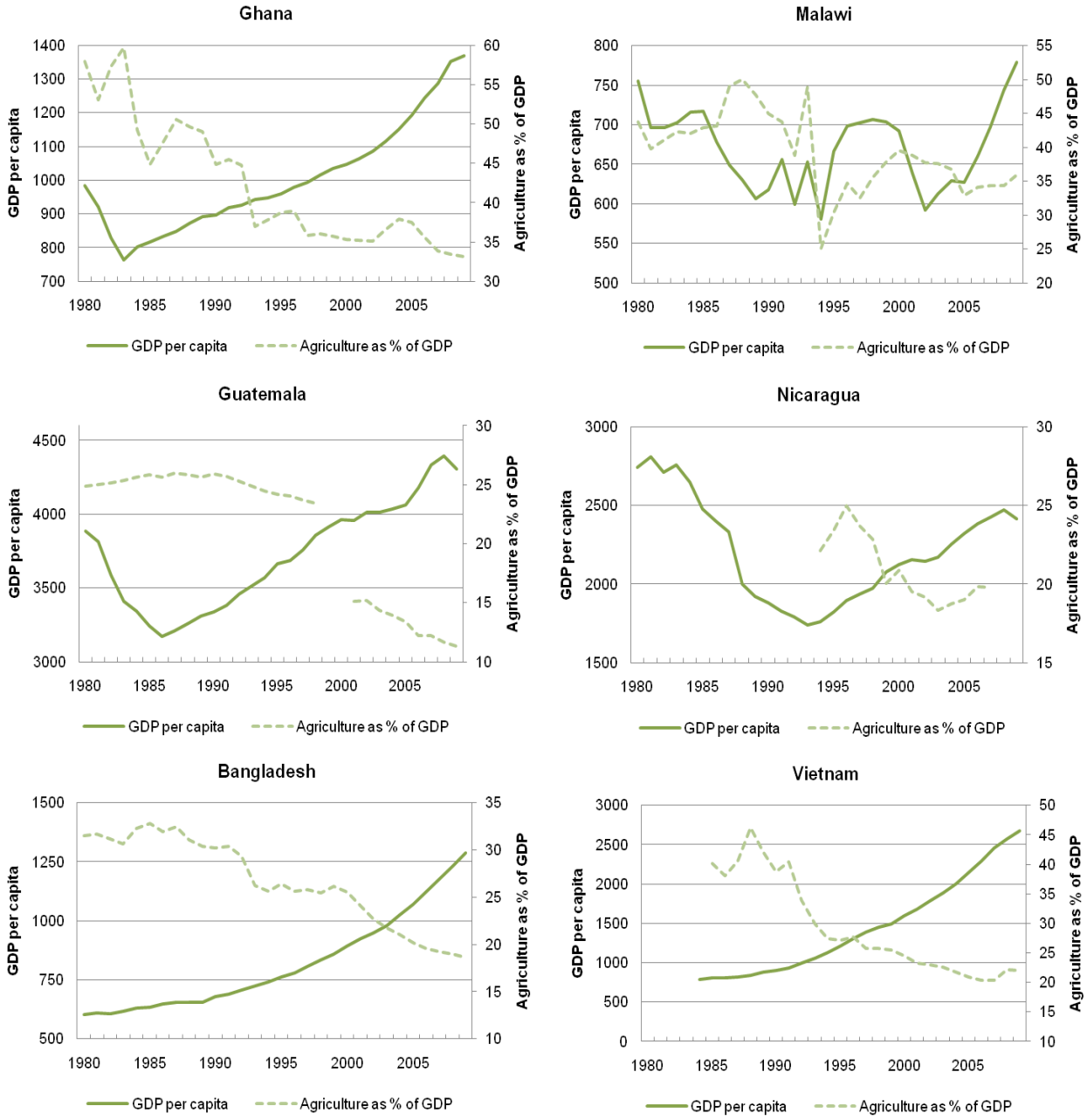
Malawi. This absolute expansion of agricultural production conforms to the general pattern of economic development, whereby output increases despite a smaller share of resources being allocated to the sector.

Table 2. Population, living standards, and agriculture in DEVPEM countries

	African countries		Latin American countries		Asian countries	
	Ghana	**Malawi**	**Guatemala**	**Nicaragua**	**Bangladesh**	**Viet Nam**
Population and living standards						
Population, million	23.4	14.8	13.7	5.7	160.0	86.2
Rural population, % of total population	50.0	81.2	51.4	43.3	72.9	72.2
GDP per capita (PPP) [a]	1 351	744	4 397	2 473	1 233	2 574
GDP per capita, world ranking [b]	132	151	93	112	136	111
Poverty, USD 2 a day, % [c]	53.6	90.5	24.3	31.9	81.3	48.4
Poverty, USD 1.25 a day [c]	30.0	73.9	11.7	15.8	49.6	21.5
Agriculture						
Agricultural value added per worker [d]	401	136	2 815	2 408	418	352
Agriculture, % of GDP	33	34	12	19	19	22
Main food crops	yams, cassava, plantains	potatoes, maize, cassava	potatoes, maize, beans	maize, rice, beans	rice, potatoes, maize	rice, cassava, maize
Main non-food crops/commodities	cocoa beans	tobacco	sugar cane	sugar cane	chillies, jute	coffee, cashew

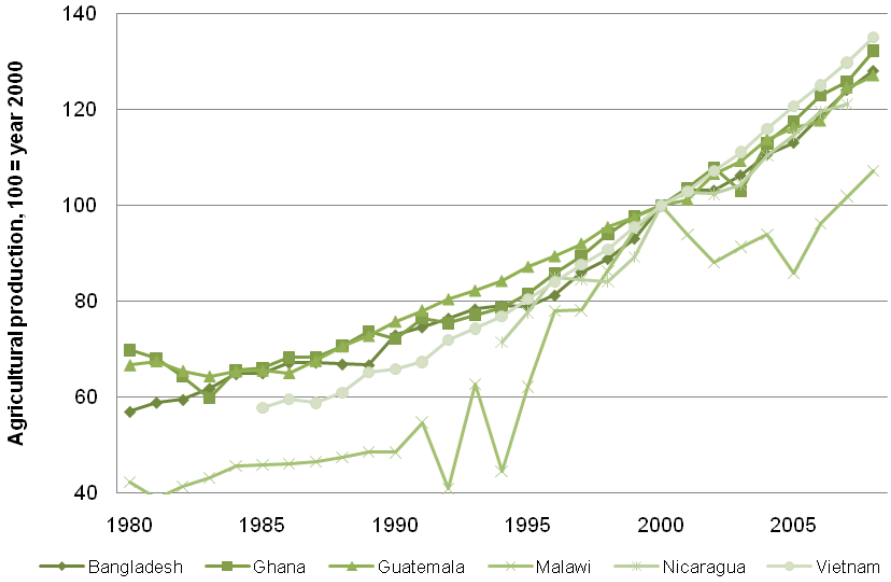
Note: Information is for year 2008 except for the poverty rates, which are based on the latest information available, 2001-06.
a Constant 2005 PPP USD.
b Of 160 countries in total.
c Headcount ratio, PPP dollars, % of total population.
d Constant 2000 PPP USD.
Source: World Development Indicators.

Figure 2. GDP per capita and agriculture in DEVPEM countries, 1980-2008 (constant 2000 USD)



Source: World Development Indicators.

Figure 3. Agricultural production in DEVPEM countries, 1980-2008



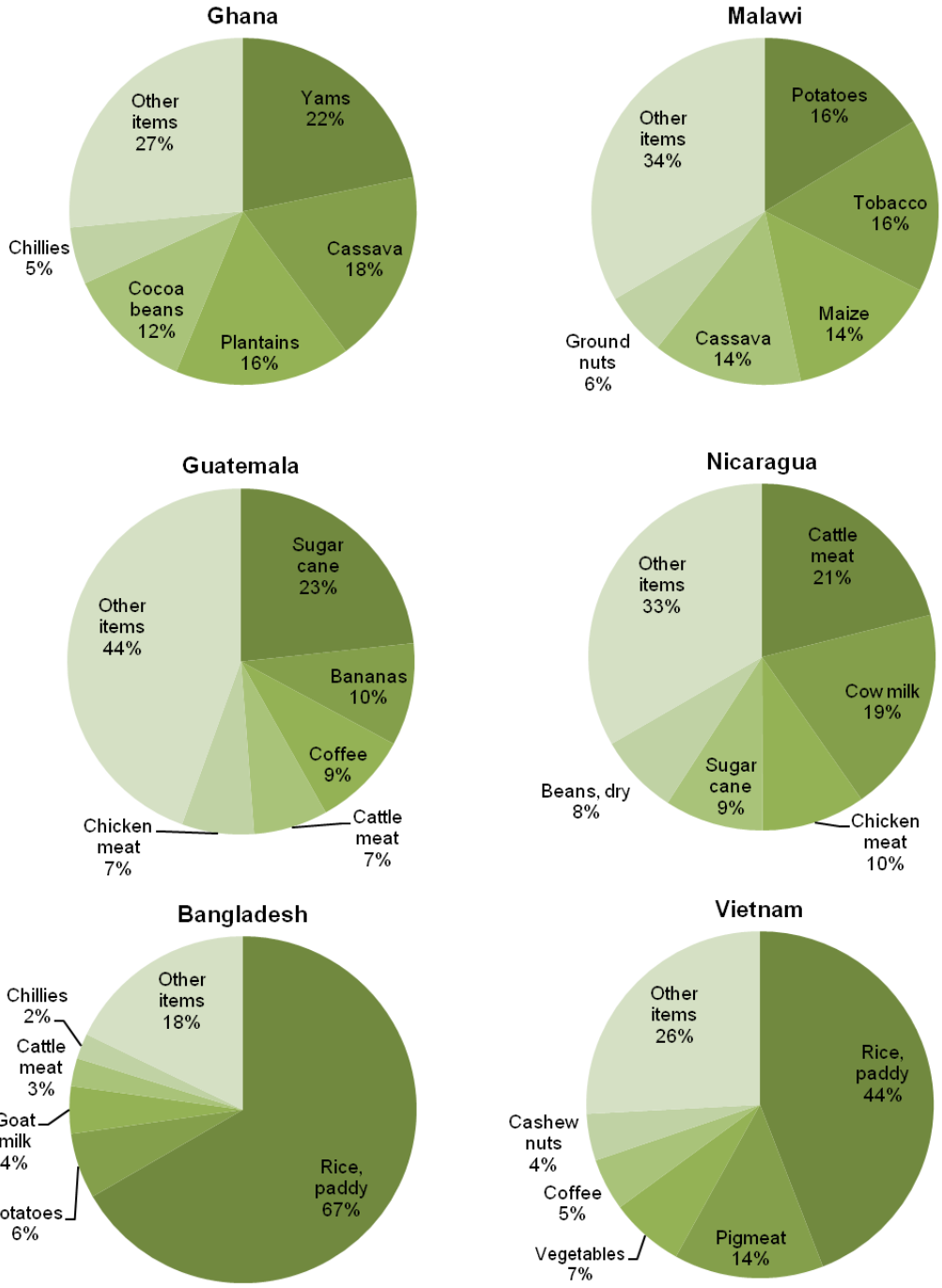
Note: Agricultural value added measured in constant 2 000 USD. Index for each country is set to 100 for year 2000.

Source: World Development Indicators.

Characteristics of agriculture and the rural economy in the DEVPEM countries

The productivity of agricultural labour, as captured by value added per worker, varies greatly across the six countries. The African and Asian countries have agricultural labour productivity ranging from USD 136 (per year and employee, constant 2 000 dollars) to USD 418 (lower part of Table 2). Labour productivity in Guatemala and Nicaragua is an order of magnitude higher, at about USD 2 800 and USD 2 400, respectively. This difference reflects not only different levels of agricultural development but also different output compositions within the agricultural sector. As shown in Figure 4, production in Ghana and Malawi is dominated by food crops, most of which are consumed locally, even though both countries have significant cash crop production (cocoa for Ghana; tobacco for Malawi). Rice production dominates in Bangladesh and Viet Nam, while less labour-intensive production based on livestock and perennial crops are important in Guatemala and Nicaragua.

Figure 4. Composition of agricultural production, by value (2008)



Source: FAOSTAT.

The type of income-generating activities that a rural household chooses to engage in is determined by a range of factors, including basic agro-climatic conditions. Given the agricultural potential of a given area, agricultural (and non-agricultural) activities are shaped by access to production factors and intermediate inputs, agricultural technology, and the functioning of input and output markets. Table 3 shows that agriculture's share of rural household income ranges from a high of 77% in Malawi to 50% or less in Guatemala and Bangladesh.[4] Among agricultural income sources (defined as crops, livestock, and agricultural wage employment), crop growing is relatively important in Malawi, Ghana, and Viet Nam, livestock in Nicaragua and Viet Nam, and agricultural wage labour in Guatemala, Nicaragua, and Bangladesh. Non-agricultural income sources essentially consist of non-agricultural employment income (wage or self-employment).

