# Trade Policy, Food Price Variability, and the Vulnerability of Low-Income Households*

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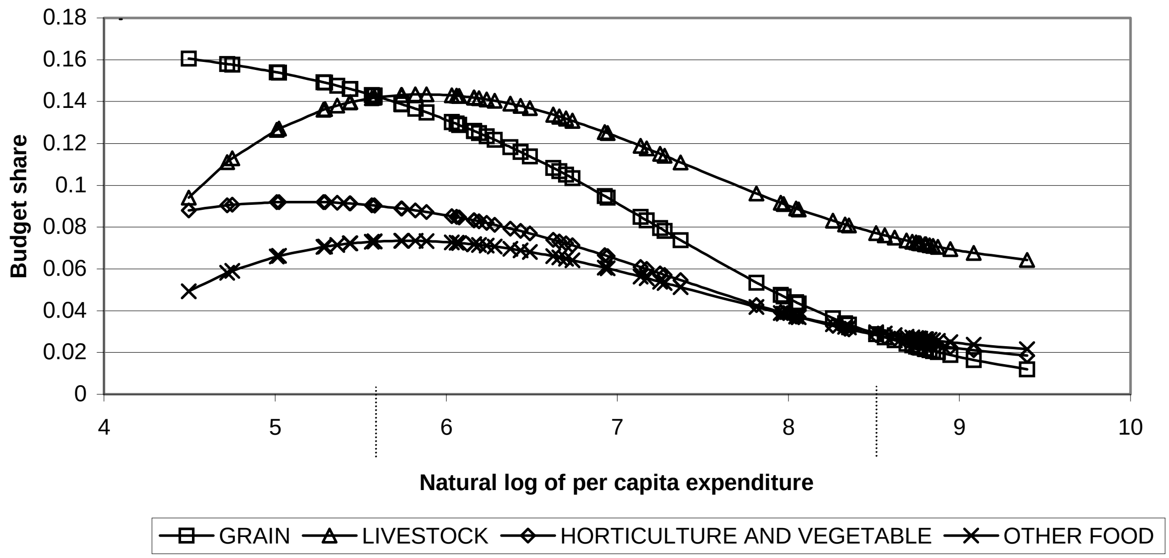
Recently there has been renewed interest in the impact of trade policy on developing countries in general and on low-income households in particular. The accumulating evidence indicates that trade policies affect the rate of economic growth, and hence the extent to which households may be lifted out of poverty (Edwards, 1998). Trade policies also affect variability in food prices and hence the vulnerability of low-income households (Tyers and Anderson, 1992). In spite of strong at the political level, research into the impact of trade policy on low-income households has been relatively scarce in the last decade. Most analyses still focus only on the average, national impact.

Figure 1 presents estimates of the share of household income spent on various food products, based on an international cross-section study (Cranfield et al., 1998). Fitted points at the lowest levels of expenditure/income represent an average household in Ethiopia in 1985. At the other end of the spectrum are households with incomes at the level of the United States in 1985. Two points stand out in Figure 1. The first is that at lower income levels, households spend about half their income on food, which underscores the importance of food prices to household well-being at the lower end of the income spectrum. The second point is the relative importance of grains in the consumption bundle of low-income households. At the lowest income levels, the estimated budget share for grains is around 15%, whereas it drops to only 1% at upper income levels. In view of the fact that grains prices are highly volatile (Tyers and Anderson, 1992), this is another count against low-income households. Not only do they spend a large share of their income on food, but a good part of it is tied up in goods for which prices are extremely volatile.

Despite the importance of the issue of commodity price volatility, trade policies and poverty, little research has been done in this area. There is an extensive literature on commodity price stabilization (e.g. Williams and Wright). Also, the link between commodity stabilization and food security in developing countries is well-developed (Berck and Bigman, 1993; Claessens and Duncan, 1993). Furthermore, some authors have explored the link between trade policy and food price

**Figure 1. Expenditure shares for food products, by income level (1985)**




variability (Vanzetti, 1998). However, the further link from food price variability and trade policy to poverty and the distribution of income within the developing countries remains largely unexplored. In a paper commissioned by the UN Conference on Trade and Development, L. Alan Winters includes this area as among the most pressing needs for research in agricultural trade (Winters, 1999). The objective of this research is to provide an assessment of the interaction between food price volatility, agricultural trade policy, and the well being of low-income households.

