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The Impact of Domestic and International Commodity Price Volatility on Agricultural Income Instability

Ghana, Vietnam and Peru

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Abstract

The extent to which commodity price volatility affects the income of producing households and their vulnerability to poverty and food insecurity depends on household diversification patterns and the degree of their exposure to markets. This article focuses on estimating agricultural income uncertainties for a number of different household types in Ghana, Vietnam and Peru. We develop explicit formulae for household income variance, and we combine information from household datasets and commodity price time-series in order to estimate the income uncertainty that emanates from price and production volatility under different scenarios of exposure to international and domestic markets shocks. Our results indicate that market and nonmarket uncertainties significantly affect the variability of agricultural income of households in these countries, and especially households that are specialized in a few commodities. However, it turns out that, under current policies, almost all of their income variability is due to domestic factors, with international prices not contributing much, at least in the short run. Wider exposure to international markets would increase the income variability of producers who have been subjected to domestic market stabilization policies in Ghana and Vietnam, while it would decrease it in the case of Peru.

Keywords: commodity prices, risk, households
JEL classification: D81, Q12, Q18

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1 Introduction

Discussion and analyses of agricultural trade liberalization have focused for the most part on the issue of changes in the level of average prices faced by the producers and consumers of agricultural products under different liberalizing scenarios. However, a rather neglected issue, at least in analytical studies, is the extent to which trade liberalization may affect the instability faced by agricultural producers. More specifically, does increased exposure to international agricultural markets increase the income instability of agricultural producers? The purpose of this paper is to investigate the issue of income instability of agricultural producers arising from domestic and international causes, and to explore the question of whether increased exposure to international markets will make farmers' incomes more or less unstable.

Agricultural producers are exposed to a variety of income uncertainties, both market related such as price variations as well as non-market related, such as unstable weather patterns. They are also exposed to a variety of idiosyncratic shocks that affect their income, such as illness. Such uncertainties induce substantial income risks that can be particularly detrimental to small and/or poor producers in developing countries. In particular it has been shown that income instability in the presence of liquidity constraints and inadequate assets that feature rather prominently in many developing countries, can create poverty traps (Zimmerman and Carter 2003).

Farmers in developing countries have developed several ways for dealing with the various risks they face. These involve risk management strategies, namely actions taken ahead of the resolution of any uncertainty to improve the *ex ante* exposure of the household to various risks, as well as risk-coping strategies, namely rules adopted *ex ante* to help the household to deal *ex post* with any undesirable consequences. Risk management strategies include, among others, crop diversification, income diversification through off-farm work and sharecropping. Such *ex ante* strategies usually sacrifice higher expected income for a more stable income stream. Risk-coping strategies may include the availability of short-term consumption credit, mutual family or village-based reciprocal giving arrangements, and other arrangements.[1]

A significant share of the income variations of rural producers in developing countries seems to be due to idiosyncratic shocks, namely shocks particular to a household (Morduch 1995; Townsend 1995; Carter 1997). Such risks can be insured through formal or informal pooling of a large number of such shocks, such as the village reciprocity relations that are present in many developing countries, or the formal private or public insurance schemes that exist in many developed countries. Covariate shocks, however, namely those that affect all households in a given community or region, such as weather or price shocks, cannot be eliminated by pooling them within a small or even larger region. It is the need to insure farmers against such covariate shocks that has induced the governments of most developed countries to institute various price or income support schemes, under the perception that the private insurance industry would not be able to provide adequate coverage at reasonable cost.

The absence of such arrangements in developing countries is what induces rural households to develop self-insurance, or what has been termed 'consumption smoothing

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1 For a recent survey of these practices, see Dercon (2004).

strategies' to deal with covariate shocks. These strategies basically involve building 'precautionary savings', in the form of liquid or near-liquid assets in good years, and depleting them in years of adverse covariate shocks (Deaton 1991). There is conflicting evidence, however, on whether such strategies are effective at smoothing consumption (Rosenzweig and Binswanger 1993; Rosenzweig and Wolpin 1993; Fafchamps, Udry and Czukas 1998; Dercon 2004). The consensus, nevertheless, appears to be that despite the variety of smoothing strategies adopted by poor households in developing countries, there is substantial residual consumption risk (Jalan and Ravallion 1999).