Table 3. Household income shares among rural households

	Ghana	Malawi	Guatemala	Nicaragua	Bangladesh	Viet Nam
Crops	55.0	56.1	27.6	21.1	15.5	41.5
Livestock	4.4	9.4	2.6	14.3	1.2	14.8
Agricultural wage employment	1.4	11.4	19.9	21.4	20.2	5.9
Agriculture, total	*60.8*	*76.9*	*50.1*	*56.8*	*36.9*	*62.2*
Non-agricultural wage employment	9.6	7.4	20.2	21.3	19.9	9.2
Non- agricultural self-employment	20.5	8.7	12.4	11.1	16.4	21.2
Transfers	8.5	6.6	16.9	6.1	13.4	7.0
Other income sources	0.5	0.3	0.5	4.6	13.4	0.3
Non-agricultural sources, total	*39.1*	*23.0*	*50.0*	*43.1*	*63.1*	*37.7*

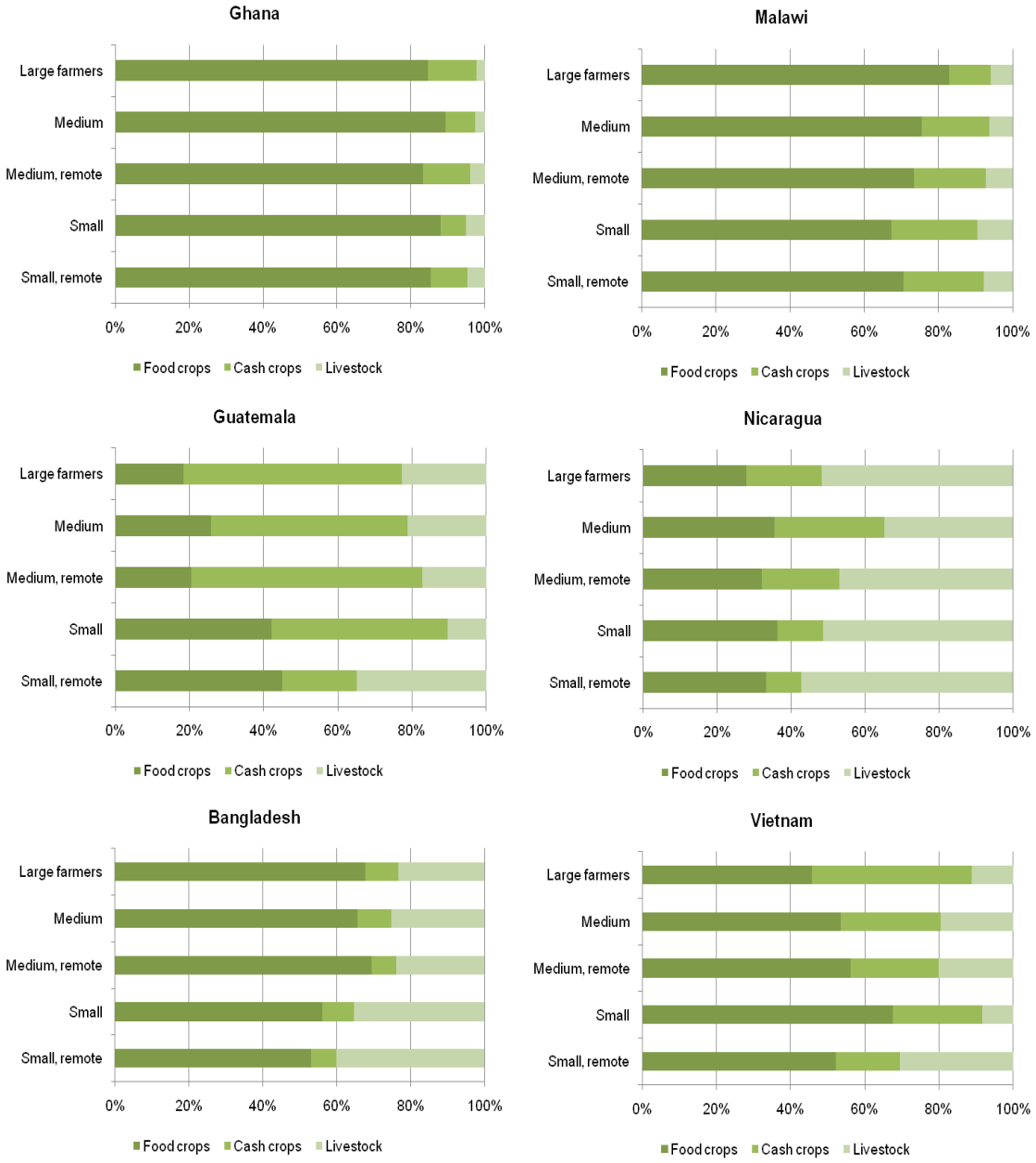
Source: Davis *et al.* (2010), Table 2. Data are latest RIGA surveys.

These differences in income sources suggest that agricultural policies will have differential impacts in the six countries. First, agricultural policies are likely to have the strongest effects in places where households derive a large share of their total income from agriculture. However, the effects of any given agricultural policy will also depend on the type of agricultural activity that households are primarily engaged in. For example, if the majority of the rural population are labourers and few are own-farmers, then, for example, input subsidies are likely to benefit them relatively little. If food crops are grown by relatively poor farmers and cash crops are grown by better-off larger farmers, then cash-crop price support is likely to have small effects on rural poverty. Among the DEVPEM household groups, income sources vary substantially, with large farmers generally deriving a larger share of their income from farming than small and medium-size farmers. Figure 5 shows how the agricultural product mix differs by household categories, both within and across countries. Farm households of all six types in Malawi and Ghana are dominated by crop production. Cash crops tend to be dominant in Guatemala, especially among large farmers, while livestock dominates across all household groups in Nicaragua. In Viet Nam, small and medium-size farmers grow primarily food crops (rice), while larger farmers have a substantial share of production

4. The income shares are based on Davis *et al.* (2010), using the RIGA database. Winters *et al.* (2009), also using the RIGA database, report an agricultural income share of 62% for Bangladesh.

allocated to cash crops. Food crops (rice) dominate among all household groups in Bangladesh.

Figure 5. Farm household production mix



Source: Authors' estimates based on the RIGA database.

The effects of policies will also depend on the degree to which farmers participate in markets and whether they are net buyers or sellers of affected goods. If few farmers are net sellers of crops, then crop price support is unlikely to provide much collective benefit. By assumption, the two household groups defined as *remote* are self-sufficient in food crops. This means that, as a group, these households are treated in the model as if they do not trade with the rest of the economy, even though they may trade with each other

locally, at prices that are disconnected with the rest of the economy. In reality, even remote households participate in trade to some extent even with the rest of the economy. The volumes are likely to be small, however, and for simulation purposes we assume that their initial trading status with the rest of the economy is zero. Except for this assumption, we have let the actual data that underlie the SAMs reveal the trading status of household groups in each country. Table 4 shows that, as a whole, the group of small farm households are net buyers of food crops in the four low-income countries but net sellers in Guatemala and Nicaragua, whereas medium and large farmers are net sellers of food crops in all six countries. Each household group in DEVPEM is modelled as one representative household. Hence, even though there are net buyers and net sellers of food in all household groups in the household data, when each group is treated as an aggregate household, small non-remote farmers are net buyers in four of the six countries and all medium non-remote and large farmers are net sellers of food.

Table 4. Trading status in food crops by DEVPEM household group

	Small remote farms	Small farms	Medium-sized remote farms	Medium-sized farms	Large farms
Ghana	0	-	0	+	+
Malawi	0	-	0	+	+
Guatemala	0	+	0	+	+
Nicaragua	0	+	0	+	+
Bangladesh	0	-	0	+	+
Viet Nam	0	-	0	+	+

Note: Trading status: net-seller (+), net-buyer (-), or self-sufficient (0). Remote households are self-sufficient by assumption.

Source: Authors' estimates based on the RIGA database.

Country-specific model assumptions

Despite the heterogeneity among the six countries, there are few country-specific assumptions in the country applications of DEVPEM. The reason for this is to ensure maximum comparability across countries. The differences all lie in the activities that the households participate in, and the corresponding production functions. There are six agricultural commodities defined for each country model. Commodities were chosen to represent the most important ones in terms of rural household consumption and overall importance to the agricultural sector of the country. We identified these by studying production and consumption patterns in the RIGA datasets and using aggregate values on production and consumption from the FAOSTAT database. While the commodities may differ from country to country, they always include a sample of staple crops, cash crops, permanent crops, and a livestock account. The specific commodities for each country are reported in Table 5. All output in each country is assigned to one of the six defined categories. While the factor and input categories are common across all six country models, the production functions are different for each country and for each household group in each country.

Table 5. Agricultural commodities defined for each country

	(1)	(2)	(3)	(4)	(5)	(6)
Ghana	Tubers	Other annual food crops	Plantains	Cocoa	Other permanent crops	Livestock
Malawi	Maize	Rice	Other annual food crops	Tobacco	Permanent crops	Livestock
Nicaragua	Maize	Beans	Other annual food crops	Cash crops	Permanent food crops	Livestock
Guatemala	Maize	Other annual food crops	Annual cash crops	Coffee	Other permanent crops	Livestock
Bangladesh	Rice	Other food staples	Other annual food crops	Cash crops	Other permanent crops	Livestock
Viet Nam	Rice	Other food crops	Coffee	Other cash crops	Other permanent crops	Livestock

4. Agricultural policy simulations with DEVPEM

In this section we report the results of policy simulations using DEVPEM. We analyse the effects of five different policies in each of the six countries included in the study. Three of the policies are *market interventions*, in the form of market price support, a production subsidy, and an input subsidy; one of them is a *social transfer*, in the form of an unconditional cash transfer; and one is a *public-good investment* that lowers transaction costs for remote households and facilitates access to markets. We are interested primarily in the ability of each policy to increase the welfare of rural households, how costs and benefits are distributed across household groups in each country, and how cost efficient each policy is in terms of raising the welfare of the targeted population for every dollar spent on the policy. It is important to bear in mind that we are concerned with a particular set of costs and benefits that DEVPEM is designed to capture. There may be other costs, such as administrative costs and losses due to corruption. Equally there could be dynamic effects that are beyond the scope of the current model.

To the extent that agricultural policies are aimed primarily at increasing the welfare of rural households, market-intervening policies are, second-best, in the sense that they involve deadweight losses and leakages to unintended beneficiaries. Public-goods investments do not suffer from deadweight losses, in the theoretical sense, but from the standpoint of raising income, they may be difficult to target and generate long-term benefits that are outside the scope of the DEVPEM model. From a targeting and efficiency point of view, direct social cash transfers to specific groups are therefore better than market intervention and public-goods investments. Before analysing the results of the policy simulations, we discuss the ways in which the policy experiments are implemented in the model.

Policy implementation

The market price support (MPS) and production subsidy (PS) experiments are both targeted at agricultural commodity markets, the main difference between the two policies being that the former affects consumer prices while the latter does not. Production

subsidies, which are formally equivalent to a deficiency payment equal to the difference between a target support price and the market price, are rarely implemented in developing countries, as they necessitate the use of scarce budgetary resources. However, they provide an instructive comparison with MPS policies because of this basic difference in effect. Input subsidy (IS) policies consist of interventions in markets where farmers are buyers and consumers do not participate, such as the markets for seeds and fertiliser. Common to all policy experiments is the assumption that the urban economy (urban consumers and taxpayers) bears all the explicit costs of the policies in terms of taxes. Some of the policies also imply implicit costs to the urban economy in terms of consumer surplus losses due to higher commodity prices.

Market price support

The MPS policy is implemented as a price floor, or a regulated minimum price, for the targeted commodity. It raises the price above the world market price for farmers and rural consumers, as well as for urban consumers. In the rural economy, farm households gain as producers and lose as consumers, their net gain depending on their production surplus. As long as they produce more than they consume they are likely to gain from the policy.

Implementing MPS will cause the quantity demanded of the targeted commodity to fall and the quantity supplied to increase. If the country is initially a net-exporter of the commodity, MPS will increase the domestic excess supply and the government will have to use taxes to cover the difference between the targeted price and the world market price, taking the surplus into storage or selling with the use of implicit export subsidies on the world market. If the country is a net-importer of the targeted commodity, the government can impose an import tariff equal to the difference between the target price and the world market price in order to keep the domestic price at the target level. Households in the urban economy lose in terms of higher prices of the commodity (a consumer surplus loss).