The rest of the paper is organized as follows. In the next section we consider previous work that has dealt with the variable nature of grain production, and lay the groundwork for the study at hand. The subsequent section describes the methods and procedures used to address the question of the study. In the final two sections, results are presented and conclusions are drawn.

**Volatility in grain supplies and prices**

Volatility in grain prices is due to the relative lack of price responsiveness in demand, coupled with the fact that short run supplies are quite volatile, and largely pre-determined. Therefore, an adverse development in the weather that reduces supply in a major producing region can require a large price adjustment to clear the market. This volatility of prices has led to an important line of research on commodity market stabilization (Williams and Wright, 1991; Timmer, 1991). It has also led governments to hold substantial stocks of grain in an effort to cushion markets in the face of volatile supplies.

It is expensive to hold stocks, however, and it is very expensive to hold sufficient stocks to make up for “worst case” scenarios (Abbott et al., 1993). Vanzetti (1998) estimates that minimum stocking costs amount to about 17 % of the purchase price, under the best of circumstances. These costs are even higher than the return that could be earned from speculation in the market. This point is reinforced by Abbott et al. (1993), who also point out that public stockholding has an important disincentive effect on private stockholding. Furthermore, those authors conclude that the impact of stockholding on food security of the poorest households is relatively weak, since the problem for these households is largely one of insufficient income. Thus it is hardly surprising that the size of publicly held stocks has greatly diminished in recent years, and the estimated stocks/use ratio for grains worldwide recently reached its lowest level in thirty years (Vanzetti 1998, Table A4).

Commodity storage seeks to reduce price variation by spreading availability of grains over time. International trade offers an alternative by spreading supplies across geographically dispersed markets. Tyers and Anderson (1992) and Vanzetti (1998) provide evidence of the potential for agricultural trade to substitute for commodity storage in world food markets. The more widely spread are the adjustments to a given supply shock, the smaller is the requisite adjustment in world prices. This risk sharing feature has benefits for all, which leads Kindleberger (1986) to point out that an efficient international market is a public good, the existence of which benefits all. However, like any public good, international trade is subject to free riding (Tyers, 1991). Some countries take advantage of international markets to absorb their own production surpluses or shortfalls, while failing to participate in the adjustments to changes in world market conditions (Timmer, 2001).

