# A Need for Caution in Applying the Volume-Based Special Safeguard Mechanism

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## Abstract

The proximate cause of the collapse of the Doha Agenda negotiations in 2008 was disagreement over the volume-based Special Safeguard Mechanism (SSM). This measure would provide a right, but not an obligation, for developing countries to impose a duty when imports increase. While many simulations of its impact on domestic prices are available, there appear to be no analyses of its potential impacts on the welfare of poor households. Whether such a safeguard will increase or reduce poverty can only be determined empirically—if there are enough small, poor farmers who are net sellers of the commodity when the duty is imposed, then imposition of a safeguard duty may reduce poverty. If, by contrast, most small, poor farmers are net buyers of the products subject to the duty, then it is likely that poverty will rise. Empirical analysis for twenty-eight countries finds that poverty is generally increased following the imposition of a safeguard-type measure. The adverse poverty impact of the safeguard-induced increase in prices is typically larger when the safeguard can be triggered, because the adverse output shocks typically giving rise to import surges when import prices have not declined reduce the benefit to poor producing households from higher prices.

# A Need for Caution in Applying the Volume-Based Special Safeguard Mechanism

The logic of the proposed volume-based special safeguard mechanism (SSM) in the Doha Agenda negotiations (WTO 2008) seems quite simple. When imports increase from baseline levels, a duty can be invoked to protect domestic producers against the threat posed by these imports. Such a measure seems appealing from the viewpoint of producers, who might find difficulty competing with imports which have, for some reason, suddenly become more competitive than domestic suppliers' production. As designed, this policy seems potentially very important for poverty reduction because most of the poor in developing countries live in rural areas, and obtain the majority of their income from farming (World Bank 2008). If all poor farmers in developing countries were net sellers of food—as are almost all commercial producers in the industrial countries—then a measure that raised the costs of competing imports would surely help to reduce poverty amongst this group, as well as to address competitive challenges posed by increases in imports.

However, it is important to remember farm structures in developing countries are very different from those in the industrial countries. Many farmers in poor countries remain subsistence-oriented, and many are actually net buyers of food. Sometimes this reflects the very limited resources available to these producers, other times a desire to diversify their output mix in order to reduce their vulnerability to shocks in affecting any one activity. Low-income producers are particularly likely to be net buyers in years when the country faces increased competition from imports, perhaps because of unfavorable seasonal conditions. Low-income non-farm households are likely to be very vulnerable to increases in the prices of staple foods, since many spend up to three-quarters of their incomes on staple foods. When many poor farm households are also vulnerable to higher food prices, the risk that higher food prices will raise overall poverty rates, and hence imperil food security, seems particularly strong.

Since the proposed measures provide a right, but not an obligation, to impose a duty, a key decision for WTO members would be when to impose such a duty. Two approaches might seem attractive: (i) to impose such a duty in line with the WTO rules that permit its use, or (ii) to impose such a duty when it seems likely that this would help reduce poverty and vulnerability, particularly among small farmers. The first decision rule is relatively simple, since it requires only information on import levels in the current year relative to imports in a three-year moving-average baseline period. The second may be much more complex because it requires much more difficult-to-obtain information on whether individual households are net buyers or net sellers of the products in question. An important question is therefore how frequently the proposed WTO rules would permit the introduction of measures that are consistent with the goals of reducing poverty and vulnerability. If they frequently do, then WTO rules could perhaps be used to provide simple rules of thumb for triggering the volume-based SSM. If they are not, then developing alternative rules of thumb is likely to be important if adverse outcomes are to be avoided.

While many studies (eg Montemayor 2008; Grant and Meilke 2009; Hertel, Martin and Leister 2010) examine the implications of the SSM proposals for their implications for aggregate variables such as market prices and farm incomes, almost no analysis is available at the household level needed to assess the implications of the SSM for its intended objectives of improving food security, livelihood security and rural development. This paper uses data at the household level to assess the implications of the volume-based SSM for household welfare, and particularly for the number of people who fall below the internationally standard poverty line of $1.25 per day (Ravallion, Chen and Sangraula 2009), and hence face increased risks to their food and livelihood security.

In the next section of this paper, we consider the methodology used to assess when the volume-based safeguard might be applied, and how its effects might be assessed. The third section presents the results of simulations using data for individual households in a range of developing countries. The fourth section concludes.

## Methodology

The proposed SSM involves both a price-based and a quantity-based measure. The price-based measure is much simpler to use, since it can be invoked whenever the price of a shipment falls below a trigger level based on a moving average of import prices from all sources (Hertel, Martin and Leister 2011). As noted by Martin and Anderson (2011), such price-based measures are likely to be attractive for individual developing countries—and have been widely used in the industrial countries in the past. They can certainly stabilize domestic prices in individual, small countries relative to the situation without such intervention. However, they point out that this widespread use leads to a collective action problem that may require a collective policy response—by increasing the volatility of world prices, these interventions are collectively ineffective in stabilizing domestic prices. The best that they can do is to redistribute volatility between countries.

The analysis begins by considering the sources of increases in imports relevant to the quantity-based SSM. Given that the price-based safeguard can be applied quickly when the price of a particular shipment is fifteen percent or more below a three-year moving average price, and the volume-based safeguard requires the authorities to wait until cumulative exports during the year exceed a three-year moving average of imports, it seems likely that the quantity-based safeguard will generally be used only when the price of imports has not fallen substantially. If this is the case, then it seems most likely that surges in imports that trigger the volume-based SSM are due to domestic shocks, such as decline in domestic production due to factors such as poor weather.