We analyse the effects of market price support for three agricultural commodities: the main food crop, the main cash crop, and livestock products. As indicated in Table 1, farm households consume some of the food crops and some of the livestock products they produce. The main cash crop, however, is produced for 'export' only, either for the world market of for the urban market. The experiment consists of raising the domestic price 10% above the world market price of one commodity at the time. This price change is small enough to assume that the model parameters for consumer preferences and production technology remain valid, yet large enough to cause noticeable behavioural adjustments among households.

Production subsidy

In contrast with MPS, a production subsidy (PS) does not affect consumers in terms of higher prices. This follows from the assumption of exogenous output prices. The subsidy, as implemented here, gives the farm household a mark-up on the world market price for each unit of the commodity it produces and sells. To the extent that the farm household consumes the targeted commodity, it is able to buy it in the market at the world market price. This means that, in the rural economy, the quantity supplied of the good increases due to the higher seller price, but the quantity demanded remains unchanged. Consequently, the rural excess supply of the commodity increases, although by less than under MPS. Urban consumers face a tax cost under this policy but are unaffected as

buyers of the good. The tax needed to finance the policy amounts to the domestic quantity produced times the subsidy amount per unit of output. As with MPS, the domestic surplus of the commodity will be exported at the world market price. Designed in this way, a production subsidy has an advantage over market price support in that it leaves rural households unaffected on the consumer side. It may, however, be difficult to administer, owing to the need for farmers to provide sales receipts in order to receive payments.

As with the MPS experiments, we analyse the effects of a production subsidy for the main food crop, main cash crop, and for livestock products. Since rural households are assumed not to consume any of the cash crops, the effects on the rural economy of an MPS and PS are identical for cash crops. As in the MPS experiments, we assume that the subsidy consists of a 10% mark-up on the world market price.

Input subsidies

An input subsidy enables farm households to buy intermediate inputs at a lower price than the market price. While there are various ways of implementing such a policy, we assume here that the policy is implemented as vouchers given to farmers, effectively giving them a 10% discount on the targeted input. The effect of subsidising an agricultural input depends crucially on the market structure for that input. The extent to which the price paid by farmers will fall depends on how sensitive the supply of the input is to price changes. The more price-elastic the supply, the more effective the subsidy will be in lowering the price paid by farmers. In the case of an exogenous price (determined by the world market), the price paid by the farmer will fall by the entire amount of the voucher and there will be no leakage to the suppliers of the input. In the other extreme – the case of fixed supply – the price paid by farmers for the input will not fall at all; the entire value of the voucher will be passed on to the suppliers of the input.

If the market for intermediate inputs is well connected with the world market, the price is essentially exogenous and an input subsidy will have little or no leakages to suppliers. If, however, these inputs are supplied at an increasing marginal cost, for example due to limited production capacity, then some degree of leakage is inevitable. Given that it is difficult to be sure of the efficiency of domestic distribution channels, we analyse the effects of an input subsidy under two scenarios. The benchmark assumption is that the supply of inputs is relatively elastic.[5] The alternative scenario is that the input market is perfectly connected with the rest of the world so that the price is fully exogenous at the going world market price. Since consumers do not to participate in the markets for intermediate inputs used in agricultural production, they suffer no losses in terms of consumer surplus. The cost of the policy is borne solely by urban taxpayers and amounts to the total quantity sold of the targeted input times the voucher value.

Cash transfers

The cash transfer that we consider in this report is an agricultural policy only in the sense that it is targeted to farm households. In contrast with policies that involve market interventions, it is not tied to crop production or to a specific use of inputs. Theoretically,

5. We assume rising internal distribution costs, reflecting infrastructure bottlenecks, which are reflected in a supply elasticity of 2.0. Quizón and Binswanger (1986) in an application to India assume a higher elasticity of 4.0, based on openness to trade. Ryan and Perrin (1974) in an examination of the market for potatoes in Peru argue that it is plausible to assume perfectly elastic supplies, since fertiliser is imported. We adopt the latter as an alternative assumption.

a cash transfer is the best way of raising the welfare of specific household groups since it is free of leakages and does not distort markets incentives. Moreover, it can in principle be targeted to poorer households. The use of any other instrument is therefore likely to reflect either administrative challenges or the simultaneous pursuit of other policy objectives, as discussed in the introduction. The way we simulate the cash transfer in this study is essentially trivial and used only as a benchmark policy experiment. The policy is untargeted and each farm household group receives a cash transfer equal to one per cent of household income.

A public-goods investment

The notion of public goods is used here in a broad sense to distinguish goods that benefit a large group of people (such as roads, irrigation systems, public health centres, and schools) from 'private' goods (such as consumer goods and agricultural production equipment) that only benefit their sole owner. Like unconditional cash transfers, rural public-goods investments are an agricultural policy only in the loose sense that they benefit people of whom a majority are farmers.

Investments in public goods can take many forms. The type that we consider here is an infrastructure-type of investment that reduces transaction costs for remote households. This does not have to be related to transportation. It could, for example, be an investment in a mobile telecommunication network, connecting people living in remote areas to people in towns and cities, allowing them to receive information about current prices of crop or livestock products or current labour demands in different regions. The policy in our experiment is assumed to be designed in a way that, after the investment, remote households face the same set of effective prices as other (non-remote) households. This policy only affects two of the household groups and we cannot say anything specific about the cost of the policy or its relative efficiency.

Measuring rural household welfare impacts

As discussed in the preceding sections, the welfare effect of a given policy on a household is the net effect of these elements: gains on the production side, possible losses on the consumption side, and additional effects in the form of wage income changes. When analysing the welfare impacts of different policies on rural households, it is important to distinguish nominal income (measured in currency units) from real income (measured in purchasing power). If a household's income increases by 10% at the same time as all prices increase by 10%, the nominal income of the household has increased by 10%. Its purchasing power, however, remains unchanged due to the equally large change in prices. Hence, its real income has not changed.

It is also important to contrast the welfare effects before and after households have been able to adjust. Farm households may be unable to respond immediately to a relative price change in the agricultural commodity market. Only with a time lag may households be able to adjust their agricultural production and consumption patterns.

The difference between nominal and real income changes, on the one hand, and pre-adjustment and post-adjustment welfare effects, on the other hand, can be illustrated with three measures. First, we define the change in *nominal income* as the change in monetary income due to changes in sales revenues and wage incomes. Second, we define the *immediate welfare change* as the change in real income (purchasing power) before any behavioural responses are allowed in the economy. This provides the change in real income, provided that the household produces, sells, and buys the same quantity of every

commodity, and supplies the same amount of labour, as before the policy shock. Third, we define the *final welfare change* (or just the *welfare change*) as the change in real income after behavioural adjustments of households. The final welfare change is measured as a compensating variation, *i.e.* the amount of income that could be taken away from the household (or would need to be given to the household) to bring it back to the welfare level it had before the policy shock. While in some cases all three measures are almost identical, they differ greatly in other cases, due to the combination of behavioural responses on the producer and consumer side as well as due to general-equilibrium linkage effects.

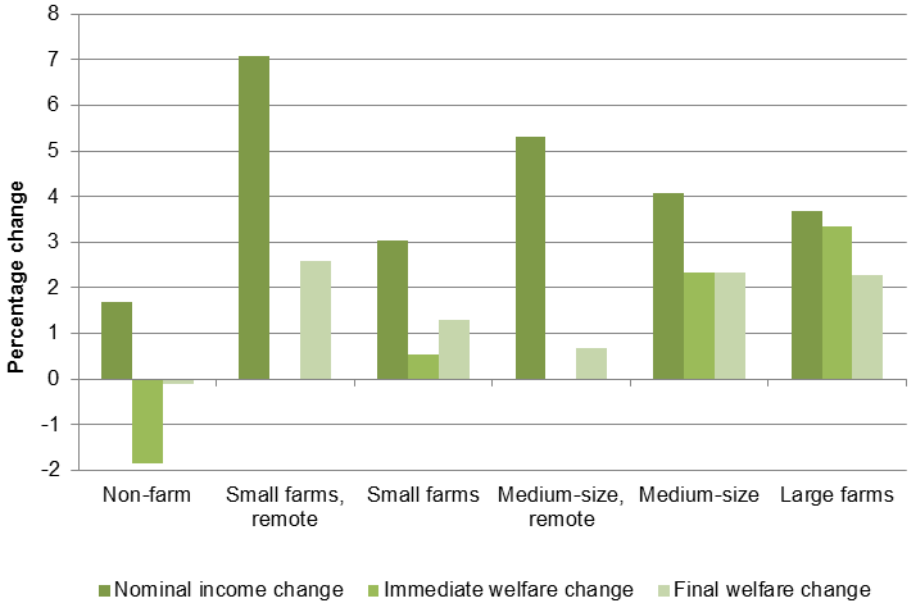
Figure 6 illustrates the difference between the three measures by showing results for one of the stylised policy simulations for Ghana: a 10% price support for the main food crop (tubers). The nominal income change is positive for each household group, ranging from less than 2% for non-farm households to 7% for small remote households. Rural non-farm households gain in nominal terms due to increased wage incomes, which, in turn are a result of increased agricultural labour demand. Small remote farm households benefit the most in nominal terms in this case, since the MPS policy allows them to enter the market and sell some of their production.

As soon as we take the loss in purchasing power into account, however, and study the immediate change in real income, the effect is smaller for all groups and even negative for rural non-farm households, whose consumption bundle is now more expensive, yet they have not had the chance to adjust their consumption or labour supply. Remote households see no immediate welfare effect, since they are assumed to be self-sufficient in the food crop before the policy shock and they are unable to adjust in the very short run to changes in market prices. Large farmers gain almost as much in real terms as in nominal terms, reflecting the fact that their losses on the consumption side are small relative to their gains on the production side.

The final welfare effect – when households have been able to adjust – may be smaller or larger than the immediate welfare effect. Rural non-farm households re-arrange their consumption bundle, substituting away from the now more costly food crop, while benefitting from higher wage income, making final welfare essentially the same as the initial level. Small remote farm households have a smaller final welfare effect than the immediate welfare effect, since part of their gain is eroded by higher consumer prices. The welfare gain by large farmers is somewhat smaller than their immediate welfare gain due to increased costs of hired labour.

As a static model, with some factors of production being fixed, DEVPEM is designed to show household response and welfare impacts in the medium run, that is, after households have been able to adjust the use of variable factors of production and consumption patterns. When analysing the welfare impacts of each policy, the focus is primarily on the final welfare change measure (all three welfare measures are provided in the full simulation results, available in Annex 1).

Figure 6. Three measures of the rural welfare effects of market price support for tubers in Ghana



Welfare effects of agricultural policies

Market price support

We ran MPS simulations for the main food crop, the main cash crop, and for livestock products. Figure 7 gives an overview of the results. Market price support for food crops harms rural non-farm households in five of the six countries, with consumption-side losses exceeding any gains from higher wage incomes. The food MPS policy has small welfare effects on all household groups in Guatemala, Nicaragua, and Viet Nam, whereas benefits are concentrated to large farmers in Malawi and Bangladesh. Only in Ghana is MPS for food able to raise welfare among all five farm household groups.

Since no one in the rural economy consumes the main cash crop, market interventions raising its price does not harm rural consumers. Consequently, according to the simulation results no one in the rural economy suffers welfare losses due to the cash crop MPS. Although non-farm households could potentially gain via an increased wage rate, the price change is not big enough to generate such an effect. The wage effect may be further limited by a relatively capital intensive technology used in cash crop production. With the exception of Ghana, where small farmers grow cocoa beans, the welfare effects of cash crop MPS are negligible also for small farmers and gains tend to be concentrated to medium-sized and large farmers (especially in the two Central-American countries, Guatemala and Nicaragua).

MPS for livestock products has the same weakness as MPS for food crops in that it hurts rural net-buyers. The simulation results suggest that non-farm households lose from livestock MPS in all six countries. Small farm households are either unaffected or suffer a small welfare loss in all countries but Nicaragua, where they gain significantly. In the two African countries and in Viet Nam effectively no one benefits from the policy. Gains are small in Bangladesh and Guatemala, the only case in which MPS for livestock significantly increases welfare being for medium-sized and large farmers in Nicaragua.

The relatively large welfare gains in Nicaragua are explained by the large share of livestock in the product mix of Nicaraguan farmers (Figure 5).

Figure 7. Rural household welfare impacts of market price support for food crops, cash crops and livestock

The general tendency in the simulation results is that non-farm households and small farmers are likely to lose from increased food prices. To the extent that the price support policies generate welfare gains, the gains tend to be concentrated among large farmers, who are able to benefit from their position as large net sellers.

Production subsidy

Production subsidies affect farmers on the producer side in the same way as market price support, but leave the consumer side unaffected. This is evident in the simulation results, which show that no household group loses from the PS policy. Figure 8 shows the simulation results of a PS for the main food crop in each country. Similar to the case of MPS, production subsidies tend to benefit medium-sized and large farmers more than small farmers. The relatively large benefits in Ghana reflect the high shares of income coming from food crops. Figure 9 shows the welfare effects for each household group, averaged across all six countries, for the MPS and the PS for the main food crop. The difference between the two highlights the negative consumer side effects of the MPS policy, which the PS policy does not have.