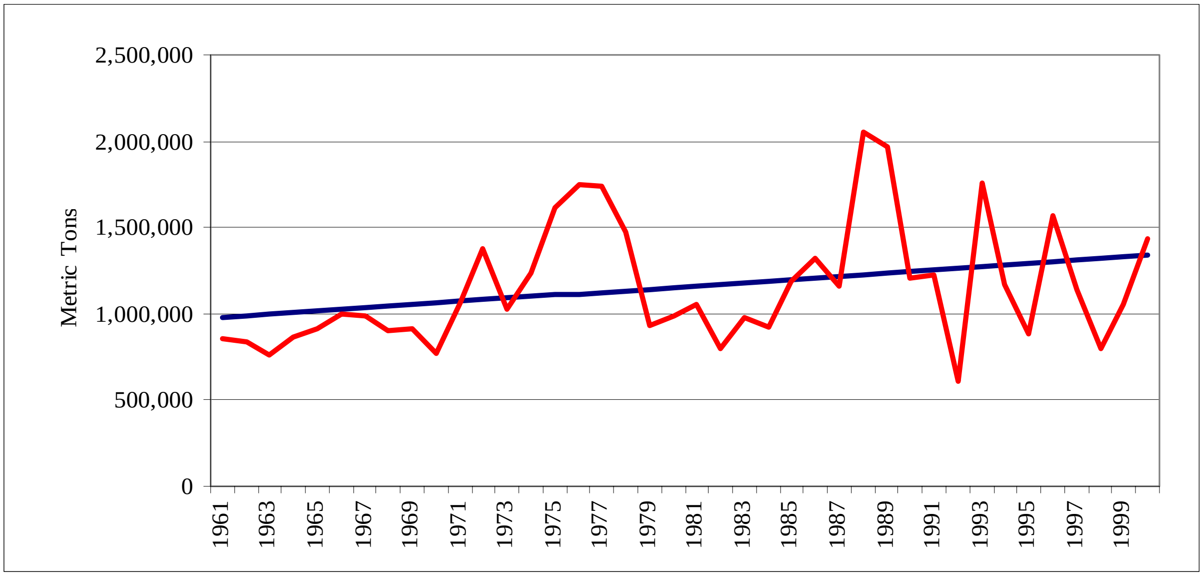
Tyers and Anderson (1992) have documented the cost of these market insulation measures to the world economy. They use a global model of agricultural trade to show that the coefficient of variation in world food prices would be reduced by two-thirds if all countries ceased to insulate their domestic markets. In the case of rice prices, they find that variation of consumer and producer prices in the heavily insulated economies would be little changed – and in some countries might even fall – when world prices are fully transmitted into domestic markets in all regions[1]. In an analysis of the world wheat market, Vanzetti (1998) finds a similar drop in variability in world prices when insulating policies are removed. He also explores the case in which trade is liberalized and public stocks are fully eliminated. He finds that this fully liberalized trading environment still delivers a lower coefficient of variation for world wheat prices than does the "business as usual" scenario. However, neither of these studies comes to grips with the potential impact on low-income households, because their analyses are pitched in terms of impacts on the average producer, or a representative consumer. Poor households often wear both hats, so it is necessary to consider both the impacts on consumption prices as well as factor returns. In fact, a general-equilibrium analysis of poverty in the Philippines by Coxhead and Warr (1995) shows that two-thirds of poverty reduction is transmitted through factor markets (e.g., via unskilled wages). Therefore, in order to accurately assess the impact of food price volatility and trade policies on poor households, more detail on both their consumption and factor earnings profiles is needed. Below we develop a methodology to remedy these gaps.

**Methods and Procedures**

Our first step is to characterize the volatility inherent to staple grain production. Examination of time series data for staple grains reveals two characteristics common to nearly every region of the world: overall production has been trending upward over the last four decades, and year-to-year production is quite volatile (FAO 2001). World staple grain production was 133 % higher in 2000 compared to 1961. This was mainly due to productivity improvements – yields were 124 % higher in 2001 compared to 1961, but area cropped was only 4 % higher. Annual volatility is also largely due to variation in yields.

[1] The variation in markets without extensive insulation would be much lower under this counterfactual scenario.

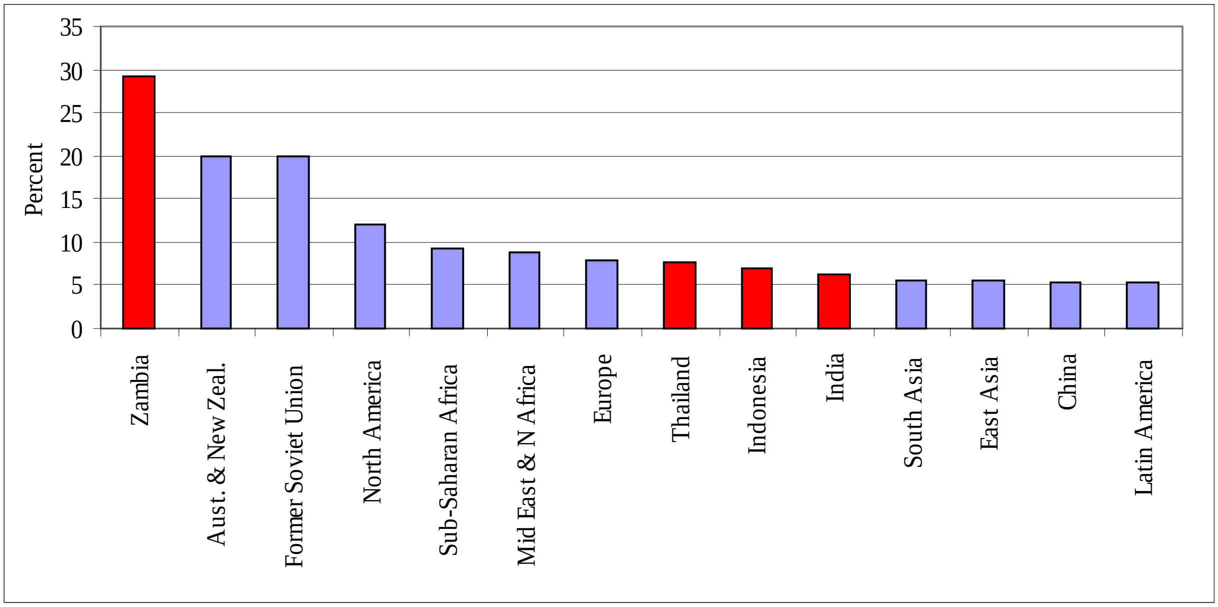
**Figure 2. Zambia production of staple grains, and trendline**