While there has been considerable research devoted to the issue of world commodity market instability and its adverse growth consequences for developing countries,[2] there has been much less research devoted to the domestic market instability faced by many producers in developing countries. Recently Bourguignon, Lambert and Suwa-Eisenmann (2004) show that international agricultural trade instability implies diverging domestic incomes for different groups of income earners. They do not, however, investigate the impact of increased exposure to international markets. The extent to which domestic markets are exposed to the international market may have important implications for domestic commodity price volatility. Domestic markets can be partly insulated by large marketing margins that arise from high transaction costs. Poor infrastructure, transport and communication services give rise to large marketing margins due to high costs of delivering the locally produced commodity to the border for export, or the imported commodity to the domestic market for consumption. As a consequence, markets in developing countries may be insulated, resulting in a limited 'buffer' capacity, as the possibility that adverse shocks such as exogenous shifts in supply and demand can be adjusted through trade is limited. Often, in insulated markets, small exogenous shocks may generate relatively large price fluctuations, thus resulting in significant increases in uncertainty. Market integration and trade, in a manner similar to commodity storage, may lead to a reduction in the volatility of domestic prices, given unanticipated shocks in domestic markets, thus reducing the burden of adjustment that is carried by producers and consumers. Partly because of the non, or low tradability of many agricultural products, partly because of the lack of transmission of world prices to domestic markets, domestic agricultural product markets in many developing countries are very unstable, not only from year to year, but also within each crop year. It is not clear how increased exposure to international markets will affect this market instability, and hence it is not clear whether trade liberalization will make the incomes of producers more or less unstable. These are the issues that this paper is set to explore.

The paper takes a microeconomic approach, in the sense that it explores potential changes in agricultural income instability caused by increased exposure to international markets. In particular, it analyses the potential changes in various representative groups of agriculture-dependent households in three diverse developing countries, namely Ghana, Peru and Vietnam. While none of these countries are in the WTO group of least developed countries (LDCs), they are all classified as food insecure according to Diaz-Bonilla *et al.* (2000) and are commodity dependent in the sense that a large share of their exports consists of primary commodities, albeit not all agricultural.

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2 For some of the most recent analyses that review earlier studies as well, see Dehn (2000) and Collier and Dehn (2001).

We estimate household income variances and coefficients of variations under a variety of assumptions, applying a theoretical framework which is an extension of the one developed by Sarris (2002). The framework combines information from both cross-section household data and time-series on prices and yields, and leads to explicit analytical formulae for estimating the household income variance. The framework is applied to the World Bank's living standards measurement survey (LSMS) data on Ghana, Vietnam and Peru. Under the assumption that producing households do not change their long-run production and income diversification patterns, household income variance changes are estimated in terms of price and yield uncertainties, in scenarios where households face domestic price uncertainties, and alternatively international price uncertainties.

The plan of the paper is the following. In section 2 we outline the analytical framework of the study. Section 3 discusses the data and the income structure of the various income groups in the three countries analysed and presents the results of the analysis of income variability. Section 4 summarizes the main conclusions.

2 Analytical framework

Consider a household that produces some agricultural commodities and is also involved in several other income-earning activities. The production-consumption-saving problem of the agricultural household in the context of risk can be formalized mathematically using standard intertemporal stochastic models but it is not our purpose to review these here (for detailed expositions see Fafchamps 2003). Following standard methods outlined in Newberry and Stiglitz (1981), one can write the welfare of the household as a function of the varying income and prices as well as the covariance of income and prices, and a set of demand and risk parameters such as the various income and price elasticities of demand, and the coefficient of relative risk aversion.