The analysis considers impacts of shocks in a range of low and middle-income countries that are or may become importers of key commodities, particularly maize, rice and wheat. For these countries, we have collected detailed data from household surveys on the sources of income and patterns of expenditure—with special emphasis on the consumption of staple foods whose price is enormously important for the poor, and on income from production of these goods—for a large sample of households. These data will be used to capture the impacts of production and price shocks on the real incomes of households.

The first step in the analysis is to take into account the impacts of unfavorable output shocks to agricultural output—such as might arise from a drought—at national and household level. These shocks will be represented using negative productivity shocks. The effect of these shocks on poor farm households will generally be to reduce their incomes both directly, through reductions in the value of agricultural output. Another potentially important effect of this shock will be to reduce the saleable surplus of farm households, or to increase the share of net expenditure on food, making these households more likely to be adversely affected by increases in the price of these foods. In importing countries using a tariff regime, the increase in imports at the initial tariff will be a source of national welfare gains, as increased quantities that cost less than their value at internal prices are imported.

The second stage in the analysis is to take into account the effects of introducing the duty permitted under the quantity-based SSM. Since the volume-based SSM can be introduced for no longer than a year, it seems likely that producers can do very little to expand output in response to the incentives created by the SSM duty. We therefore use a very simple balance-sheet approach to determine the impact of changes in output on import volumes. For simplicity, we assume that imported and domestic product are homogeneous, and hence that an increase in a duty on imported goods translates one-for-one into an increase in the price of the domestic good. We follow Deaton (1989) in assessing the impact of a price change using only the net buyer or net seller status of the household in a particular commodity. We considered allowing for welfare impacts resulting from food-price-induced changes in wages (see Ivanic and Martin 2008) but the evidence (Ravallion 1990) suggests that this effect may take some time to emerge in poor countries. The income effect of a yield change was measured very simply using the change in the value of producers' output volumes valued at domestic prices.

When the change in imports required to maintain the existing level of domestic use following the negative output shock exceeds one of the SSM thresholds, we assume a change in the duty along the lines specified in the SSM proposal (WTO 2008).[1] When the country in question is a net importer, the impact of the duty imposition is assumed to translate into an equal increase in the domestic price. Where farmers were, and remain, net sellers of food, the increase in prices will help compensate for any losses resulting from the decline in their output. However, for farmers who were—or who have become after the adverse output shock—net buyers, the increase in prices resulting from the duty will have an adverse impact on real incomes.

The estimated impacts on each household will be used to assess the impacts of the duty on the poverty headcount. Given our use of the simple balance-sheet approach we also ignore the impact of higher prices on consumption volumes. As noted in Ivanic, Martin and Zaman (2011), these changes have very small, second-order impacts on the estimated welfare impacts of price changes on household welfare. This simple framework provides the most intuitive and clear introduction to the nature of the problem. In subsequent analysis, we plan to extend the analysis to take into account phenomena like imperfect substitution between domestic and imported products.

[1] When imports are between 110 and 115 percent of the trigger, a duty of 25 percent is imposed. For imports between 115 and 135 percent, a duty of 40 percent is imposed. For imports over 135 percent of the trigger, a duty of 50 percent is imposed. The Modalities additionally limit each of these duties to no more than 25, 40 and 50 percent of the bound tariff rates.

Since the focus of the volume-based safeguard is on situations where the price of imports does not decline we need to carefully ask why imports might rise when import prices are not declining. For most agricultural commodities, this is likely to be the case because of weather-induced shocks to output which—in the case of crops—manifest themselves through changes in yields (Roberts and Schlenker 2010). We considered following Roberts and Schlenker in using the deviations of yields from trends, but finally decided to use a three year average of past yields as our benchmark against which to compare current yields. To the extent that changes in imports reflect changes in the volume of output, use of this average-yield measure as the base should better reflect the deviations in imports from their three-year moving average that trigger the volume-based SSM than would deviations from a linear trend. We compared the deviations from the three-year moving average with those from a linear trend and found those from the three-year moving average to be smaller.

For simplicity and transparency, we begin by analyzing a particularly simple case in which yields are one standard deviation below the three-year moving average of the most recent past yields. Examination of these yield deviations suggests that these deviations are approximately normally distributed, so that an adverse shock of one standard deviation shock or greater is likely to occur roughly 17 percent of the time. In the latter part of the analysis, we run a full Monte Carlo analysis of the observed covariation of changes in yields of maize, rice and wheat for the twenty-eight countries included in our sample. This simulation allows us to understand global poverty impacts of the SSM mechanism with the frequency of triggered instances of protection for one or more commodities corresponding to the historically data on yield changes.

# Data

## Commodity yield and trade balance data

We analyze historical volatility of maize, rice and wheat yields and the likely impact of a stylized output reduction on domestic imports using the FAO's FAOSTAT data and the United States Department of Agriculture's PSD database. Both datasets contain information on annual yields, production, total imports and total exports with slightly different coverage: the PSD database contains data and estimates for 187 countries and regions for the period of 1960–2011 while the FAO database contains information for a wider range of 211 countries and regions for the shorter period 1961–2009.

In order to maximize the amount of data available for the analysis, we combine the two datasets. Yield data were combined in the following way: when a data series for a particular commodity and country was only available from one data source, we used that source; when data points from both data sources were matching (over 90 percent of values were within a 10-percent range of each other), we averaged the two sources and filled any missing observations from the available source; when the two data sources differed, we considered three additional criteria intended to filter out data of poorer quality in the following order of importance: the number of non-changing values as a manifestation of masked missing values (we selected the data source which had fewer than 10 percent of non-changing values), the relative size of the greatest annual change in the series as a sign of a change in the units used or the collection methods (we selected the data source with the largest jump in data 30 percentage points lower than the other data source); and the number of observations available (with everything else equal we chose the longer data series).