Figure 8. Household welfare impacts of a production subsidy for the main food crop

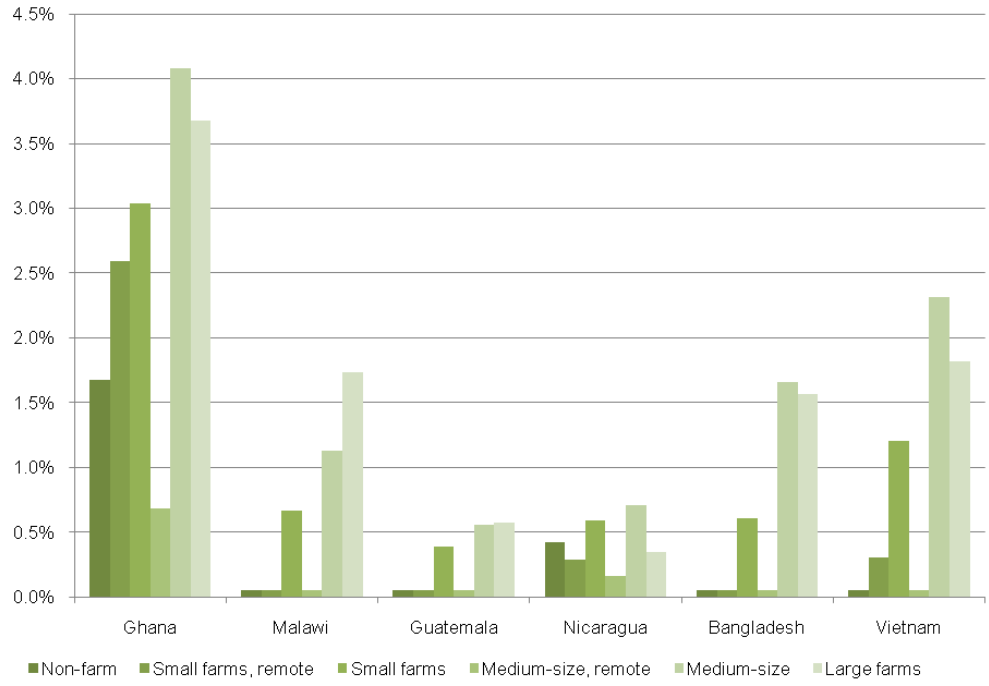
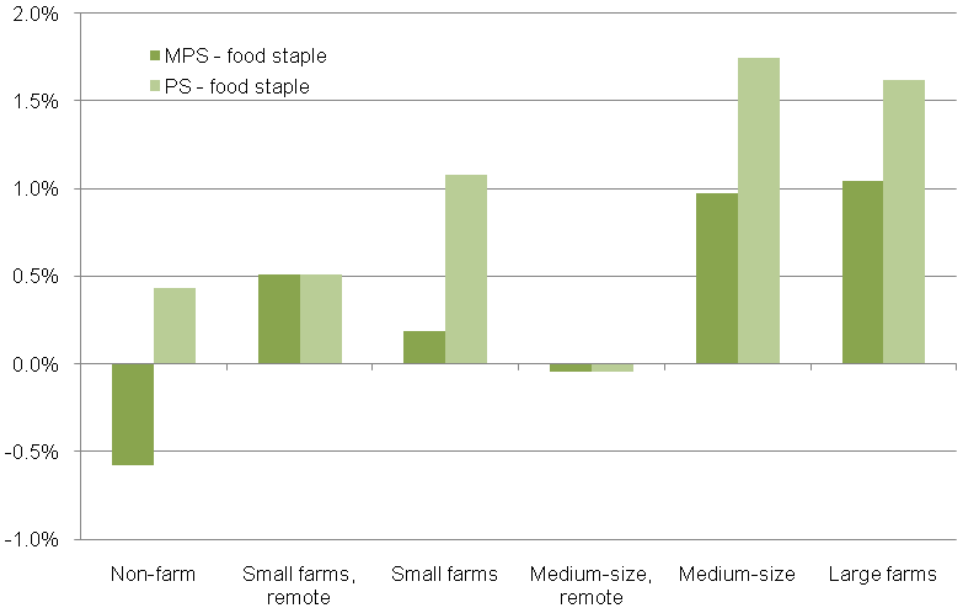


Figure 9. Rural welfare impacts of market price support (MPS) versus a production subsidy (PS)

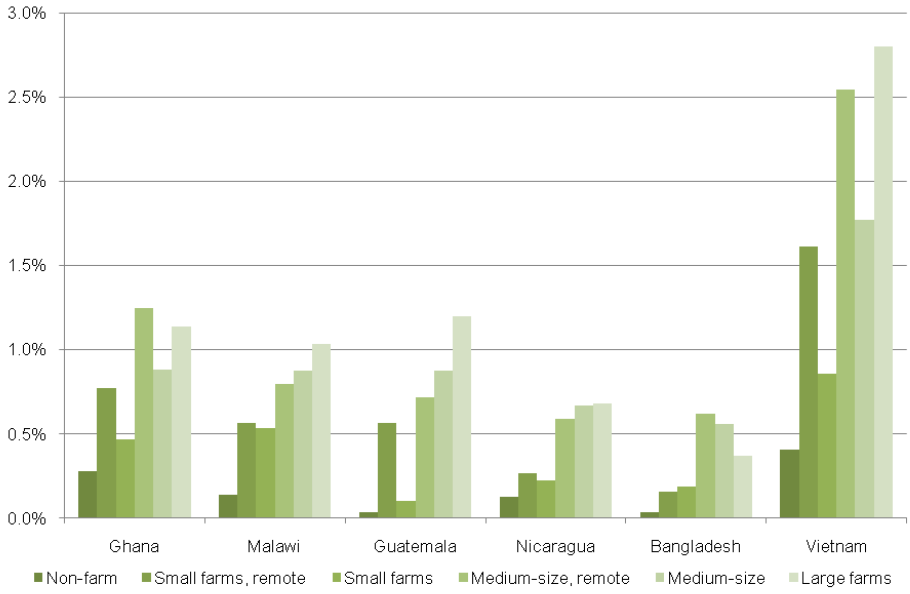


Input subsidies

The input subsidy experiment that we simulate involves giving farmers a 10% discount on purchases of intermediate inputs used in crop production. As we discussed, the simulations are run under two different assumptions about the structure of the market for these inputs, the benchmark assumption being that the price is endogenously determined and the alternative assumption being that the price is exogenously set at the world market price. It turns out that the welfare effects across household groups and across countries are about twice as large under the alternative assumption. This follows directly from the fact that there are no leakages as long as the suppliers are unable to affect the price (that is, raise the price above the world market price).

Figure 10, which shows results under the benchmark assumption of endogenous input prices, indicates that the welfare effects are generally in the range of 0.5 and 1% change, except in the case of Viet Nam, where they are between 1 and 2.5%. With few exceptions, and similar to other market-intervening policies, large farmers tend to gain more than small. While the final welfare change due to an input subsidy is the result of several behavioural changes and general-equilibrium effects, the effect is also determined by the intensity with which intermediate inputs are used in production. If fertiliser is subsidised, but certain groups of farmers use very little fertiliser, their direct cost savings will be small, and the price change may not generate any large substitution effects (i.e. using relatively more of the subsidised fertiliser and less of other factors of production). In general, the welfare impacts are similarly distributed, but about twice as large under the alternative assumption of exogenous input prices.

Figure 10. Rural welfare impacts of an input subsidy



An unconditional cash transfer

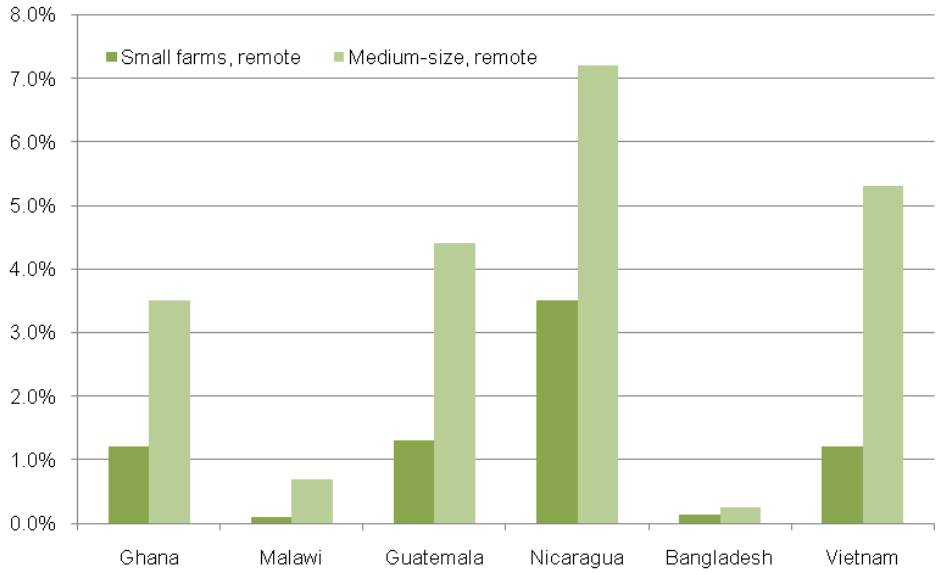
The way we designed the unconditional cash transfer simulation gives all farm households a cash transfer equal to 1% of their income. Theoretically, such a transfer could generate second round effects in such a way that final welfare among rural households increases by more than 1%. Some households may shift away from agricultural income, either by selling less of their product (and consuming more), or by reducing their agricultural production altogether. Others may increase their farm activity, if the transfer policy frees some resources for them to use as agricultural inputs. Yet other households may respond to a cash transfer by shifting their time away from wage labour, while others may increase their supply to the labour market. Non-farm households, who do not receive the transfer in this simulation, may also respond to the economic changes brought about by the behavioural responses of other households. In terms of simulation results, however, we are not able to find any such multiplier effects. Effectively all household groups in all countries experience exactly a 1% change in final welfare due to the transfer. Multiplier effects may only be visible with transfers of a larger magnitude or when additional constraints on household production, such as those arising from liquidity problems or risk aversion, are captured explicitly by the model and relaxed under the policy experiment.

Public good investment

The simulation of the public-good investment is designed so that remote households are freed from transaction costs on buying and selling agricultural commodities. Even though, theoretically, there may be positive spill-over effects to other household groups, such effects are not significant in the simulation results; in effect, only the two remote household groups are affected by the policy. As shown in Figure 11, the welfare effects on remote households vary greatly from country to country. The effects are close to zero in Bangladesh and Malawi, while there are increases of 5% and 7% for medium-size households in Nicaragua and Viet Nam respectively. The absence of benefits in

Bangladesh and Malawi suggests that remote households face constraints other than transaction costs. If, for example, these households have in general very small endowments of land and production equipment, they will be unable to respond by increasing their production to any large extent. While simplistic in its design, this simulation shows that lowering transaction costs could have substantial welfare effects. It also shows that the effects may be small, if remotely located farm households face additional constraints to expand their production (such as important factors or production or lack of knowledge about the most efficient farming techniques).

Figure 11. Welfare impacts of removing transaction costs for remotely located households



Distribution of policy benefits

In the previous sub-section we analysed how each policy experiment affects welfare at the household level. In this sub-section we look at how the aggregate change in rural welfare from each policy is distributed across household groups. This depends on the relative size of each household group, but also on how much each group produces and consumes the target commodity. As shown in Table 6, the household groups vary in relative size for each country. They are not defined as quintiles, but based on access to land and distance to markets. The biggest household groups are the *small non-remote* and *medium-sized non-remote* farm households, on average accounting for 38% and 27%, respectively, of all rural households. Medium-sized remote and large farm households account each account for on average 10%, while rural non-farm households and small remote households represent, are on average the smallest groups, representing less than 10% each. Hence, if policy impacts were distributed evenly across households, the group of small non-remote households would on average get the biggest share of the benefits.

Farm size and proximity to markets are in general both positively related to household income. In four of the six DEVPEM countries, small remote farm households have the lowest average income. In five out of six cases, large farmers have the highest average income. Rural non-farm households tend to be relatively poor, with the second lowest income in four out of six cases. Viet Nam is an exception, with the rural non-farm household group the richest and large farmers have the lowest average income, according to the RIGA database. On balance, for a policy to be considered pro-poor, it would need to give the small remote farm households and the non-farm households disproportionately large shares of the benefits.