To characterize year-to-year instability while ignoring the overall trend, we follow Vanzetti (1998) and estimate a linear trend model of grain production for individual regions. An illustration of this procedure for the case of Zambia is given in Figure 2. We focus on the residuals from this regression, which we assume to be normally distributed. Using the standard deviation of residuals and mean level of production over 1961-2000, we derive a distribution of staple grain production for individual regions. For our analysis we divide the world into 10 major producing regions, and break out four focus countries: India, Indonesia, Thailand, and Zambia. The standard deviation of residuals divided by mean production levels for each of the 14 regions is given in Figure 3. It is clear that Zambia must contend with tremendous variation in staple grains production from year to year. The other focus regions have relatively less instability. As major exporters with volatile production, Australia/New Zealand, the Former Soviet Union, and North America are substantial sources of instability in the world market.

The next step in our analysis is to analyze the effect of variable grain production on prices under alternative trading regimes. To carry out this task a global trade-modeling framework was needed. As indicated earlier, both commodity and factor prices are of importance, since we are interested in impoverished households. For this reason we adopt a general-equilibrium model instead

**Figure 3. Standard deviation of residuals from trendline, staple grain production 1961-2000**




of the partial-equilibrium approach of Tyers/Anderson and Vanzetti. We employ the GTAP model of global trade (Hertel 1997), and aggregate the GTAP database up to eleven sectors to permit a sharp focus on grains and other food products. These production sectors are also mapped to the six International Comparisons Program (ICP) consumption categories of Cranfield et al. (1998) to permit a determination of spending effects on household welfare. The six ICP goods are staple grains, livestock products, other food products, other non-durable goods, durable goods, and services. The GTAP database disaggregates factors of production into four categories: unskilled labor, skilled labor, capital, and land. The 60 regions of the GTAP database are aggregated to the same 10 regions and four focus countries as was done with the FAO production data.

We consider three representations of trade policies in our analysis. These regimes are necessarily stylized, because we aim for global coverage. Regimes examined are: (1) current levels of openness and import substitution, (2) current levels of openness and no import substitution, and (3) fully liberalized global trade in all goods. Scenario (1) is the baseline regime, which assumes tariffication of import barriers. Scenario (2) is designed to represent a broad class of institutional arrangements aimed at frustrating import substitution. These include: variable levies, tariff rate quotas with prohibitive out-of-quota tariffs, quotas set at a fixed percentage of the domestic market (Japanese and Korean rice imports), as well as some state trading regimes. These regimes are characterized by setting the import-domestic substitution elasticity to zero. Scenario (3) represents the other extreme, wherein there are no policy barriers to trade whatsoever (the so-called "free trade" scenario)[2].

With this framework in place, we are able to generate distributions of world and domestic prices for all consumption commodities, and for factor returns, under alternative trade policy regimes. Using the Gaussian-Quadrature approach of DeVuyst and Preckel (1997), we sample from the distributions of grain production to generate distributions of commodity and factor prices. To facilitate this procedure we assume that the regional distributions of grain production are independent[3]. Using the Gaussian-Quadrature approach requires that the general-equilibrium model be simulated 28 times for each of the three trade regimes. An alternative procedure such as Monte Carlo would require as many as 1000 simulations for each of the three trade regimes (computationally very expensive for a CGE model), and would likely offer little added precision (DeVuyst and Preckel).