We combined the data on imports, exports and domestic production in a similar way, merging the two datasets when the share of matches between the two data series was greater than 90 percent and in the case of greater differences between the two data sources choosing those series which had fewer than 10 percent of non-changing values. In those cases when both data sets had the same share of non-changing values, we selected the series which extended over a longer period of time. For the commodity balance sheet data used in the analysis, we used 2009 for all countries except Belize and Timor Leste, and 2007 for those two countries.

## Household survey data

We use household surveys representing twenty-eight developing countries (Table 1) collected between 2000 and 2009. All of the surveys contain household-level information on production and consumption of the three cereals considered in this study (maize, rice and wheat) as well as total household expenditures. Using this information, we were able to assess the impact of changes in productivity and prices for these commodities on household welfare by calculating the changes in each household's cost of living and the change in agricultural profits (sales). By counting the number of households whose change in the real income moves them across the poverty line, we were then able to calculate the changes in national poverty rates.

# Results

## Impact of one-standard deviation yield reductions

Based on the combined FAO and United States Department of Agriculture data on annual crop yield variation for the twenty-eight developing countries, we calculated the standard deviation of annual yield changes from the preceding three-year average and applied this as a negative productivity shock in each country. For all of these shocks, we calculated the resulting decline in domestic production and the increase in imports necessary to maintain domestic consumption unchanged. Finally, we assessed whether such a level of import increase could trigger any of the quantity-based SSM duties and in those cases of net-importers where a particular mechanism could be triggered, we applied the appropriate duty as a domestic price shock and calculated the resulting poverty impacts.

In Table 2 we report the changes in productivity, imports and duties for a decline of one standard deviation in maize yields from the previous three-year average. In the first set of columns, we report the available information on countries' current production, imports and exports. In the next two columns, we report the yield reduction considered in the exercise and the resulting increases in imports required to replace the reduction in domestic output. Finally, we report the price shock represented by the change in tariff among those countries which are net importers of maize and we note whether a country has remained an exporter through the simulation or whether it has become a net-importer as a result of the productivity shock.

Table 2 shows the size of the productivity shock equal to the negative of one standard deviation from the three-year average. In most countries an adverse shock of this size or greater is expected to occur with close to a 17-percent probability, and represents a noticeable decline in production of maize with the most severe case being Moldova with a yield reduction of 41 percent. In 19 out of 28 cases, this reduction in production would translate into large enough increases in imports to make the country a net importer and to impose a safeguard duty, often at its highest possible level of fifty percent.

We use the price and productivity shocks reported in Table 2 to calculate the changes in poverty in our sample of developing countries reported in Table 3. For simplicity, we assume that the productivity shock affects all producing households equi-proportionately, reducing their output from its level in the initial database. A key effect of this productivity shock at the household level is to reduce the incomes of the producing households in line with the reduction of their output of the product(s) under consideration. In the first column of the table, we report the direct poverty impacts of the productivity shock. In the second, we report the impacts of the price shock following the imposition of safeguard duty.  In the third column we report the combined impact of the productivity and price shocks. In the final column, we report the change in poverty which would result from the same increase in the safeguard duty without a previous reduction in productivity.

The results reported in Table 3 suggest that the reduction in productivity of maize considered in our simulation would raise poverty by the average of 0.23 percentage points. The subsequent increase in domestic price would raise poverty further by additional 0.12 percentage points for a total average poverty change of 0.35 percentage points. If the duty had been imposed without any previous reduction in output, its poverty impacts would have been milder, equal to 0.03 percentage points. The observed difference between the poverty impacts of the same price shocks can be explained by the fact that a previous reduction in productivity is likely to make more households net buyers of maize, making them more vulnerable to price rises. If we exclude countries where the SSM is not triggered—whether because the country remains a net exporter or because the shock is not large enough to trigger a safeguard duty—the productivity and price shocks are larger, with 0.48 percent of the population being forced into poverty.

At the national level, we observe considerable variation in the size of the productivity shocks, the impacts on domestic prices, and the combined impacts on poverty. While poverty rises or remains the same in almost all countries, there are a few exceptions where poverty falls because higher prices benefit some low-income producers who are net sellers of maize. At the other extreme, there are substantial increases in poverty in a number of countries, with the largest increase, of over 5 percentage points, estimated for Malawi.

For rice (Table 4 and Table 5), the direct adverse impacts of the output shocks on poverty are larger than for maize in the countries where the SSM is triggered, with an average increase of 0.30 percentage points. This shocks is exacerbated by the effects of the price increase resulting from imposition of the safeguard duty, which raises the impact by a further 0.53 percentage points, to a total increase of 0.91 percentage points. At the national level, there is only one case, Cambodia, where the imposition of the safeguard duty reduces poverty because there are enough small poor producers who are net sellers of rice. In many cases, such as Bangladesh, Belize, Indonesia and Nicaragua, the adverse impact of the rice price rise on poverty is much larger than the direct impact of the yield shock.

Repeating the analysis for wheat (Table 6 and Table 7) shows a similar pattern in which the negative impacts of the imposition of duties is exacerbated by a previous reduction in productivity. In this case, the average poverty impacts are much larger than for maize, with the average impact of the productivity and price shocks in countries imposing the duty being over one percentage point. The poverty-increasing impact of the price safeguard intended to combat the import "surge" is almost ten times the direct impact of the productivity change. At the national level, the effect of the safeguard duty is to increase poverty in all of the countries that are eligible to impose it.

We complete our analysis by analyzing the poverty impacts of a combination of the negative shocks of all three commodities. As in the case of individual commodities, we again find that the adverse poverty impact of the output declines is exacerbated by the imposition of the safeguard duties (Table 8).