In this paper we do not attempt to estimate the demand and risk characteristics of different groups of households. Rather, we concentrate only on the coefficient of variation (CV) of income, as it is the main component of welfare under risk, especially if prices of the different expenditure categories are not strongly correlated with each other. We develop an explicit expression for the CVs of agricultural income, conditional on information twelve months ahead (in order to capture the inherent uncertainty of agricultural production decisions). The CV of income of a household can be written as follows:

$$CV^2(Y) = \alpha^2 \sum_i \sum_j s_i s_j E\left[\Delta p_i \Delta p_j \Delta q_i \Delta q_j + \Delta p_i \Delta p_j + \Delta p_i \Delta q_j + \Delta p_j \Delta q_i + \Delta q_i \Delta q_j\right] \quad (1)$$

where α denotes the share of agriculture[3] in total income, s_i denotes the average shares of each agricultural product i in agricultural income, and q_i is the normalized (by average income) quantity of product i produced.

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3 This share in the subsequent empirical calculations will comprise only the part of agricultural income for which we have enough information to compute the stochastic variables. Prices are normalized by the average price faced by the household

Consider the relationship between the domestic and international prices of the various commodities. Empirical models of domestic price formation usually adhere to the following generic specification:

$$p_{it}^{d} = \alpha_i + \zeta_i p_{it}^{w} + u_{it} \tag{2}$$

where p_{it}^{d} and p_{it}^{w} denote the domestic and international price of commodity *i,* respectively, and u_{it} is an error term. Equation (2) implies that commodity prices in the domestic market are determined by international market prices, at least in the long run. The parameter ζ_i is interpreted as the elasticity of transmission of world prices to domestic prices, when prices are converted in logarithms, and can be thought of as a measure of the extent to which international price signals pass-through to the domestic market. Nevertheless, the interpretation of ζ_i, and the quantification of the relationship between domestic and international prices depends on the statistical methodology applied for estimation rather than the underlying theoretical concept itself.

Denote by σ_{i} the CV of production of the i^{th} crop produced by the household, by κ_{ij} the correlation coefficient between the production of the i^{th} crop and the j^{th} other crop produced by the household, by v_i^{w} the CV of the world price of the i^{th} product, by ρ_{ij} the correlation coefficient of world prices of the i^{th} and j^{th} products (if they are tradable), by v_i the CV of the random component u_{it} of the domestic price of the i^{th} product, and by ψ_{ij} the correlation coefficient between the random components u_{it} of the domestic prices of the i^{th} and j^{th} products.

Given Equation (2), and certain additional normality and independence assumptions, the various terms in Equation (1) can be evaluated explicitly as follows:

$$E(\Delta p_i \Delta p_j \Delta q_i \Delta q_j) = (\zeta_i \zeta_j \rho_{ij} v_i^{w} v_j^{w} + \psi_{ij} v_i v_j) \kappa_{ij} \sigma_i \sigma_j \tag{3}$$

$$E(\Delta p_i \Delta p_j) = \zeta_i \zeta_j \rho_{ij} v_i^{w} v_j^{w} + \psi_{ij} v_i v_j \tag{4}$$

$$E(\Delta p_i \Delta q_j) = 0 \tag{5}$$

$$E(\Delta q_i \Delta q_j) = \kappa_{ij} \sigma_i \sigma_j \tag{6}$$

By setting the transmission coefficient ζ_i equal to zero in the above expressions, we obtain the components that are accounted for only by domestic factors such as production, and are not due to international price variability. If, in turn, we set the transmission coefficient ζ_i equal to 1 and, at the same time set the variance of the domestic error term u_{it} equal to zero, then we can simulate the situation where the domestic prices are equal to international prices, with the resulting expressions simulating a scenario in which the household is faced only with international price variability.