Table 6. Relative size of household groups and average income

		Non-farm	Small remote	Small non-remote	Medium remote	Medium non-remote	Large farm
Ghana	Share of households	8%	4%	29%	11%	34%	13%
	Income index	100	88	103	117	109	156
Malawi	Share of households	3%	6%	25%	14%	38%	14%
	Income index	100	100	129	144	153	205
Guatemala	Share of households	7%	9%	50%	6%	20%	8%
	Income index	100	84	112	79	99	117
Nicaragua	Share of households	6%	10%	48%	9%	19%	7%
	Income index	100	79	120	100	118	127
Bangladesh	Share of households	13%	11%	42%	6%	20%	8%
	Income index	100	84	100	99	121	139
Viet Nam	Share of households	7%	5%	31%	12%	33%	12%
	Income index	100	50	79	34	68	33
Average	*Share of households*	*7%*	*8%*	*38%*	*10%*	*27%*	*10%*
	Income index	*100*	*81*	*107*	*96*	*111*	*130*

Note: The income index is 100 for non-farm households in each country.

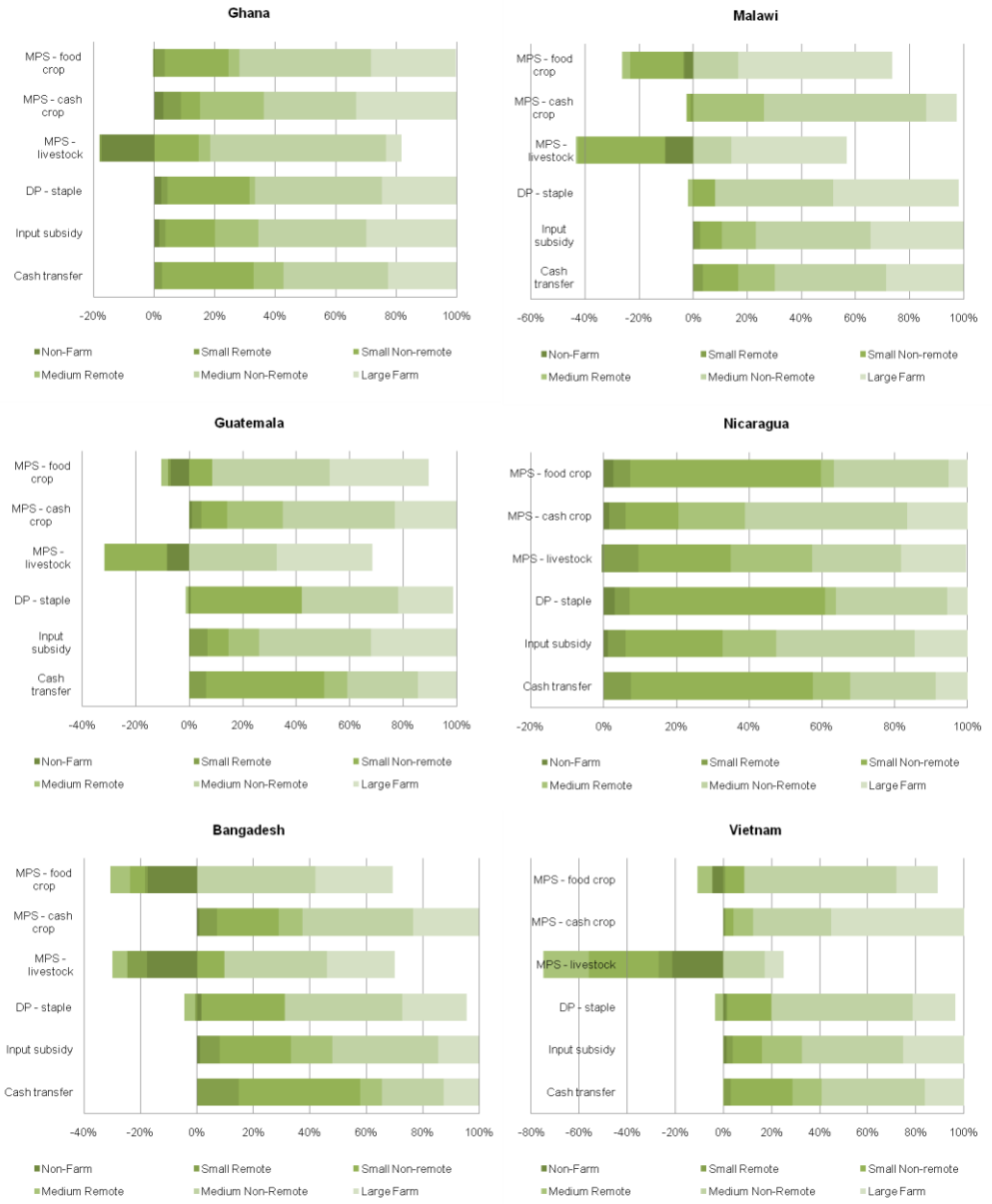
Source: The income index is based on total household income estimates from the RIGA database, *www.fao.org/economic/riga*.

As we saw in the simulation results above, there are household groups that lose from some policies. In terms of measuring the distribution of welfare changes, it is necessary to decide on the total welfare change that needs to be distributed, and how to account for negative values. One possibility is to report the change (positive or negative) divided by the aggregate net welfare change; the other is to report the welfare change as a share of the sum of absolute welfare changes. The former approach may be slightly more intuitive, but if the aggregate welfare change is small due to gains and losses cancelling each other out, the shares in percentage terms may get arbitrarily large. The latter approach may be slightly less intuitive but has the benefit of providing shares that are in the range from -100 to100%. We use this latter approach here, but report the benefit shares based on the net approach in Annex 1, which contains the detailed simulation results for all countries.

Figure 12 gives an overview of the distribution of the aggregate welfare gains and losses in the rural economy for each policy in each country. In general, the welfare impacts are distributed unequally across the household groups. In very few cases do small farm households get a share of the benefit that corresponds to their size as a group. The one exception is in the case of the market price support policy in Nicaragua, for which small non-remote farm households get about 50% of the benefit while accounting for an equally large share of the rural households. In contrast, large farm households tend to get a disproportionately large share of the benefits, considering their size as a group (only 10% of the number of households). On average, they account for 22% to 30% of the welfare changes across policies and countries. Across countries, non-farm households and small farm households (remote and non-remote) typically get a disproportionately small share of the welfare gains for every policy, meaning that their share of the benefit is smaller than their relative size as household groups. The opposite is true for large and medium-sized non-remote households, which, for each policy, on average get a disproportionately large share of the benefit.

In terms of policy-specific observations, it can be noted that, in the case of market price support for food crops, medium-sized non-remote and large households share the bulk of the welfare gains in all countries but Nicaragua. These two groups receive on average 70% of the benefits, whereas they constitute 37% of all households. Losses are negligible in Ghana and Nicaragua, while being particularly sizeable in Malawi and Bangladesh, accounting for about 30% of welfare changes. For cash-crop MPS, the gains are also concentrated among medium-sized non-remote and large farm households. The negative welfare effects are particularly large for MPS policies on livestock. In the specific case of livestock MPS policy in Viet Nam, the losses faced by four of the household groups account for more than 75% of the total welfare changes. This is the only case in which rural welfare losses are actually greater than total rural welfare gains. With production subsidies for food crops and input subsidies, medium non-remote and large farm households account for 75% of the aggregate effects. The policy least skewed towards large and non-remote medium-sized farm households is the cash transfer, for which these two groups receive 50% of the aggregate welfare gains. Overall, none of the policies are pro-poor in the sense of giving a greater share of the benefits to lower income households than their share in the number of households.

Figure 12. Distribution of welfare gains and losses of various policies among household groups



Assessing the relative efficiency of policies

Our third policy impact measure aims to capture the overall cost efficiency of each policy. We assume that all explicit costs of the policy, in terms of taxpayer costs, are borne by the urban population. For policies affecting urban consumer prices (the MPS policies), urban households also face implicit costs in the form of consumer surplus losses.[6] We define the policy's cost efficiency as the ratio of the aggregate change in rural household welfare to the urban cost of the policy. In other words, our policy efficiency measure gives the rural dollar welfare change for every dollar of cost imposed on urban consumers and taxpayers. The efficiency measure disregards the distribution of the rural welfare gains and only considers the aggregate change.[7] In addition, it does not reflect influences not captured explicitly in the model, including a loosening of liquidity or risk constraints that could, in theory, produce efficiency rates greater than 1.0. Moreover, as noted earlier, there may be other significant costs and benefits that are not captured by the model.

The efficiency measures from the different policies are summarised in Table 7. The benchmark experiment of an unconditional cash transfer, as designed, has a cost efficiency of 100%. As we discussed, we do not take into account any administrative costs or implementation failures but simply assume that each farm households is given a transfer equal to 1% of its income.

Table 7. Aggregate cost efficiency of policies, in the order of average level of efficiency

	Malawi	Ghana	Guatemala	Nicaragua	Bangladesh	Viet Nam	*Average*
Unconditional cash transfer	100%	100%	100%	100%	100%	100%	*100%*
IS, exogenous price	90%	90%	81%	100%	91%	92%	*91%*
PS, livestock products	89%	93%	87%	65%	63%	50%	*75%*
PS, main food staple	78%	76%	76%	75%	67%	63%	*72%*
MPS, main cash crop	54%	47%	83%	84%	63%	72%	*67%*
IS, endogenous price	56%	57%	46%	60%	53%	52%	*54%*
MPS, main food staple	47%	62%	46%	71%	30%	44%	*50%*
MPS, livestock products	23%	67%	49%	61%	29%	0%	*38%*

Note: MPS – market price support (10% of market price), PS – deficiency payment (10% of market price), IS – input subsidy (10% of market price). Policy efficiency is negative in the case of livestock MPS for Viet Nam.

6. These consumer losses are calculated outside the model assuming an urban own price elasticity of demand of -1 for food crop and livestock consumption. Given that demand is more likely to be relatively inelastic, the resulting cost efficiency ratios for food price support place a lower bound on the urban costs and an upper bound on cost efficiency.

7. The measure of cost efficiency bears some similarity to the concept of "transfer efficiency" used in the PEM studies, which measures the gain in net farm income for a given policy relative to the cost to consumers and taxpayers. DEVPEM cannot give a meaningful interpretation to this ratio, due to the joint role of farm households as producers and consumers of food, i.e. unlike in PEM there is an overlap between those who pay for the policy and those who benefit from it. The measure adopted here has the advantage of separating clearly two constituencies: the urban economy, which pays all taxpayer costs but may incur some consumer losses, and the rural economy, which constitutes the intended beneficiaries of the policy, even though some household groups may lose.

The underlying model assumptions affect the ranking of policy instruments in terms of cost efficiency. The input subsidy is, on average, the most efficient policy after a cash transfer, under the alternative assumption that the price of the targeted input (e.g. fertiliser) is exogenous. On average, of each urban dollar spent on the policy, 91 cents are transferred as welfare improvements among rural households. If, however, the price of the targeted input is not exogenous but rises due to changes in rural demand, the average level of efficiency falls to 54 cents per urban dollar spent on the policy. Among the policies that involve interventions in commodity markets, those without negative consumer side-effects have higher levels of efficiency. The efficiency of the deficiency payment exceeds 70%, while the efficiency of MPS to cash crops is on average 67%. The policies with the lowest levels of efficiency are those that harm rural households on the consumption side, namely price supports for food crops and livestock products, with efficiency levels below 50% in many cases. The efficiency of these measures drops further if input prices rise due to increases in rural demand.

In terms of country-specific observations, Malawi follows the average efficiency ranking of policies, whereas in Ghana, the predominance of net sellers means that the efficiency of MPS for food crops and livestock products is relatively high despite negative consumer side-effects. In Guatemala and Nicaragua, MPS for cash crops is relatively efficient in raising farm household welfare, while also distributing benefits relatively evenly among household groups. In Bangladesh and Viet Nam, the efficiency of MPS for food crops and livestock products is particularly low, implying major losses on the consumption side for rural households. While patterns differ across countries, the general conclusion is that input subsidies are the most cost efficient instrument after cash, provided that input prices do not rise as a result of increases in demand. If prices rise, the efficiency of input subsidies might be no higher than interventions in agricultural output markets, which do not to affect consumer prices. In general, production subsidies tend to be more cost effective than market price supports. This is because they affect neither rural nor urban consumer prices, so the rural net benefits are higher and the urban costs are lower.

5. Conclusions

The results of the DEVPEM simulations show that, for alternative policy instruments, there are significant differences in household-level impacts across countries. The observed effects also differ in some systemic ways with those found in OECD countries. Some general findings stand out.

The first point to note is that no untargeted agricultural policy intervention is pro-poor within the rural economy. Market price support for food crops harms net buyers of food, often the poorest farm and non-farm (landless) households, although the proportion of net buyers varies significantly across countries. Support for cash crops does not have this drawback; however, cash crops are in most cases grown by farmers with relatively high incomes, so support seldom reaches the incomes of the poorest.