## Distribution of SSM triggers

To estimate the distribution of poverty impacts of the quantity-based SSM mechanism, we estimated the variance-covariance matrix of national yield deviations from three-year moving averages for each commodity for the twenty-eight countries included in our survey. For each commodity and country, we began with a matrix of pseudo-normally distributed variables and transformed them into series with the estimated variance-covariance using a Choleski decomposition technique. We then use Monte Carlo techniques to simulate a set of productivity changes and the safeguard duty permitted by the quantity-based SSM provisions.

Our analysis of the Monte-Carlo-simulated distribution of productivity changes suggests that quantity-based SSM measures are likely to be triggered quite often: considering the historical variation in the yields of maize, rice and wheat in our sample of twenty-eight developing countries, in about half of the cases we observe that at least one SSM duty has been triggered in more than twenty percent of the countries. While simultaneous triggers of all three commodities within one country are quite rare (observed in less than one percent of all cases), SSM duties for two commodities are triggered at the same time much more often (11 percent of the cases). At least one commodity triggers an SSM duty very often (in 41 percent of the cases) and no triggers are observed in 47 percent of all cases.

With regard to the average size of the SSM tariff response, we observe that the probability of the largest response, a fifty-percent duty, is the most frequently-imposed. In other words, when imports rise above the minimum trigger level, they most often rise sufficiently to trigger the highest duty, as shown in Table 9. The table also shows that SSM tariffs are more likely to be triggered in the case of rice and maize than in the case of wheat, reflecting the relative yield volatility levels among these crops.

## Monte Carlo Simulation

In our stochastic Monte Carlo simulation, we considered 400 randomly drawn vectors of yield changes (each vector containing yield shocks for all countries and commodities) the distributions of which resembled closely the historically observed multivariate distribution of yields, i.e. the covariance matrices of both distributions were roughly equal. In each run, we calculated the resulting global poverty impacts of the yield changes and also of yield changes accompanied with the triggered tariff response (for net importers). We then apply the simulated productivity and price changes to the households in our survey sample and calculate national changes in poverty rates. Following the approach of Ivanic, Martin and Zaman (2011), we then extrapolate national poverty changes into global poverty changes, expressed in actual numbers of people.

The results of these two simulations are shown in Figure 1 which suggests that the imposition of quantity-based SSM is likely to significantly raise the poverty impacts of the existing productivity shocks. The red line in the figure shows the recovered poverty distribution of the historical yield variations in maize, rice and wheat. This baseline distribution is, as expected, centered above zero, reflecting the fact that the average change in productivity is zero with no net poverty impacts. Interestingly, the recovered distribution of global poverty changes appears to have a relatively large standard deviation of 17.7 million people, reflecting the facts that yield variations in larger countries and covariations across commodities and regions are significant.

When we combine the impacts of the productivity shocks with the SSM tariff responses (only applied when triggered and only to net importers), we can see that the distribution of poverty changes shifts to the right, raising the average net poverty impact of the existing yield variation. The mean of the new distribution is 45.4 million people and the standard deviation is 32.3 million.

## Conclusions

In this work we considered the implications of the proposed quantity-based special safeguard mechanism (SSM), which would allow developing countries to impose safeguard duties when their imports agricultural commodities rise above defined threshold levels. Identifying domestic yield variations as the most likely causes of these import surges, we analyze the likely impact of these policy responses on poverty in the imposing countries. To make our analysis a faithful representation of the real world, we consider historically observed variations in and covariations between the yields of several crops (maize, rice and wheat) in a representative sample of twenty-eight developing countries, and perform a Monte Carlo simulation of the SSM policy which mimics the observed patterns of yield volatility.

Our analysis suggests that yield volatility of the main cereals (maize, rice and wheat) is sufficient for SSM tariffs to be triggered quite often—about 53 percent of the time for at least one commodity in an average developing country. Our short-run analysis shows that imposition of a quantity-based SSM is likely to raise poverty in countries imposing it by placing additional burdens on consumers, including farmers who are net buyers because their crop yields have declined. It seems clear that a very substantial degree of caution is advised when considering imposition of a volume-based safeguard following a surge in imports.