In the empirical applications, Equation (2) is replaced by a reduced (or standard) Vector Autoregression (VAR) assuming that both domestic and international monthly prices are stochastic in nature, have similar statistical properties and are jointly determined:

$$p_{it}^{w} = c_1 + \sum_{j=1}^{k} a_{11,j} p_{it-j}^{w} + \sum_{j=1}^{k} a_{12,j} p_{it-j}^{d} + \varepsilon_{it}^{w} \quad (7)$$

$$p_{it}^{d} = c_2 + \sum_{j=1}^{k} a_{21,j} p_{it-j}^{d} + \sum_{j=1}^{k} a_{22,j} p_{it-j}^{w} + \varepsilon_{it}^{d} \quad (8)$$

where p_{it}^{d} and p_{it}^{w} denote the domestic and international price of commodity *i* respectively, while the α's are parameters and the ε's are contemporaneously correlated white noise error terms.

Equations (7)-(8) provide a basis for the estimation of *h*-step forecast of means and variances of the prices, conditional on the VAR relationships, and, under the implicit assumption that economic agents form expectations according to the VAR relationships, the relative importance of shocks to the domestic and international prices as well as their overall impact on the domestic price can be analysed. The existence and the direction of causal effects between domestic and international prices can be assessed within the VAR environment, by applying Granger's causality tests.[4]

In view of the above discussion, we proceed in the implementation of the conceptual model in two stages. At the first stage, we estimate 12-*month* forecast of conditional variances and covariances for each commodity price on the basis of an estimate autoregressive model, or VAR depending on whether or not the commodity is internationally traded. In more detail, we proceed by assessing the statistical properties of the series, specifying and estimating a VAR for the prices that have similar time-series properties, testing for Granger causality and ordering the system, and estimating conditional variances and covariances through variance decomposition. We also estimate the variances of domestic production. In the second step, these estimates are used in conjunction with the income structure of the households in order to estimate household income variances and CVs.

In order to evaluate the impact of the extent to which world market exposure affects household income volatility, we estimate agricultural income CVs under three assumptions:

i) current conditions of exposure to domestic and international shocks, taking into consideration the estimated price transmission coefficient;

ii) household exposure to domestic price volatility only, and;

iii) household exposure to international market prices only, reflecting perfect market integration.

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4 A technical discussion of the estimation of VARs and of the corresponding conditional variances through variance decomposition in the context of a VAR system is beyond the scope of this paper. Interested readers may refer to Hamilton (1994: Chapter 11), and Lütkepohl (1993: Chapter 3). Granger (1969, 1988) proposes an empirical definition of causality based only on its forecasting content.

3 The data and empirical analysis

We specify the income and expenditure structure of the various farm households in the countries under examination by using the living standards measurement studies (LSMS) data surveys carried out by the World Bank and the respective national statistical institutions.[5] We restrict our analysis to those households that have some agricultural activities, and classify farm households by first distributing them according to geographical regions in order to capture any agro-climatic conditions that may determine crop production structure. The households are further classified according to their characterization as poor and nonpoor by utilizing the general poverty thresholds established by studies undertaken by the World Bank and national statistical institutes. The sample is subsequently divided according to the share of income from all agricultural activities (households with shares either larger or smaller than 60 per cent) and their share of agricultural income derived from a main agricultural commodity that depends on the country and the agro-climatic region. These classifications capture the extent to which households depend on agricultural activities and on the production of specific major commodities. For the households in each classification, we estimate the average income and the shares of income derived from the production of agricultural commodities as well as from wages, self-employment, rents and remittances. We also compute average total expenditure, and the expenditure shares for food, subdivided by food items.