An untargeted cash transfer based on current income aggravates rural income inequality, but by less than untargeted agricultural policies, and in principle a cash transfer can be targeted to low income households. In policy terms, the question is therefore whether there are considerations outside the scope of the model which might militate against the use of direct transfers. One is administrative difficulties, for example due to the absence of a population registry, or because of concerns about corruption (although these concerns also apply to other instruments). Another is the possibility of

dynamic gains from market interventions, in terms of enabling farmers to break out of poverty traps. These issues are outside the scope of the DEMPEM model but are considered in *Agricultural Policies for Poverty Reduction: A Synthesis (OECD, 2011)*.

Input subsidies tend to benefit those farmers who are using inputs already – often larger farmers. The extent to which the benefits of support are retained by farmers depends, as with output-related support, partly on the degree to which the price of inputs rises in response to the increase in input demand. Parallel investments that increase distribution capacity and help keep marginal distribution costs constant would reduce the leakage of benefits away from the farmer. Input subsidies can also in principle be targeted to improve their distributional outcomes.

A significant finding is that public investment in reducing transaction costs is the only pro-poor instrument, since it helps remote farm households, who are typically poorer than those engaged with markets. However, we do not know the cost of generating these improvements.

In general, the results show that direct payments are the most efficient way of boosting incomes in the short-term, while public investments, which should have broader long-term pay-offs, have short to medium term impacts that are pro-poor. These results are fully consistent with the best practice advice established for OECD countries of using social policies to safeguard incomes in the short term, and non-distorting public investments to boost competitiveness in the long term.

In general, farmers are less likely to rent land than in OECD countries and they tend to purchase fewer inputs. This means that some of the leakages away from the farm level that are important in developed OECD countries may be less of an issue in poorer developing countries.

In contrast to OECD countries, the efficiency of some market interventions, notably input subsidies, is not always dramatically inferior to the preferred mechanism of transferring cash directly. This result may have implications if the instruments can be targeted and if other factors germane to policy design and implementation are sufficiently important. Thus, while the DEVPEM results are instructive, they do not independently provide a sufficient basis for decisions on instrument choice.

Some features of developing country agriculture that DEVPEM is currently unable to capture, such as liquidity or risk constraints, could be addressed by further development of the model. Such a development could provide insights into a wider range of policy impacts.

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Annex 1.

Detailed simulation results

The eight tables in this annex provide detailed results from each of the policy simulations. Tables A1.1-A1.6 provide results by country and Table A1.7 gives the averages of the results across all six countries. Table A1.8 provides the aggregate effects of each policy, including each the cost efficiency of each policy. The following information is reported.

Tables A1.1–A1.7

[1] *Nominal income change, %*: The percentage change in nominal income (from agricultural production and wage labour) for each household group, after behavioural adjustments in the rural economy. (See Section 4.2 for details.)

[2] *Immediate welfare change, %*: The percentage change in real income (purchasing power) for each household group, before any behavioural adjustments has taken place in the rural economy. (See Section 4.2 for details.)

[3] *Final welfare change, %*: The percentage change in real income (purchasing power) for each household group, after behavioural adjustments in the rural economy, essentially answering the question: "What is the amount of income that could be taken away from the household (or would need to be given to the household) to bring it back to the welfare level it had before the policy shock?"

[4] *Final welfare change (LCU)*: The welfare change for each household group, expressed in local currency units (LCU); the numerator of measure [3]. Table A1.7 does not report [4] since local currency units are not comparable across countries.

[5] *Share of welfare change*: The change in welfare for each household group, expressed in per cent of all welfare changes. For each household group *h*, it is defined as $[4]_h \div \Sigma_h \text{abs}[4]_h$, where 'abs' denotes absolute value.

[6] *Share of net benefit*: The change in welfare for each household group, expressed in per cent of the aggregate net welfare change. For each household group h, it is defined as $[4]_h \div \Sigma_h [4]_h$. Thus the difference between [5] and [6] is that the former uses the sum of absolute welfare changes as denominator, while the latter uses the sum of welfare changes (which equals the aggregate net welfare change).

Table A1.8

[1] – [4] at the aggregate (economy-wide) level

[5] *Urban cost of policy*: The estimated cost of each policy to urban households, in terms of tax payments and losses in consumer surplus.

[6] *Policy cost efficiency*: The cost efficiency of the policy, defined as the ratio of rural net benefits to urban costs, that is, [4] ÷ [5].

Abbreviations

MPS – market price support

PS – production subsidy

IS – input subsidy

Table A1.1. Bangladesh – detailed simulation results

	[1]	[2]	[3]	[4]	[5]	[6]
BANGLADESH	Nominal income change, %	Immediate welfare change, %	Final welfare change, %	Final welfare change (LCU)	Share of welfare change	Share of net benefit
MPS – food staple						
Non-farm	0.12	-0.97	-0.81	-104	-17%	-45%
Small remote	0.52	0.00	-0.04	-6	-1%	-3%
Small non-remote	0.60	-0.13	-0.06	-31	-5%	-14%
Medium remote	2.07	0.00	-0.44	-42	-7%	-18%
Medium non-remote	1.66	1.25	0.91	251	42%	109%
Large farm	1.57	1.61	1.02	163	27%	71%
MPS – cash crop						
Non-farm	0.01	0.00	0.01	2	1%	1%
Small remote	0.14	0.05	0.06	11	6%	6%
Small non-remote	0.07	0.06	0.07	39	22%	22%
Medium remote	0.57	0.22	0.16	15	9%	9%
Medium non-remote	0.26	0.24	0.26	71	39%	39%
Large farm	0.27	0.32	0.27	42	23%	23%
MPS – livestock						
Non-farm	0.01	-0.59	-0.56	-72	-18%	-44%
Small remote	0.04	0.00	-0.15	-28	-7%	-17%
Small non-remote	0.45	0.17	0.07	39	10%	24%
Medium remote	0.17	0.00	-0.22	-21	-5%	-13%
Medium non-remote	1.01	0.86	0.53	147	36%	90%
Large farm	1.02	1.00	0.61	97	24%	60%
PS – food staple						
Non-farm	0.12	0.00	0.12	15	1%	2%
Small remote	0.52	0.00	-0.04	-6	-1%	-1%
Small non-remote	0.60	0.56	0.60	327	30%	33%
Medium remote	2.07	0.00	-0.44	-42	-4%	-4%
Medium non-remote	1.66	2.03	1.66	457	42%	46%
Large farm	1.57	2.18	1.57	250	23%	25%

Table A1.1. Bangladesh – detailed simulation results *(cont.)*

	[1]	[2]	[3]	[4]	[5]	[6]
BANGLADESH	Nominal income change, %	Immediate welfare change, %	Final welfare change, %	Final welfare change (LCU)	Share of welfare change	Share of net benefit
PS – livestock						
Non-farm	0.01	0.00	0.01	1	0%	0%
Small remote	0.04	0.00	-0.15	-28	-4%	-4%
Small non-remote	0.45	0.57	0.45	243	33%	38%
Medium remote	0.17	0.00	-0.22	-21	-3%	-3%
Medium non-remote	1.01	1.36	1.01	278	38%	44%
Large farm	1.02	1.43	1.02	163	22%	26%
IS – endogenous price						
Non-farm	0.03	0.00	0.03	4	1%	1%
Small remote	0.14	0.25	0.16	29	7%	7%
Small non-remote	0.19	0.29	0.19	102	25%	25%
Medium remote	0.59	1.07	0.62	60	15%	15%
Medium non-remote	0.56	0.98	0.56	154	38%	38%
Large farm	0.37	0.78	0.37	59	15%	15%
IS – exogenous price						
Non-farm	0.06	0.00	0.06	8	1%	1%
Small remote	0.27	0.25	0.29	54	7%	7%
Small non-remote	0.36	0.29	0.36	194	25%	25%
Medium remote	1.11	1.07	1.15	111	15%	15%
Medium non-remote	1.04	0.98	1.04	286	38%	38%
Large farm	0.69	0.78	0.69	109	14%	14%
Cash transfer						
Non-farm	0.00	0.00	0.00	0	0%	0%
Small remote	1.03	1.00	1.00	183	15%	15%
Small non-remote	1.00	1.00	1.00	540	43%	43%
Medium remote	1.19	1.00	1.00	96	8%	8%
Medium non-remote	1.00	1.00	1.00	274	22%	22%
Large farm	0.99	1.00	0.99	158	13%	13%
Public-good investment						
Non-farm	0.0	0.0	0.0	0.6	1%	1%
Small remote	0.1	0.0	0.1	17.5	36%	36%
Small non-remote	0.0	0.0	0.0	3.8	8%	8%
Medium remote	0.2	0.0	0.2	23.8	48%	48%
Medium non-remote	0.0	0.0	0.0	3.4	7%	7%
Large farm	0.0	0.0	0.0	0.1	0%	0%

Table A1.2. Ghana – detailed simulation results

	[1]	[2]	[3]	[4]	[5]	[6]
GHANA	Nominal income change, %	Immediate welfare change, %	Final welfare change, %	Final welfare change (LCU)	Share of welfare change	Share of net benefit
MPS – food staple						
Non-farm	1.68	-1.86	-0.11	-1	0%	0%
Small remote	7.08	0.00	2.60	14	3%	3%
Small non-remote	3.04	0.54	1.29	86	21%	21%
Medium remote	5.32	0.00	0.68	15	4%	4%
Medium non-remote	4.08	2.35	2.32	177	44%	44%
Large Farm	3.68	3.34	2.29	114	28%	28%
MPS – cash crop						
Non-farm	0.34	0.00	0.34	3	3%	3%
Small remote	2.25	0.41	1.26	7	6%	6%
Small non-remote	0.11	0.05	0.11	7	6%	6%
Medium remote	2.21	1.06	1.15	25	21%	21%
Medium non-remote	0.47	0.32	0.47	36	30%	30%
Large farm	0.78	1.05	0.78	39	33%	33%
MPS – livestock						
Non-farm	0.01	-0.36	-0.34	-4	-17%	-27%
Small remote	0.02	0.00	-0.03	0	-1%	-1%
Small non-remote	0.22	0.01	0.04	3	15%	23%
Medium Remote	0.03	0.00	0.04	1	4%	6%
Medium non-remote	0.30	0.08	0.15	12	58%	91%
Large farm	0.31	-0.05	0.02	1	5%	8%
PS – food staple						
Non-farm	1.68	0.00	1.68	17	2%	2%
Small remote	7.08	0.00	2.60	14	2%	2%
Small non-remote	3.04	2.35	3.04	202	27%	27%
Medium remote	5.32	0.00	0.68	15	2%	2%
Medium non-remote	4.08	4.18	4.08	311	42%	42%
Large farm	3.68	4.79	3.68	183	25%	25%

Table A1.2. Ghana – detailed simulation results *(cont.)*

	[1]	[2]	[3]	[4]	[5]	[6]
GHANA	Nominal income change, %	Immediate welfare change, %	Final welfare change, %	Final welfare change (LCU)	Share of welfare change	Share of net benefit
PS – livestock						
Non-farm	0.01	0.00	0.01	0	0%	0%
Small remote	0.02	0.00	-0.03	0	0%	0%
Small non-remote	0.22	0.20	0.22	15	27%	28%
Medium remote	0.03	0.00	0.04	1	1%	1%
Medium non-remote	0.30	0.23	0.30	23	42%	43%
Large farm	0.31	0.25	0.31	15	28%	29%
IS – endogenous price						
Non-farm	0.28	0.00	0.28	3	2%	2%
Small remote	1.17	0.54	0.77	4	2%	2%
Small non-remote	0.46	0.60	0.46	31	16%	16%
Medium remote	1.19	1.82	1.25	27	14%	14%
Medium non-remote	0.88	1.54	0.88	67	36%	36%
Large farm	1.14	2.13	1.14	57	30%	30%
IS – exogenous price						
Non-farm	0.47	0.00	0.47	5	2%	2%
Small remote	1.96	0.54	1.30	7	2%	2%
Small non-remote	0.78	0.60	0.78	52	16%	16%
Medium remote	2.00	1.82	2.10	45	14%	14%
Medium non-remote	1.47	1.54	1.47	112	36%	36%
Large farm	1.90	2.13	1.90	94	30%	30%
Cash transfer						
Non-farm	0.00		0.00	0	0%	0%
Small remote	1.06	1.00	1.01	5	3%	3%
Small non-remote	1.00	1.00	1.00	66	30%	30%
Medium remote	1.05	1.00	1.00	21	10%	10%
Medium non-remote	1.00	1.00	1.00	76	35%	35%
Large farm	1.00	1.00	1.00	50	23%	23%
Public-good investment						
Non-farm	0.2	0.0	0.2	1.9	2%	2%
Small remote	1.2	0.0	1.2	6.8	7%	8%
Small non-remote	0.1	0.0	0.1	4.5	5%	6%
Medium remote	5.0	0.0	3.5	74.4	79%	93%
Medium non-remote	0.0	0.0	0.0	-2.1	-2%	-3%
Large farm	-0.1	0.0	-0.1	-5.1	-5%	-6%