**Table 1: Household surveys used in the study**

| Country | Survey name | Year | Population, millions | Number of households | Number of people | Poverty rate, % |
|---|---|---|---|---|---|---|
| Albania | Living Standards Measurement Survey | 2005 | 3.2 | 1,671 | 4,814 | 0.8 |
| Armenia | Integrated Survey of Living Standards | 2005 | 3.3 | 6,815 | 28,502 | 10.6 |
| Bangladesh | Household Income-Expenditure Survey | 2000 | 150 | 7,440 | 38,518 | 40.2 |
| Belize | Household Income and Expenditure Survey | 2009 | 0.3 | 1,546 | 6,794 | 33.5 |
| Cambodia | Household Socio-economic Survey | 2003 | 13.4 | 14,984 | 74,719 | 50.5 |
| Côte d'Ivoire | Enquete Niveau de Vie des Menages | 2002 | 21.6 | 10,798 | 57,906 | 23.3 |
| Ecuador | Encuesta Condiciones de vida – Quinta Ronda | 2006 | 14.3 | 13,581 | 55,666 | 15.8 |
| Guatemala | Encuesta Nacional de Condiciones de Vida | 2006 | 14.4 | 13,686 | 68,739 | 12.6 |
| India | Socio-economic survey (schedules 33/59, 1/61 and 10/61) | 2002–4 | 1193.6 | 301,085 | 1,499,010 | 43.8 |
| Indonesia | Indonesia Family Life Survey | 2007 | 230.0 | 12,999 | 69,624 | 7.5 |
| Malawi | Second Integrated Household Survey | 2004 | 15.7 | 11,280 | 52,707 | 73.9 |
| Moldova | Cercetarea Bugetelor de Familie | 2009 | 3.6 | 5,532 | 15,066 | 8.1 |
| Mongolia | Household Income and Expenditure Survey | 2002 | 2.8 | 3308 | 14789 | 22.4 |
| Nepal | Nepal Living Standards Survey II | 2002 | 28.6 | 5,071 | 28,099 | 55.1 |
| Nicaragua | Encuesta Nacional de Hogares sore Medicion de Nivel de Vida | 2005 | 5.8 | 6,619 | 36,642 | 45.1 |
| Niger | Enquete National sur Le Budget et la Consommation des Menages | 2007 | 15.2 | 4,000 | 28,683 | 65.9 |
| Nigeria | Nigeria Living Standards Survey | 2003 | 158.3 | 19,121 | 92,501 | 64.4 |
| Pakistan | Pakistan Social and Living Standards Measurement Survey | 2005 | 171.7 | 15,453 | 79,354 | 22.6 |
| Panama | Encuesta de Niveles de Vida | 2003 | 3.4 | 6362 | 26,434 | 9.4 |
| Peru | Encuesta Nacional de Hogares | 2007 | 29.5 | 22,201 | 95,466 | 7.9 |
| Rwanda | Integrated Household Living Conditions Survey | 2005 | 10.4 | 6,900 | 34,785 | 76.6 |
| Sri Lanka | Household Income and Expenditure Survey | 2007 | 20.4 | 4,633 | 20,290 | 14.0 |
| Tajikistan | Living Standards Measurement Survey | 2007 | 7.1 | 4,644 | 29,412 | 21.5 |
| Timor-Leste | Poverty Assessment Project | 2000 | 1.2 | 1,800 | 9,113 | 52.9 |
| Uganda | Socio-Economic Survey | 2005 | 31.8 | 7,425 | 42,220 | 51.5 |
| Vietnam | Household Living Standard Survey | 2004 | 86.9 | 9,188 | 40,438 | 21.4 |
| Yemen | Household Budget Survey | 2006 | 22.5 | 13,136 | 98,941 | 17.5 |
| Zambia | Living Conditions Monitoring Survey | 2002 | 13.3 | 4,166 | 23,074 | 61.9 |
| Total | — | — | 2,272.3 | 535,444 | 2,672,306 | 38.8 |

**Table 2: Change in food balance, maize**

| | Production, kt | Imports, kt | Exports, kt | Change in imports, kt | Productivity shock, percent | Price shock, percent | Note |
|---|---|---|---|---|---|---|---|
| Albania | 216 | 83 | - | 37 | -17 | 50 | |
| Armenia | 19 | 120 | - | 7 | -35 | NA | |
| Bangladesh | 902 | 232 | - | 195 | -22 | 50 | |
| Belize | 38 | 5 | - | 8 | -21 | 50 | |
| Cambodia | 523 | - | 300 | 116 | -22 | NA | Remains exporter |
| Côte d'Ivoire | 700 | 22 | - | 103 | -15 | 50 | |
| Ecuador | 945 | 574 | 5 | 187 | -20 | 40 | |
| Guatemala | 1,200 | 758 | 5 | 138 | -11 | 40 | |
| India | 20,500 | 7 | 2,500 | 2,188 | -11 | NA | Remains exporter |
| Indonesia | 6,750 | 795 | 25 | 456 | -7 | 50 | |
| Malawi | 3,226 | 39 | 300 | 848 | -26 | 50 | Becomes importer |
| Moldova | 1,422 | 5 | 26 | 588 | -41 | 50 | Becomes importer |
| Mongolia | - | 1 | - | - | NA | NA | |
| Nepal | 1,700 | 60 | - | 112 | -7 | 50 | |
| Nicaragua | 435 | 125 | 6 | 56 | -13 | 50 | |
| Niger | 7 | 39 | - | 2 | -24 | NA | |
| Nigeria | 8,700 | 20 | 100 | 1,329 | -15 | 50 | Becomes importer |
| Pakistan | 3,000 | 7 | - | 260 | -9 | 50 | |
| Panama | 86 | 406 | - | 9 | -11 | NA | |
| Peru | 1,670 | 1,500 | 10 | 152 | -9 | 25 | |
| Rwanda | 440 | - | - | 99 | -23 | 50 | |
| Sri Lanka | 56 | 88 | - | 9 | -15 | NA | |
| Tajikistan | 130 | 5 | - | 39 | -30 | 50 | |
| Uganda | 2,000 | 43 | 107 | 286 | -14 | 50 | Becomes importer |
| Viet Nam | 4,303 | 536 | - | 411 | -10 | 50 | |
| Yemen | 60 | 500 | 15 | 12 | -20 | NA | |
| Zambia | 2,800 | 201 | 25 | 789 | -28 | 50 | |
| Average (excluding zeros) | | | | | -18 | 48 | |
| Average (all values) | | | | | -18 | 34 | |