For estimating the vector autoregressions and the conditional measures of price variability for each country, we use monthly data on domestic prices, compiled by the corresponding ministries of agriculture for the period 1992 to 2002. As it was not possible to obtain monthly domestic price data series for all the commodities produced and described in the household classifications, we assume that such agricultural income sources as fruits and vegetables, for which data are not available, present no uncertainties. All prices are in the national currency per ton and have been deflated utilizing the IMF consumer price index. Data on international prices have been collected by the International Financial Statistics (IMF 2005), and have been transformed to domestic prices with the appropriate exchange rates, while conditional measures for yield variability have been estimated utilizing time-series data from FAOSTAT.

3.1 Ghana

The results of the household classification analysis of the 1998/9 LSMS data on Ghana are given in Table 1.[6] The sample represents 2.2 million farm households, out of a total of 4.1 million, and are divided in three regions: forest, coast and savannah. These are divided according to their income level as poor and nonpoor, utilizing a general poverty threshold of 900,000 cedis per capita per year.[7] The sample is further subdivided according to the contribution of agricultural activities to the total income and according to the portion of cocoa sales contributing to agricultural income (i.e., households with

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5 Information on the LSMS data surveys is available at: www.internationalbank.org/html/prdph/lsms/index.htm .

6 Further information on the Ghana LSMS 1998/9 dataset is available at: www4.internationalbank.org/afr/poverty/pdf/docnav/02684.pdf

7 The average exchange rate in Ghana for the period of the survey was 2,930 cedis per US$.

shares smaller than 30 per cent, with shares between 30-60 per cent or shares larger than 60 per cent).

Table 2 presents the conditional measures of the variability of agricultural prices faced by producers and the conditional CVs of international prices. These have been calculated with estimated single autoregressive models for the domestic price of commodities not traded internationally (cocoyam, yam, cassava and millet), as well as for the domestic and international prices of goods with dissimilar statistical properties (bananas, maize and sorghum). For the domestic and international prices of rice, which were found to have similar statistical properties on the basis of the unit root tests, the estimated VAR revealed that there was no significant relationship between the two prices, with neither being Granger-caused by the other. Consequently, producers in Ghana are exposed to shocks from domestic markets only and international shocks do not pass through to the domestic market. Table 3 presents the estimates of income variability measures. These conditional income CVs may underestimate the actual variability of income as they are estimated on the basis of partial agricultural income for which data on commodity prices are available.[8] The estimates suggest that the agricultural income uncertainty faced by farm households is significant. The agricultural income CV for most household groups ranges between 10 and 20 per cent, while several households face CVs that are estimated to be higher than 20 per cent. As the portion of agricultural income in the calculations in Table 3 constitutes only a part of the total income variation, the overall income variability of farm households from agricultural shocks is smaller than indicated in the table, but not much less for those households with a large share of agriculture in total income.

Due to high production variability, the households that depend for a larger part of their agricultural income on the main export commodity, cocoa, seem to be exposed to larger agricultural income variability, despite the market intervention policies of Cocobod, the government parastatal, to stabilize producer prices. The per capita incomes of the household groups in Table 1 suggest that farm households receiving a larger share of their agricultural income from cocoa have a better income per capita. This indicates that in Ghana, households specializing in cocoa farming are, on average, richer but at the same time more exposed to price and production risks. Income volatility is still significant for the predominantly agricultural households that rely on cocoa to a lesser extent for their agricultural income, mainly because of high variability in domestic prices for maize and cassava. In the coast region, the predominantly poor agricultural households, for whom cocoa sales constitute less than 30 per cent of their agricultural income, experience relatively high uncertainty, with a coefficient of variation raising 12.9 per cent, as cassava and maize production generate up to 68 per cent of their agricultural income. Similarly, poor households in the forest and savannah regions relying on roots and cereals are also subject to significant agricultural income fluctuations. The findings suggest that crop diversification strategies in Ghana, although important as a risk management strategy, may be relatively insufficient in shielding poor producers from large income fluctuations.

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8 The part of total income accounted by the portion of agricultural income for which we have enough information to compute the income variance is indicated in the Annex Table.