Table A1.3. Guatemala – detailed simulation results

	[1]	[2]	[3]	[4]	[5]	[6]
GUATEMALA	Nominal income change, %	Immediate welfare change, %	Final welfare change, %	Final welfare change (LCU)	Share of welfare change	Share of net benefit
MPS – food staple						
Non-farm	0.04	-0.30	-0.25	-2	-7%	-9%
Small remote	0.10		-0.03	0	-1%	-1%
Small non-remote	0.38	-0.01	0.03	2	8%	11%
Medium remote	0.05		-0.04	-1	-2%	-3%
Medium non-remote	0.56	0.25	0.26	10	44%	55%
Large farm	0.57	0.44	0.40	8	37%	47%
MPS – cash crop						
non-farm	0.23		0.23	1	1%	1%
Small remote	1.25	0.58	0.62	5	3%	3%
Small non-remote	0.25	0.22	0.25	15	10%	10%
Medium remote	3.33	2.62	2.70	33	21%	21%
Medium non-remote	1.78	1.79	1.78	65	42%	42%
Large farm	1.77	1.94	1.77	36	23%	23%
MPS – livestock						
Non-farm	0.25	-1.44	-1.13	-7	-8%	-23%
Small remote	1.98	0.00	-0.02	0	0%	-1%
Small non-remote	0.61	-0.39	-0.32	-20	-23%	-62%
Medium remote	1.43	0.00	-0.01	0	0%	0%
Medium non-remote	1.23	0.83	0.76	28	33%	89%
Large Farm	1.82	1.56	1.49	30	36%	97%
PS – food staple						
Non-Farm	0.04		0.04	0	0%	0%
Small Remote	0.10		-0.03	0	0%	0%
Small Non-remote	0.38	0.36	0.38	24	42%	43%
Medium Remote	0.05		-0.04	-1	-1%	-1%
Medium non-remote	0.56	0.57	0.56	20	36%	37%
Large farm	0.57	0.63	0.57	12	21%	21%

Table A1.3. Guatemala – detailed simulation results *(cont.)*

	[1]	[2]	[3]	[4]	[5]	[6]
GUATEMALA	Nominal income change, %	Immediate welfare change, %	Final welfare change, %	Final welfare change (LCU)	Share of welfare change	Share of net benefit
PS – livestock						
Non-farm	0.24		0.24	1	1%	1%
Small remote	0.64		-0.05	0	0%	0%
Small Non-remote	0.62	0.58	0.62	38	30%	31%
Medium remote	0.56		-0.04	0	0%	0%
Medium non-remote	1.28	1.32	1.28	47	37%	38%
Large farm	1.89	1.91	1.89	39	31%	31%
IS – endogenous price						
Non-farm	0.03		0.03	0	0%	0%
Small remote	0.25	0.87	0.56	5	6%	6%
Small non-remote	0.10	0.66	0.10	6	8%	8%
Medium remote	0.46	1.12	0.72	9	11%	11%
Medium non-remote	0.88	1.39	0.88	32	42%	42%
Large farm	1.20	1.89	1.20	24	32%	32%
IS – exogenous price						
Non-farm	0.18		0.18	1	1%	1%
Small remote	0.74	0.87	1.03	9	6%	6%
Small non-remote	0.41	0.66	0.41	25	17%	17%
Medium remote	1.03	1.12	1.28	16	11%	11%
Medium non-remote	1.46	1.39	1.46	53	37%	37%
Large farm	1.94	1.89	1.94	40	28%	28%
Cash transfer						
Non-farm	0.00		0.00	0	0%	0%
Small remote	1.14	1.00	1.00	9	6%	6%
Small non-remote	1.00	1.00	1.00	61	44%	44%
Medium remote	1.08	1.00	1.00	12	9%	9%
Medium non-remote	1.00	1.00	1.00	36	26%	26%
Large Farm	0.99	1.00	0.99	20	15%	15%
Public-good investment						
Non-farm	0.1	0.0	0.1	0.8	1%	1%
Small remote	2.9	0.0	1.3	10.9	15%	19%
Small non-remote	0.0	0.0	0.0	-0.1	0%	0%
Medium remote	5.6	0.0	4.4	53.6	74%	93%
Medium non-remote	-0.1	0.0	-0.1	-3.6	-5%	-6%
Large farm	-0.2	0.0	-0.2	-3.8	-5%	-7%

Table A1.4. Malawi – detailed simulation results

	[1]	[2]	[3]	[4]	[5]	[6]
MALAWI	Nominal income change, %	Immediate welfare change, %	Final welfare change, %	Final welfare change (LCU)	Share of welfare change	Share of net benefit
MPS – food staple						
Non-farm	0.01	-1.78	-1.71	-2	-3%	-7%
Small remote	0.03		-0.08	0	0%	-1%
Small non-remote	0.67	-1.03	-0.93	-12	-20%	-42%
Medium remote	0.01		-0.13	-2	-3%	-6%
Medium non-remote	1.13	0.20	0.25	10	17%	35%
Large farm	1.74	1.23	1.22	36	57%	120%
MPS – cash crop						
Non-farm	0.00		0.00	0	0%	0%
Small remote	0.02		-0.08	0	-1%	-1%
Small non-remote	-0.04	0.03	-0.04	-1	-2%	-2%
Medium remote	1.21	0.65	0.59	8	26%	28%
Medium non-remote	0.44	0.50	0.44	19	60%	63%
Large farm	0.12	0.25	0.12	4	11%	12%
MPS – livestock						
Non-farm	0.01	-1.45	-1.37	-2	-10%	-77%
Small remote	0.09	0.00	-0.01	0	0%	-2%
Small non-remote	0.52	-0.45	-0.38	-5	-32%	-241%
Medium remote	0.10		-0.01	0	-1%	-5%
Medium non-remote	0.48	0.01	0.05	2	14%	105%
Large Farm	0.53	0.19	0.23	7	43%	320%
PS – food staple						
Non-farm	0.01		0.01	0	0%	0%
Small remote	0.03		-0.08	0	0%	0%
Small non-remote	0.67	0.64	0.67	9	8%	8%
Medium remote	0.01		-0.13	-2	-2%	-2%
Medium non-remote	1.13	1.13	1.13	48	44%	45%
Large farm	1.74	1.77	1.74	51	46%	48%

Table A1.4. Malawi – detailed simulation results *(cont.)*

	[1]	[2]	[3]	[4]	[5]	[6]
MALAWI	Nominal income change, %	Immediate welfare change, %	Final welfare change, %	Final welfare change (LCU)	Share of welfare change	Share of net benefit
PS – livestock						
Non-farm	0.01		0.01	0	0%	0%
Small remote	0.00		-0.01	0	0%	0%
Small non-remote	0.52	0.50	0.52	7	16%	16%
Medium remote	0.09		-0.01	0	0%	0%
Medium non-remote	0.48	0.46	0.48	20	47%	48%
Large Farm	0.53	0.50	0.53	15	36%	36%
IS – endogenous price						
Non-farm	0.14		0.14	0	0%	0%
Small remote	0.74	0.82	0.56	2	2%	2%
Small non-remote	0.53	0.73	0.53	7	8%	8%
Medium remote	1.01	1.29	0.80	11	13%	13%
Medium non-remote	0.88	1.41	0.88	37	42%	42%
Large farm	1.03	1.78	1.03	30	35%	35%
IS – exogenous price						
Non-farm	0.24		0.24	0	0%	0%
Small remote	1.25	0.82	0.95	3	2%	2%
Small non-remote	0.90	0.73	0.90	12	8%	8%
Medium remote	1.70	1.29	1.34	19	13%	13%
Medium non-remote	1.47	1.41	1.47	62	42%	42%
Large farm	1.73	1.78	1.73	51	35%	35%
Cash transfer						
Non-farm	0.01		0.01	0	0%	0%
Small remote	1.27	1.00	1.00	4	4%	4%
Small non-remote	1.00	1.00	1.00	13	13%	13%
Medium remote	1.27	1.00	1.00	14	14%	14%
Medium non-remote	1.00	1.00	1.00	42	41%	41%
Large farm	1.00	1.00	1.00	29	29%	29%
Public-good investment						
Non-farm	0.0	0.0	0.0	0.0	0%	0%
Small remote	-0.5	0.0	0.1	0.3	2%	4%
Small non-remote	0.0	0.0	0.0	-0.3	-2%	-4%
Medium remote	0.7	0.0	0.7	9.7	72%	149%
Medium non-remote	0.0	0.0	0.0	-1.7	-13%	-26%
Large farm	-0.1	0.0	-0.1	-1.5	-11%	-23%

Table A1.5. Nicaragua – detailed simulation results

	[1]	[2]	[3]	[4]	[5]	[6]
NICARAGUA	Nominal income change, %	Immediate welfare change, %	Final welfare change, %	Final welfare change (LCU)	Share of welfare change	Share of net benefit
MPS – food staple						
Non-farm	0.42	-0.11	0.31	0	3%	3%
Small remote	0.71		0.29	1	5%	5%
Small non-remote	0.59	0.20	0.49	8	52%	52%
Medium remote	0.84		0.16	1	4%	4%
Medium non-remote	0.71	0.51	0.63	5	32%	32%
Large farm	0.35	0.85	0.28	1	5%	5%
MPS – cash crop						
Non-farm	0.44		0.44	1	1%	1%
Small remote	1.17	0.30	0.68	2	4%	4%
Small non-remote	0.34	0.18	0.34	5	15%	15%
Medium remote	3.18	1.93	2.04	7	18%	18%
Medium non-remote	2.20	2.03	2.20	16	45%	45%
Large farm	2.18	2.76	2.18	6	17%	17%
MPS – livestock						
Non-farm	0.77	-1.03	-0.21	0	0%	0%
Small remote	3.66	2.80	2.31	6	10%	10%
Small non-remote	1.54	0.92	0.92	15	25%	26%
Medium remote	5.77	4.82	3.93	13	22%	23%
Medium non-remote	2.30	2.54	1.89	14	24%	25%
Large farm	4.11	7.46	3.67	10	18%	18%
PS – food staple						
Non-farm	0.42		0.42	1	3%	3%
Small remote	0.71		0.29	1	4%	4%
Small non-remote	0.59	0.30	0.59	9	54%	54%
Medium remote	0.84		0.16	1	3%	3%
Medium non-remote	0.71	0.59	0.71	5	30%	30%
Large farm	0.35	0.92	0.35	1	6%	6%

Table A1.5. Nicaragua – detailed simulation results *(cont.)*

	[1]	[2]	[3]	[4]	[5]	[6]
NICARAGUA	Nominal income change, %	Immediate welfare change, %	Final welfare change, %	Final welfare change (LCU)	Share of welfare change	Share of net benefit
PS – livestock						
Non-farm	0.51		0.51	1	1%	1%
Small remote	0.09		-0.25	-1	-1%	-1%
Small non-remote	1.54	1.57	1.54	24	41%	44%
Medium remote	-0.01		-0.41	-1	-2%	-2%
Medium non-remote	2.40	2.97	2.40	18	30%	32%
Large farm	5.07	7.91	5.07	14	24%	26%
IS – endogenous price						
Non-farm	0.13		0.13	0	1%	1%
Small remote	0.25	0.28	0.26	1	5%	5%
Small non-remote	0.22	0.29	0.22	3	27%	27%
Medium remote	0.39	0.86	0.59	2	15%	15%
Medium non-remote	0.67	1.06	0.67	5	38%	38%
Large farm	0.68	1.39	0.68	2	15%	15%
IS – exogenous price						
Non-farm	0.23		0.23	0	1%	1%
Small remote	0.44	0.28	0.47	1	5%	5%
Small non-remote	0.39	0.29	0.39	6	27%	27%
Medium remote	0.70	0.86	1.04	3	15%	15%
Medium non-remote	1.19	1.06	1.19	9	38%	38%
Large farm	1.21	1.39	1.21	3	15%	15%
Cash transfer						
Non-farm	0.00		0.00	0	0%	0%
Small remote	1.07	1.00	1.00	2	8%	8%
Small non-remote	1.00	1.00	1.00	16	50%	50%
Medium remote	1.13	1.00	1.00	3	10%	10%
Medium non-remote	1.00	1.00	1.00	7	23%	23%
Large farm	0.99	1.00	0.99	3	9%	9%
Public-good investment						
Non-farm	0.4	0.0	0.4	0.5	1%	2%
Small remote	4.0	0.0	3.5	8.3	22%	28%
Small non-remote	0.1	0.0	0.1	1.3	3%	4%
Medium remote	7.5	0.0	7.2	23.7	63%	79%
Medium non-remote	-0.1	0.0	-0.1	-0.6	-2%	-2%
Large farm	-1.1	0.0	-1.1	-3.1	-8%	-10%