Table 3: Poverty impacts of a one-standard-deviation productivity shock for maize and the SSM, percentage points

| | Productivity | +Price | Productivity+price | Price only |
|---|---|---|---|---|
| Albania | 0.00 | 0.00 | 0.00 | 0.00 |
| Armenia | 0.00 | NA | NA | NA |
| Bangladesh | 0.00 | 0.00 | 0.00 | 0.00 |
| Belize | 0.00 | 0.15 | 0.15 | 0.15 |
| Cambodia | 0.06 | NA | NA | NA |
| Côte d'Ivoire | 0.26 | 0.41 | 0.66 | 0.35 |
| Ecuador | 0.17 | -0.24 | -0.08 | -0.28 |
| Guatemala | 0.85 | 0.88 | 1.72 | 0.56 |
| India | 0.05 | NA | NA | NA |
| Indonesia | 0.02 | 0.01 | 0.03 | -0.01 |
| Malawi | 3.24 | 2.05 | 5.29 | 0.73 |
| Moldova | 0.11 | 0.05 | 0.17 | 0.05 |
| Mongolia | 0.00 | NA | NA | NA |
| Nepal | 0.14 | 0.00 | 0.14 | 0.01 |
| Nicaragua | 0.20 | -0.27 | -0.06 | -0.43 |
| Niger | 0.02 | NA | NA | NA |
| Nigeria | 0.19 | -0.01 | 0.18 | -0.09 |
| Pakistan | 0.00 | 0.03 | 0.03 | 0.03 |
| Panama | 0.04 | NA | NA | NA |
| Peru | 0.09 | -0.03 | 0.06 | -0.06 |
| Rwanda | 0.04 | 0.11 | 0.14 | 0.11 |
| Sri Lanka | 0.00 | NA | NA | NA |
| Tajikistan | 0.01 | -0.01 | 0.00 | -0.06 |
| Timor Leste | 0.00 | 0.00 | 0.00 | 0.00 |
| Uganda | 0.29 | 0.29 | 0.58 | 0.14 |
| Viet Nam | 0.17 | NA | NA | NA |
| Yemen | 0.01 | 0.00 | 0.01 | 0.00 |
| Zambia | 0.37 | NA | NA | NA |
| Simple average | 0.23 | 0.12 | 0.35 | 0.03 |
| Simple average when SSM triggered | 0.30 | 0.18 | 0.48 | 0.06 |

### Table 4: Change in food balance, rice

| | Production, kt | Imports, kt | Exports, kt | Change in imports, kt | Productivity shock, percent | Price shock, percent | Note |
|---|---|---|---|---|---|---|---|
| Albania | - | 56 | - | - | -15 | NA | |
| Armenia | - | 25 | - | - | NA | NA | |
| Bangladesh | 32,300 | 614 | - | 1,611 | -5 | 50 | |
| Belize | 12 | - | - | 4 | -33 | 50 | |
| Cambodia | 5,020 | 13 | 2 | 654 | -13 | 50 | |
| Côte d'Ivoire | 416 | 900 | - | 54 | -13 | NA | |
| Ecuador | 900 | - | 106 | 102 | -11 | NA | Remains exporter |
| Guatemala | 23 | 67 | - | 6 | -26 | NA | |
| India | 94,500 | 22 | 6,490 | 7,050 | -7 | 50 | Becomes importer |
| Indonesia | 36,900 | 1,439 | - | 1,764 | -5 | 50 | |
| Malawi | 75 | 4 | - | 19 | -25 | 50 | |
| Moldova | - | 16 | - | - | NA | NA | |
| Mongolia | - | 28 | - | - | NA | NA | |
| Nepal | 2,900 | 244 | - | 214 | -7 | 50 | |
| Nicaragua | 248 | 85 | - | 27 | -11 | 40 | |
| Niger | 47 | 178 | - | 13 | -28 | NA | |
| Nigeria | 3,600 | 577 | - | 482 | -13 | 50 | |
| Pakistan | 5,000 | - | 2,650 | 382 | -8 | NA | Remains exporter |
| Panama | 195 | 60 | - | 38 | -20 | 50 | |
| Peru | 1,950 | 75 | - | 157 | -8 | 50 | |
| Rwanda | 44 | 35 | - | 6 | -15 | 40 | |
| Sri Lanka | 2,400 | 40 | 10 | 233 | -10 | 50 | |
| Tajikistan | 35 | 10 | - | 7 | -21 | 50 | |
| Uganda | 130 | 55 | 20 | 10 | -8 | 40 | |
| Viet Nam | 24,983 | 600 | 6,000 | 1,583 | -6 | NA | Remains exporter |
| Yemen | - | 335 | - | - | NA | NA | |
| Zambia | 12 | 22 | - | 4 | -30 | 40 | |
| Average (excluding zeros) | | | | | -15 | 48 | |
| Average (all values) | | | | | -13 | 28 | |

**Table 5: Poverty impacts of a one-standard-deviation productivity shock for rice and the SSM, percentage points**

| | Productivity | +Price | Productivity+price | Price only |
|---|---|---|---|---|
| Albania | 0.00 | NA | NA | NA |
| Armenia | 0.00 | NA | NA | NA |
| Bangladesh | 0.31 | 3.19 | 3.49 | 2.96 |
| Belize | 0.09 | 0.53 | 0.62 | 0.62 |
| Cambodia | 3.95 | -4.78 | -0.83 | -6.29 |
| Côte d'Ivoire | 0.32 | NA | NA | NA |
| Ecuador | 0.09 | NA | NA | NA |
| Guatemala | 0.02 | NA | NA | NA |
| India | 0.41 | 2.85 | 3.26 | 2.87 |
| Indonesia | 0.18 | 0.71 | 0.88 | 0.69 |
| Malawi | 0.12 | 0.22 | 0.34 | 0.19 |
| Moldova | 0.00 | NA | NA | NA |
| Mongolia | 0.00 | NA | NA | NA |
| Nepal | 0.57 | 0.65 | 1.22 | 0.59 |
| Nicaragua | 0.08 | 0.94 | 1.03 | 0.97 |
| Niger | 0.00 | NA | NA | NA |
| Nigeria | 0.16 | 0.94 | 1.10 | 0.89 |
| Pakistan | 0.04 | NA | NA | NA |
| Panama | 0.18 | 0.62 | 0.81 | 0.44 |
| Peru | 0.01 | 0.40 | 0.41 | 0.39 |
| Rwanda | 0.04 | 0.13 | 0.16 | 0.15 |
| Sri Lanka | 0.21 | 1.40 | 1.61 | 1.47 |
| Tajikistan | 0.19 | 0.93 | 1.12 | 0.87 |
| Timor Leste | 0.00 | 0.00 | 0.00 | 0.00 |
| Uganda | 0.01 | NA | NA | NA |
| Viet Nam | 1.15 | NA | NA | NA |
| Yemen | 0.00 | 0.00 | 0.00 | 0.00 |
| Zambia | 0.00 | 0.29 | 0.29 | 0.26 |
| Simple average | 0.29 | 0.36 | 0.41 | 0.35 |
| Simple average when SSM triggered | 0.38 | 0.53 | 0.91 | 0.42 |