Table 1
Household classification and characteristics, Ghana

	Share of agriculture in POOR household income						Share of agriculture in NONPOOR household income					
	<60%			>60%			<60%			>60%		
	Share of cocoa in agricultural income, %						Share of cocoa in agricultural income, %					
	<30	30-60	>60	<30	30-60	>60	<30	30-60	>60	<30	30-60	>60
	Coast											
Estimated no. of households	262,790	7,238	5,190	48,055	1,058	1,151	87,740	982	1 835	19,229		
Share of total households (%)	6.41	0.18	0.13	1.17	0.03	0.03	2.14	0.02	0.04	0.47	–	–
Total income per capita ('000 cedi)	812	1,339	1,669	550	514	804	2,683	1,290	8,399	1,575		
Share of agriculture in total income (%)	16.91	14.66	14.49	71.32	69.94	61.75	17.27	34.96	4.45	75.66	–	–
	Forest											
Estimated no. of households	503,790	51,169	31,785	149,464	26,710	8,935	192,334	16,632	11,746	86,874	19,283	6,108
Share of total households (%)	12.29	1.25	0.78	3.65	0.65	0.22	4.69	0.41	0.29	2.12	0.47	0.15
Total income per capita (000 cedi)	1,017	1,244	1,374	563	647	633	3,103	1,914	3,328	1,577	2,431	4,502
Share of agriculture in total income (%)	22.86	35.21	34.18	70.90	68.66	67.00	21.77	32.49	40.39	74.31	69.87	69.10
	Savannah											
Estimated no. of households	488,980	1,393		133,115	1,420	1,420	55.436			37,500	609	
Share of total households (%)	11.93	0.03	–	3.25	0.03	0.03	1.35	–	–	0.91	0.01	–
Total income per capita ('000 cedi)	759	1,003		534	866	7,281	2,700			1,544	2,431	
Average share of agriculture in total income (%)	26.92	49.99		71.48	64.95	75.94	26.66			73.82	79.93	

Source: Authors' computations.

Table 2
Decomposed coefficients of variation of domestic prices, Ghana (per cent)*

	CV of domestic prices accounted for by:			World price coefficients of variation
	Domestic shocks	International shocks	Total	
Maize	21.24	0.00	21.24	18.4
Cassava	25.80	0.00	25.80	14.9
Plantains	36.06	0.00	36.06	
Cocoyam	17.33	0.00	17.33	
Yam	23.93	0.00	23.93	
Sorghum	24.81	0.00	24.81	16.6
Millet	13.58	0.00	13.58	16.6
Rice	13.30	0.00	13.30	11.5
Cocoa	8.35	0.00	8.35	20.2
Groundnuts	14.46	0.00	14.46	16.0

Note: * Conditional coefficients of variation projected for 12 months ahead.
Source: Authors' calculations.

Table 3
Coefficients of variation (CVs) of agricultural incomes, Ghana (per cent)

	Share of agriculture in POOR household income						Share of agriculture in NONPOOR household income					
	<60%			>60%			<60%			>60%		
	% share of cocoa in agricultural income						% share of cocoa in agricultural income					
	<30	30-60	>60	<30	30-60	>60	<30	30-60	>60	<30	30-60	>60
	Coast											
Actual CVs due to:												
Price and production shocks	12.87	13.81	19.00	17.19	16.00	16.68	10.71	13.69	20.90	12.19	–	–
Domestic market price and production shocks only	12.87	13.81	19.00	17.19	16.00	16.68	10.71	13.69	20.90	12.19	–	–
Simulated CVs due to world prices (in US$) and production shocks	8.66	14.68	24.28	8.97	13.07	20.34	7.13	12.69	27.09	6.67	–	–
	Forest											
Actual CVs due to:												
Price and production shocks	14.41	14.48	18.23	14.86	14.85	18.30	14.15	15.21	18.09	14.41	15.19	17.64
Domestic market price and production shocks only	14.41	14.48	18.23	14.86	14.85	18.30	14.15	15.21	18.09	14.41	15.19	17.64
Simulated CVs due to world prices (in US$) and production shocks	10.16	15.07	23.05	9.25	14.33	23.06	9.90	15.48	22.68	8.48	14.37	22.18
	Savannah											
Actual CVs due to:												
Price and production shocks	10.00	15.22	–	10.62	15.23	20.15	12.78	–	–	14.73	14.94	–
Domestic market price and production shocks only	10.00	15.22	–	10.62	15.23	20.15	12.78	–	–	14.73	14.94	–
Simulated CVs due to world prices (in US$) and production shocks	9.23	16.54	–	9.17	17.60	25.81	10.79	–	–	11.88	17.84	–