Table A1.6. Viet Nam – detailed simulation results

	[1]	[2]	[3]	[4]	[5]	[6]
VIET NAM	Nominal income change, %	Immediate welfare change, %	Final welfare change, %	Final welfare change (LCU)	Share of welfare change	Share of net benefit
MPS – food staple						
Non-farm	0.32	-1.27	-0.89	-45	-5%	-6%
Small remote	0.91		0.30	8	1%	1%
Small non-remote	1.21	-0.09	0.30	76	8%	10%
Medium remote	0.39		-0.51	-59	-6%	-8%
Medium non-remote	2.32	1.69	1.46	610	63%	80%
Large farm	1.82	2.25	1.05	168	17%	22%
MPS – cash crop						
Non-farm	0.19	-0.04	0.15	8	1%	1%
Small remote	0.52	-0.04	0.13	4	0%	0%
Small non-remote	0.23	0.10	0.20	51	3%	3%
Medium remote	1.91	1.33	1.04	120	8%	8%
Medium non-remote	1.15	1.33	1.14	475	32%	32%
Large farm	5.12	5.42	5.09	815	55%	55%
MPS – livestock						
Non-farm	0.22	-1.64	-1.36	-69	-21%	43%
Small remote	0.77		-0.67	-19	-6%	12%
Small non-remote	1.09	0.18	-0.38	-95	-29%	59%
Medium remote	0.83		-0.53	-61	-19%	38%
Medium non-remote	1.32	0.86	0.13	56	17%	-34%
Large farm	1.36	0.58	0.16	26	8%	-16%
PS – food staple						
Non-farm	0.32		0.32	16	1%	1%
Small remote	0.91		0.30	8	1%	1%
Small non-remote	1.21	0.85	1.21	303	18%	20%
Medium remote	0.39		-0.51	-59	-4%	-4%
Medium non-remote	2.32	2.59	2.32	970	59%	63%
Large farm	1.82	3.06	1.82	291	18%	19%

Table A1.6. Viet Nam – detailed simulation results *(cont.)*

	[1]	[2]	[3]	[4]	[5]	[6]
VIET NAM	Nominal income change, %	Immediate welfare change, %	Final welfare change, %	Final welfare change (LCU)	Share of welfare change	Share of net benefit
PS – livestock						
Non-farm	0.22		0.22	11	1%	1%
Small remote	0.77		-0.67	-19	-2%	-2%
Small non-remote	1.09	1.71	1.09	274	24%	28%
Medium remote	0.83		-0.53	-61	-5%	-6%
Medium non-remote	1.32	2.10	1.32	552	49%	57%
Large farm	1.36	1.83	1.36	218	19%	22%
IS – endogenous price						
Non-farm	0.41		0.41	21	1%	1%
Small remote	1.78	1.64	1.61	45	3%	3%
Small non-remote	0.85	0.91	0.85	214	12%	12%
Medium remote	2.73	4.03	2.54	296	17%	17%
Medium non-remote	1.77	3.31	1.77	741	42%	42%
Large farm	2.80	5.82	2.80	448	25%	25%
IS – exogenous price						
Non-farm	0.78		0.78	40	1%	1%
Small remote	3.43	1.64	3.10	87	3%	3%
Small non-remote	1.65	0.91	1.65	414	12%	12%
Medium remote	5.25	4.03	4.89	568	17%	17%
Medium non-remote	3.41	3.31	3.41	1,426	42%	42%
Large farm	5.38	5.82	5.38	860	25%	25%
Cash transfer						
Non-farm	0.00		0.00	0	0%	0%
Small remote	1.08	1.00	1.00	28	3%	3%
Small non-remote	1.00	1.00	1.00	251	26%	26%
Medium remote	1.17	1.00	1.00	116	12%	12%
Medium non-remote	1.00	1.00	1.00	416	43%	43%
Large farm	0.99	1.00	0.99	159	16%	16%
Public-good investment						
Non-farm	0.1	0.0	0.1	7.2	1%	1%
Small remote	-1.0	0.0	1.2	32.7	4%	7%
Small non-remote	0.1	0.0	0.1	17.9	2%	4%
Medium remote	6.7	0.0	5.3	620.2	72%	124%
Medium non-remote	-0.2	0.0	-0.2	-95.0	-11%	-19%
Large farm	-0.5	0.0	-0.5	-84.1	-10%	-17%

Table A1.7. Detailed simulation results, averaged across all six countries

	[1]	[2]	[3]	[4]	[5]
ALL COUNTRIES	Nominal income change, %	Immediate welfare change, %	Final welfare change, %	Share of welfare change	Share of net benefit
MPS – food staple					
Non-farm	0.43	-1.05	-0.58	-5%	-11%
Small remote	1.56	0.00	0.51	1%	1%
Small non-remote	1.08	-0.09	0.19	11%	7%
Medium remote	1.45	0.00	-0.05	-2%	-5%
Medium non-remote	1.74	1.04	0.97	40%	59%
Large farm	1.62	1.62	1.04	29%	49%
MPS – cash crop					
Non-farm	0.20	-0.01	0.20	1%	1%
Small remote	0.89	0.26	0.44	3%	3%
Small non-remote	0.16	0.11	0.16	9%	9%
Medium remote	2.07	1.30	1.28	17%	17%
Medium non-remote	1.05	1.04	1.05	41%	42%
Large farm	1.71	1.96	1.70	27%	27%
MPS – livestock					
Non-farm	0.21	-1.09	-0.83	-13%	-22%
Small remote	1.09	0.56	0.24	-1%	0%
Small non-remote	0.74	0.08	-0.01	-6%	-29%
Medium remote	1.39	1.21	0.53	0%	8%
Medium non-remote	1.11	0.86	0.59	30%	61%
Large farm	1.53	1.79	1.03	22%	81%
PS – food staple					
Non-farm	0.43	0.00	0.43	1%	1%
Small remote	1.56	0.00	0.51	1%	1%
Small non-remote	1.08	0.84	1.08	30%	31%
Medium remote	1.45	0.00	-0.05	-1%	-1%
Medium non-remote	1.74	1.85	1.74	42%	44%
Large farm	1.62	2.22	1.62	23%	24%

Table A1.7. Detailed simulation results, averaged across all six countries (*cont.*)

	[1]	[2]	[3]	[4]	[5]
ALL COUNTRIES	Nominal income change, %	Immediate welfare change, %	Final welfare change, %	Share of welfare change	Share of net benefit
PS – livestock					
Non-farm	0.17	0.00	0.17	1%	1%
Small remote	0.26	0.00	-0.19	-1%	-1%
Small non-remote	0.74	0.85	0.74	29%	31%
Medium remote	0.28	0.00	-0.19	-2%	-2%
Medium non-remote	1.13	1.41	1.13	41%	43%
Large farm	1.70	2.31	1.70	27%	28%
IS – endogenous price					
Non-farm	0.17	0.00	0.17	1%	1%
Small remote	0.72	0.73	0.66	4%	4%
Small non-remote	0.39	0.58	0.39	16%	16%
Medium remote	1.06	1.70	1.09	14%	14%
Medium non-Remote	0.94	1.62	0.94	40%	40%
Large farm	1.20	2.30	1.20	25%	25%
IS – exogenous price					
Non-farm	0.33	0.00	0.33	1%	1%
Small remote	1.35	0.73	1.19	4%	4%
Small non-remote	0.75	0.58	0.75	18%	18%
Medium remote	1.97	1.70	1.97	14%	14%
Medium non-remote	1.67	1.62	1.67	39%	39%
Large farm	2.14	2.30	2.14	24%	24%
Cash transfer					
Non-farm	0.00	0.00	0.00	0%	0%
Small remote	1.11	1.00	1.00	6%	6%
Small non-remote	1.00	1.00	1.00	34%	34%
Medium remote	1.15	1.00	1.00	10%	10%
Medium non-remote	1.00	1.00	1.00	32%	32%
Large farm	0.99	1.00	0.99	17%	17%
Public-good investment					
Non-farm	0.1	0.0	0.1	1%	1%
Small remote	1.1	0.0	1.2	14%	17%
Small non-remote	0.0	0.0	0.0	3%	3%
Medium remote	4.3	0.0	3.6	68%	98%
Medium non-remote	-0.1	0.0	-0.1	-4%	-8%
Large farm	-0.3	0.0	-0.3	-7%	-10%

Table A1.8. Simulation results of aggregate effects

	[1]	[2]	[3]	[4]	[5]	[6]
	Nominal income change, %	Immediate welfare change, %	Final welfare change, %	Final welfare change (LCU)	Urban cost of policy	Policy cost efficiency, [4]/[5]
BANGLADESH						
MPS – food staple	1.0	0.3	0.2	231	767	30%
MPS – cash crop	0.2	0.1	0.1	180	284	63%
MPS – livestock	0.5	0.3	0.1	162	567	29%
PS – food staple	1.0	0.9	0.7	1 000	1 499	67%
PS – livestock	0.5	0.7	0.5	636	1 013	63%
IS – endogenous price	0.3	0.5	0.3	408	770	53%
IS – exogenous price	0.5	0.5	0.6	762	835	91%
Cash transfer	0.9	0.9	0.9	1 252	1 255	100%
Public-good investment	0.0	0.0	0.0	49.2	n/a	n/a
GHANA						
MPS – food staple	3.8	1.6	1.8	404	653	62%
MPS – cash crop	0.6	0.5	0.5	117	249	47%
MPS – livestock	0.2	0.0	0.1	13	19	67%
PS – food staple	3.8	3.1	3.2	742	980	76%
PS – livestock	0.2	0.2	0.2	54	58	93%
IS – endogenous price	0.8	1.3	0.8	188	332	57%
IS – exogenous price	1.4	1.3	1.4	315	351	90%
Cash transfer	1.0	1.0	1.0	219	219	100%
Public-good investment	0.5	0.0	0.3	80.3	n/a	n/a
GUATEMALA						
MPS – food staple	0.4	0.1	0.1	17	37	46%
MPS – cash crop	1.2	1.1	1.1	156	188	83%
MPS – livestock	1.1	0.2	0.2	31	64	49%
PS – food staple	0.4	0.4	0.4	55	73	76%
PS – livestock	0.9	0.8	0.9	124	142	87%
IS – endogenous price	0.5	1.0	0.5	77	165	46%
IS – exogenous price	0.9	1.0	1.0	143	177	81%
Cash transfer	1.0	1.0	1.0	139	139	100%
Public-good investment	0.6	0.0	0.4	57.8	n/a	n/a

Table A1.8. Simulation results of aggregate effects (*cont.*)

	[1]	[2]	[3]	[4]	[5]	[6]
	Nominal income change, %	Immediate welfare change, %	Final welfare change, %	Final welfare change (LCU)	Urban cost of policy	Policy cost efficiency, [4]/[5]
MALAWI						
MPS – food staple	1.0	0.3	0.3	30	63	47%
MPS – cash crop	0.4	0.4	0.3	30	55	54%
MPS – livestock	0.4	0.0	0.0	2	9	23%
PS – food staple	1.0	1.0	1.0	106	136	78%
PS – livestock	0.4	0.4	0.4	42	48	89%
IS – endogenous price	0.9	1.4	0.8	88	155	56%
IS – exogenous price	1.5	1.4	1.4	148	165	90%
Cash transfer	1.0	1.0	1.0	102	102	100%
Public-good investment	0.0	0.0	0.1	6.6	n/a	n/a
NICARAGUA						
MPS – food staple	0.6	0.3	0.4	15	21	71%
MPS – cash crop	1.3	1.0	1.1	37	44	84%
MPS – livestock	2.5	2.3	1.7	57	94	61%
PS – food staple	0.6	0.4	0.5	17	23	75%
PS – livestock	1.7	2.1	1.7	55	85	65%
IS – endogenous price	0.4	0.6	0.4	13	22	60%
IS – exogenous price	0.7	0.6	0.7	23	23	100%
Cash transfer	1.0	1.0	1.0	32	32	100%
Public-good investment	1.0	0.0	0.9	30.0	n/a	n/a
VIETNAM						
MPS – food staple	1.6	1.0	0.7	758	1 703	44%
MPS – cash crop	1.6	1.6	1.4	1 474	2 034	72%
MPS – livestock	1.1	0.4	-0.2	-162	860	-19%
PS – food staple	1.6	1.7	1.5	1 530	2 445	63%
PS – livestock	1.1	1.6	1.0	976	1 938	50%
IS – endogenous price	1.7	3.0	1.7	1 764	3 379	52%
IS – exogenous price	3.4	3.0	3.3	3,394	3 691	92%
Cash transfer	1.0	1.0	0.9	970	974	100%
Public-good investment	0.6	0.0	0.5	498.9	n/a	n/a