### Table 6: Change in food balance, wheat

| | Production, kt | Imports, kt | Exports, kt | Change in imports, kt | Productivity shock, percent | Price shock, percent | Note |
|---|---|---|---|---|---|---|---|
| Albania | 250 | 300 | - | 30 | -12 | 25 | |
| Armenia | 225 | 519 | - | 52 | -23 | 25 | |
| Bangladesh | 1,000 | 3,000 | - | 141 | -14 | NA | |
| Belize | - | 18 | - | - | NA | NA | |
| Cambodia | - | 43 | - | - | NA | NA | |
| Côte d'Ivoire | - | 350 | 150 | - | NA | NA | |
| Ecuador | 9 | 525 | 4 | 1 | -14 | NA | |
| Guatemala | 9 | 500 | 30 | 1 | -13 | NA | |
| India | 80,800 | 2,690 | 200 | 5,823 | -7 | 50 | |
| Indonesia | - | 5,499 | 250 | - | NA | NA | |
| Malawi | 5 | 98 | 14 | 2 | -35 | NA | |
| Moldova | 739 | 75 | 47 | 324 | -44 | 50 | |
| Mongolia | 230 | 235 | - | 67 | -29 | 40 | |
| Nepal | 1,400 | - | - | 133 | -9 | 50 | |
| Nicaragua | - | 150 | 20 | - | NA | NA | |
| Niger | 7 | 65 | - | 3 | -39 | NA | |
| Nigeria | 100 | 3,700 | - | 25 | -25 | NA | |
| Pakistan | 23,900 | 200 | 500 | 1,754 | -7 | 50 | Becomes importer |
| Panama | - | 125 | - | - | NA | NA | |
| Peru | 230 | 1,700 | 100 | 20 | -8 | NA | |
| Rwanda | 20 | 52 | 1 | 3 | -17 | NA | |
| Sri Lanka | - | 986 | 250 | - | NA | NA | |
| Tajikistan | 500 | 900 | - | 75 | -15 | NA | |
| Uganda | 19 | 344 | 30 | 2 | -12 | NA | |
| Viet Nam | - | 1,343 | - | - | NA | NA | |
| Yemen | 200 | 2,268 | 15 | 38 | -19 | NA | |
| Zambia | 172 | 107 | - | 48 | -28 | 50 | |
| Average (excluding zeros) | | | | | -20 | 43 | |
| Average (all values) | | | | | -14 | 13 | |

**Table 7: Poverty impacts of a one-standard-deviation productivity shock for wheat and the SSM, percentage points**

| | Productivity | +Price | Productivity+price | Price only |
|---|---|---|---|---|
| Albania | 0.00 | 0.10 | 0.10 | 0.10 |
| Armenia | 0.06 | 0.29 | 0.36 | 0.32 |
| Bangladesh | 0.00 | NA | NA | NA |
| Belize | 0.00 | NA | NA | NA |
| Cambodia | 0.00 | NA | NA | NA |
| Côte d'Ivoire | 0.00 | NA | NA | NA |
| Ecuador | 0.03 | NA | NA | NA |
| Guatemala | 0.01 | NA | NA | NA |
| India | 0.25 | 0.82 | 1.07 | 0.83 |
| Indonesia | 0.00 | NA | NA | NA |
| Malawi | 0.03 | NA | NA | NA |
| Moldova | 0.34 | 1.76 | 2.10 | 1.50 |
| Mongolia | 0.02 | 2.09 | 2.11 | 2.09 |
| Nepal | 0.14 | 0.07 | 0.21 | 0.07 |
| Nicaragua | 0.00 | NA | NA | NA |
| Niger | 0.00 | NA | NA | NA |
| Nigeria | 0.00 | NA | NA | NA |
| Pakistan | 0.09 | 3.82 | 3.91 | 3.77 |
| Panama | 0.00 | NA | NA | NA |
| Peru | 0.01 | NA | NA | NA |
| Rwanda | 0.02 | NA | NA | NA |
| Sri Lanka | 0.00 | NA | NA | NA |
| Tajikistan | 0.37 | NA | NA | NA |
| Timor Leste | 0.00 | NA | NA | NA |
| Uganda | 0.00 | NA | NA | NA |
| Viet Nam | 0.00 | NA | NA | NA |
| Yemen | 0.05 | 0.00 | 0.05 | 0.00 |
| Zambia | 0.00 | 1.00 | 1.00 | 1.00 |
| Simple average | 0.05 | 0.36 | 0.41 | 0.35 |
| Simple average when SSM triggered | 0.11 | 1.11 | 1.21 | 1.08 |