In order to use the commodity price changes from GTAP, they must be aggregated and adjusted to incorporate the marketing margins necessary to bring them up to the ICP consumer goods categories and prices used in demand system estimation, which is described below. To address this issue, a simple Cobb-Douglas wholesale/retail/trade sector is introduced in the post-simulation analysis. This sector combines GTAP producer goods with GTAP's trade and transport services to produce aggregated consumer price changes consistent with the general equilibrium results. We do not have data on the share of margins services embodied in consumer goods for the four focus countries. Therefore, we simply assume that for manufactures and processed products, the margin is equal to 50 % of the producer price. For farm products that are consumed without further processing, the margin is assumed to be 20 % of the producer price.

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[2] An important limitation of our study at this stage is that we do not model stockholding by the government or private sector. This shortcoming is to be remedied before presentation of the paper.

[3] This assumption is potentially quite important, and we hope to relax it in future work. It is used here because it was determined to be appropriate in previous studies (e.g. Vanzetti 1998), and it greatly facilitates the analysis.

The next step in our analysis is to assess the impact of grain production variability on households at the poverty line in the four focus countries. We adopt the World Bank's definition of poverty as applying to households living on less than one dollar per day, where this is measured in terms of 1985 international dollars. Based on an AIDADS expenditure function estimated for each country (which is used to characterize the consumption and factor earnings profiles of low-income households), we can then compute the poverty level of utility in each case. When a household that was previously below this level of utility rises above it under a given production/trade scenario, it is deemed to have moved out of poverty. We can also use the AIDADS expenditure function to compute the transfer necessary to lift an impoverished household out of poverty. This will be relevant below, when we report the Foster-Greer-Thorbecke poverty measures.

In order to facilitate analysis of the factors driving the changes in household welfare, we use the following first-order approximation to the percentage change in the *i*-th group's compensating variation relative to initial expenditure ($cv^i$):

$$cv^i = -\left(\sum_f \Omega_f^i w_f - \sum_n \theta_n^i p_n\right), \qquad (1)$$

where $\sum \Omega_f^i w_f$ is the percentage change in income received by group *i*, with $\Omega_f^i$ the share of income from primary factor *f*, and $w_f$ the return to factor *f*. Likewise, $\theta_n^i$ is the *i*-th group's budget share for good *n*, and $p_n$ is the percentage change in the price of that good. If the share-weighted average for consumer prices rises relative to income, for example, then compensation will be required ($cv^i > 0$) in order to hold this household at its initial level of utility.[4]

We focus our analysis on the *marginal* household, defined as those individuals that find themselves just below the poverty line prior to the policy change. (We denote this household by

[4] While this CV measure is distinct from the EV measure commonly used in welfare analysis, the CV approximation and the exactly computed EV yield nearly identical findings. Since (2) greatly facilitates our analysis, we work with that expression.

setting $i$=$m$ in (1)). Since previous analyses have focused only on the *per capita* household (Tyers and Anderson, Vanzetti), it is of particular interest to see how much the marginal and per capita households differ. This may be seen by introducing per capita changes in income ($y$) and consumer prices ($cpi$), as well as differences in expenditure and income shares between the marginal household $m$ and the per capita household:

$$-cv^m = (y - cpi) + \sum_f (\Omega_f^m - \Pi_f) w_f - \sum_n (\theta_n^f - \lambda_n) p_n \,, \qquad (2)$$

where $\Pi_f$ is primary factor $f$'s share in the per capita household's income, $\lambda_n$ is the share of consumer good $n$ in the average per capita household's budget, $y = \sum \Pi_f w_f$ , and $cpi = \sum \lambda_n p_n$ . The larger the two right-most terms in (2), the greater the need for disaggregated analysis as opposed to per capita analysis when attempting to isolate the impact of trade policy on poverty.

The next step in our analysis is to characterize the consumption and factor earnings profiles of low-income households in the target countries. We draw on the work of Cranfield (1999), who estimates a set of expenditure relationships by quintile for an international cross-section of countries using the ICP database in conjunction with the Deninger and Squire (1996) data on income distribution. Cranfield uses the AIDADS demand system (Rimmer and Powell, 1996), which has been shown to perform particularly well in predicting budget shares for food over wide ranges of income (Cranfield et al., 1998). The estimation approach is such that parameters of the demand system are estimated while simultaneously utilizing data on the distribution of expenditure by quintile to permit recovery of the unobservable distribution of expenditure for each quintile. This requires data typically used in demand system estimation (i.e., prices, per capita quantities and per capita expenditure), which come from the ICP database. Summary measures of the distribution of expenditure (i.e. variance, skewness, kurtosis, and quintile information) are also used from the Deninger and Squire data.

In the ideal scenario we would have direct observations on the earnings shares ( $\Omega_f^m$ ) in equation (2). However, there is no comparable international set of estimates on the supply side to aid in the estimation of the factor earnings profile of low-income households. As with the consumption side, we use an indirect approach to estimate this relationship, capitalizing on data on the income distribution from Deninger and Squire and total factor earnings in each region from the GTAP database. Specific functional forms are assumed for the distribution of ownership for each factor. For instance, it is assumed that land ownership changes as a linear function of an individual's relative position in the income spectrum. The values of the parameters of these functions are estimated so as to minimize the sum of squared differences between the given quintile fractions of economy-wide income, and those implied by the factor ownership allocation functions.

The last step in the research involves combining the price distributions with the information on expenditure and factor earnings profiles for low-income households. In our results we estimate the rate at which households move into and out of poverty. We employ a parametric class of poverty measures proposed by Foster, Greer, and Thorbecke (1984), which focus on incomes below some critical level. Denoting this level by *z*, the Foster-Greer-Thorbecke (F-G-T) measure is:

$$\Phi_{\alpha} = \frac{1}{n}\sum_{i=1}^{n}\left[\max\left(\frac{z-y_i}{z},0\right)\right]^{\alpha}. \qquad (3)$$

The most common values of $\alpha$ considered are $\alpha = 0$, 1 or 2. Taking the convention that zero to the zero power equals zero, the case of $\alpha = 0$ results in a "head count" measure – the fraction of the population below the critical level. We calculate the F-G-T measure at $\alpha = 0$ for each of the 28 simulations carried out to replicate variable grain production in each region. We then calculate the standard deviation at which people are moving into and out of poverty for each of the three trade regimes, for each country of interest.

**Results**

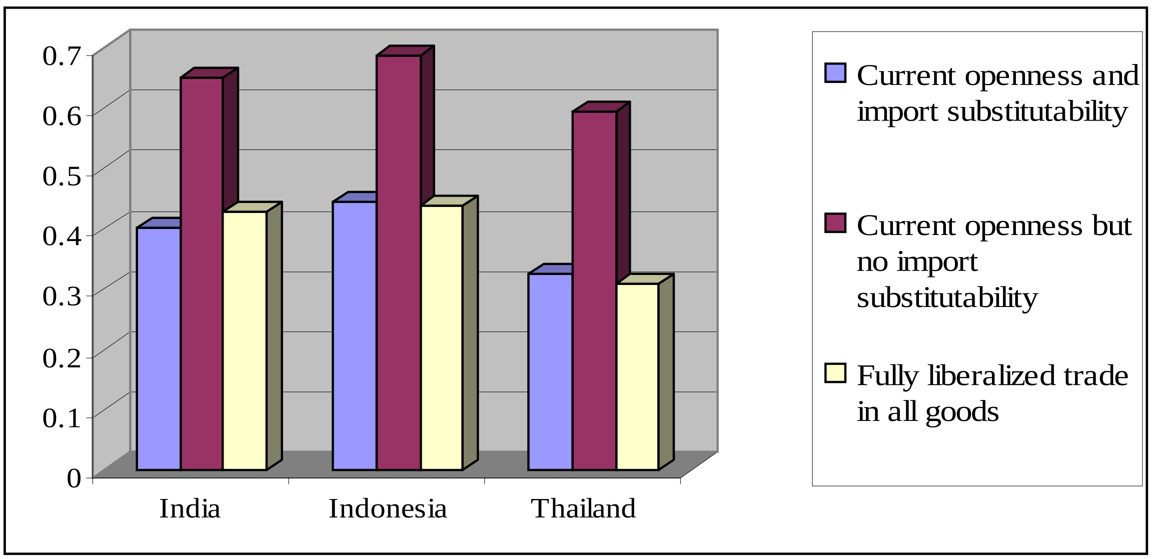
We begin by looking at the volatility of domestic staple grains prices under alternative trade regimes. A priori it is not clear whether increased exposure to trade will reduce this volatility for countries like India, where domestic production is relatively stable. Indeed, in the absence of a reduction in the volatility of staple grains prices on world markets, one might expect that an increased exposure to trade could actually increase domestic price volatility. However, from the results in Table 1, which reports the standard deviation of staple grains prices for each region under the three trade regimes, we see that free trade reduces price volatility in all regions. For example, comparing the first and second columns of Table 1 we see that grain prices are much more variable when countries insulate themselves from the rest of the world by limiting the substitution of domestic and imported grains. Comparing the first and third columns, we see that when countries go to fully liberalized trade, grain prices have less variability than in the baseline case (scenario 1), or when there is no import substitution (scenario 2).