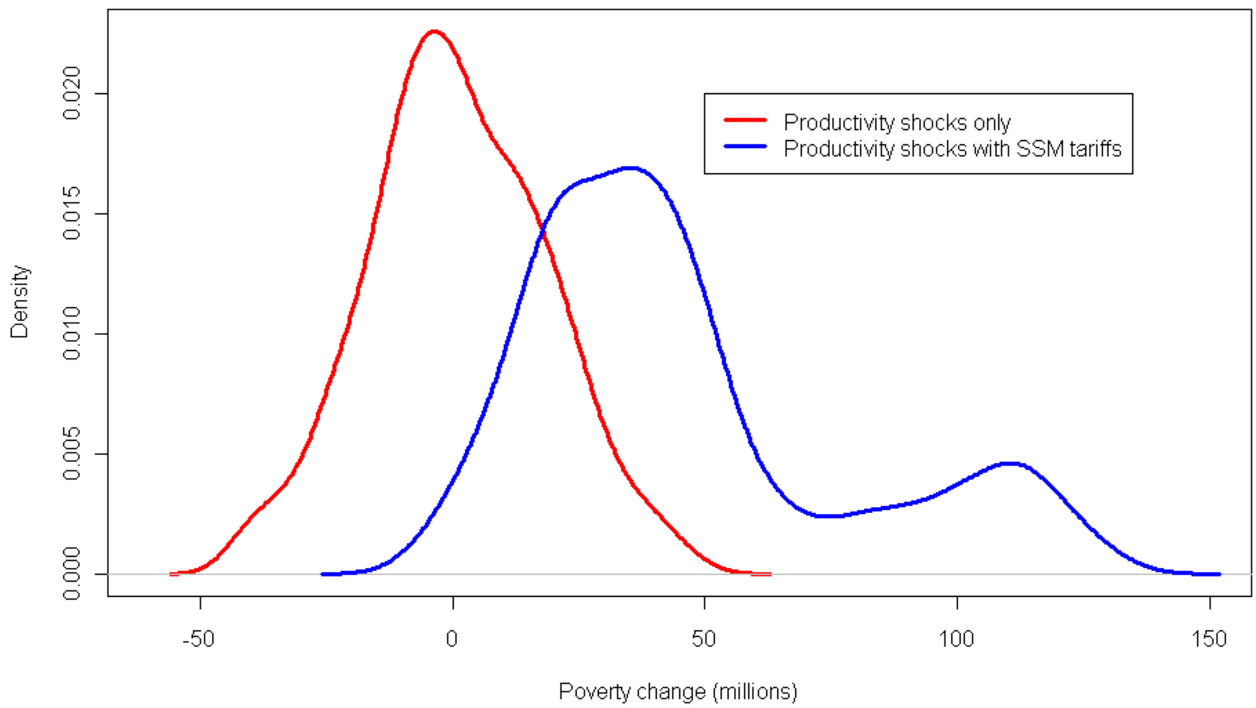
**Table 8: Poverty impacts of the application of SSM measures in one-standard-deviation productivity shock, maize, rice and wheat together**

| | Productivity | +Price | Productivity+price | Price only |
|---|---|---|---|---|
| Albania | 0.00 | 0.10 | 0.10 | 0.10 |
| Armenia | 0.06 | 0.29 | 0.36 | 0.32 |
| Bangladesh | 0.33 | 3.17 | 3.50 | 2.96 |
| Belize | 0.09 | 0.53 | 0.62 | 0.62 |
| Cambodia | 4.03 | -4.79 | -0.76 | -6.29 |
| Côte d'Ivoire | 0.60 | 0.35 | 0.95 | 0.35 |
| Ecuador | 0.31 | -0.27 | 0.04 | -0.28 |
| Guatemala | 0.88 | 0.89 | 1.77 | 0.56 |
| India | 0.71 | 3.70 | 4.40 | 3.76 |
| Indonesia | 0.20 | 0.71 | 0.91 | 0.72 |
| Malawi | 3.33 | 2.34 | 5.67 | 0.94 |
| Moldova | 0.39 | 1.98 | 2.38 | 1.56 |
| Mongolia | 0.02 | 2.09 | 2.11 | 2.09 |
| Nepal | 0.78 | 0.72 | 1.51 | 0.54 |
| Nicaragua | 0.32 | 0.75 | 1.07 | 0.69 |
| Niger | 0.02 | 0.00 | 0.02 | 0.00 |
| Nigeria | 0.30 | 1.06 | 1.36 | 0.86 |
| Pakistan | 0.11 | 3.89 | 4.00 | 3.81 |
| Panama | 0.21 | 0.66 | 0.87 | 0.44 |
| Peru | 0.13 | 0.32 | 0.45 | 0.31 |
| Rwanda | 0.07 | 0.22 | 0.30 | 0.25 |
| Sri Lanka | 0.21 | 1.40 | 1.61 | 1.47 |
| Tajikistan | 0.56 | 0.98 | 1.54 | 0.85 |
| Timor Leste | 0.00 | 0.00 | 0.00 | 0.00 |
| Uganda | 0.30 | 0.42 | 0.72 | 0.16 |
| Viet Nam | 1.36 | -0.57 | 0.79 | -0.80 |
| Yemen | 0.06 | 0.00 | 0.06 | 0.00 |
| Zambia | 0.37 | 1.95 | 2.32 | 1.73 |
| Simple average | 0.56 | 0.82 | 1.38 | 0.63 |

**Table 9: Relative frequency of triggered SSM responses**

| | No response triggered | Triggered minimum response (25%) | Triggered medium response (40%) | Triggered maximum response (50%) |
|---|---|---|---|---|
| All | 72.5% | 2.2% | 4.6% | 20.7% |
| Maize | 68.9% | 2.4% | 5.5% | 23.2% |
| Rice | 68.1% | 2.1% | 4.7% | 25.2% |
| Wheat | 83.5% | 2.2% | 3.2% | 11.2% |

Figure 1: Density (kernel-smoothed) of poverty changes, Monte Carlo simulation of 400 runs



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