**Table 1. Standard deviation of staple grain price under alternative trade regimes**

| Region | Current openness and import substitution | Current openness and no import substitution | Fully liberalized global trade in all goods |
|---|---|---|---|
| India | 24.5 | 30.8 | 19.4 |
| Indonesia | 27.4 | 36.2 | 25.5 |
| Thailand | 15.5 | 60.3 | 14.4 |
| Zambia | 98.3 | 611.5 | 93.1 |
| China | 14.3 | 16.7 | 13.0 |
| North America | 20.5 | 59.9 | 19.1 |
| Australia & New Zeal. | 48.0 | 239.8 | 44.7 |
| Latin America | 13.3 | 23.4 | 12.4 |
| Europe | 12.8 | 17.5 | 10.9 |
| Rest of South Asia | 20.6 | 40.6 | 18.6 |
| Rest of Asia | 17.5 | 33.0 | 13.4 |
| Former Soviet Union | 52.2 | 149.6 | 43.4 |
| Middle East & N. Africa | 13.1 | 23.6 | 11.7 |
| Sub-Saharan Africa | 22.5 | 30.1 | 19.8 |

We now explore the results of our post-simulation analysis, in which the price distributions from the simulation exercise are plugged into the post-simulation income and expenditure systems of the income groups of interest. Figure 2 is based on the F-G-T poverty headcount measure calculated for each country under the 28 production outcomes. The columns of Figure 4 correspond to the standard deviation of the number of people in poverty under the three trade regimes. In each of India, Indonesia, and Thailand we see that the second trade scenario (no import substitution) results in the largest number of people moving into and out of poverty as grain supplies vary. The other two scenarios, which are the baseline and free trade regimes (the leftmost and rightmost columns, respectively), have approximately the same standard deviations. This is quite interesting given that grain prices are notably more stable under the free trade regime (Table 1). In India, the standard deviation of the poverty headcount is actually slightly higher under a free trade regime than in the baseline scenario, despite less variable grain prices under free trade. This result suggests that factor markets and consumption of other commodities also play a role, and underscores the value of analyzing poverty incidence in a general equilibrium setting.

**Figure 4. Standard deviation of poverty headcount (percent of population)**




**Conclusions and future directions**

A framework has been developed to allow calculation of the rate at which households move into and out of poverty under alternative trade regimes. This framework enables internationally-comparable analyses, beyond the average per capita household. This approach should be viewed as a complementary to detailed country case-studies, which offer a definitive assessment for any one country. Our initial findings indicate that the vulnerability of low income households to volatile staple grains production is moderated by import substitution. Moving from current levels of openness to free trade may offer a slight reduction in vulnerability.

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