Source: Authors' computations.

The degree of agricultural income fluctuation that producers face if directly exposed to international prices for all globally-traded commodities suggests that there would be a considerable increase in income variability of the cocoa-dependent households, irrespective of whether they are poor or nonpoor. On the other hand, agricultural income fluctuations would decrease for those households that are not as dependent on cocoa. This is largely the outcome of the fact that the domestic price of cocoa currently continues to be stabilized by Cocobod. Hence the abolition of this parastatal and full exposure to international prices are bound to have adverse effects on the overall income variability of producers.

3.2 Vietnam

Table 4, utilizing the 1997/8 LSMS dataset, presents the results of the household classification for Vietnam.[9] The sample covers a weighted 13 million households, representing 80 per cent of all households in the country. These are divided in three regions, namely urban and northern Vietnam, Red River and the north coast and south and central Vietnam. The households are classified as poor and nonpoor on the basis of a total household expenditure threshold of 19,590 thousand dong per capita per year.[10] They are further divided according to the contribution of agricultural activities in the total income (i.e., households with agricultural contributions less than and householders with contributions larger than 60 per cent of total income). The households are also classified according to the portion of internationally tradable commodities in agricultural income (i.e., households with a share less than 30 per cent, a share of 30-60 per cent and a share larger than 60 per cent). Households in the urban and northern, and Red River and north coast regions are examined according to the share of rice in agricultural income while households in the south and central region are classified according to their activities in coffee production. Production activities are categorized for rice, other cereals (including maize, wheat, barley malt, millet and kaoliang), meat (pork, chicken and beef), fish, cassava, coffee, sugar, fruits, vegetables and other roots.

Table 5 estimates the agricultural price variability of the producers and the share of this variability resulting from domestic and international shocks. The price variations of the producers are largely due to domestic factors, with the exception of rice- and coffee-dependent producers. In addition, except for coffee prices, the US$ denominated international prices are either more unstable than, or equally unstable as, the domestic prices for all commodities. Variability was decomposed to components that are identified with domestic and international shocks with a series of single autoregression models and VARs. For the price pairs with dissimilar statistical properties, namely for sugar and pork, we estimate single autoregressive models. For coffee, the estimated VAR parameters are statistically significant, revealing a correlation between domestic and international prices, while the Granger-causality test provides evidence that international prices impact on the Vietnamese domestic price, in the Granger sense. The correlation coefficient between the VAR innovations is estimated to be approximately 0.49, indicating that shocks are passed through from the international to the domestic market to a large extent. The domestic and the international prices account for 80 and 20

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[9] Further information on the Vietnam LSMS 1997/8 dataset can be found in www.internationalbank.org/lsms/country/vn98/vn98bif.pdf .

[10] The average exchange rate pertinent to the survey period is 13,091 dong per US$.

per cent of the domestic price forecast variance respectively, while variation in the domestic price can explain 38 per cent of the variation in the international price.

Domestic and international price VARs for maize and beef in conjunction with the corresponding causality tests suggest that domestic prices are not determined nor Granger-caused by international prices. Consequently, for these commodities, the variance decomposition suggests that the proportion of the domestic price forecast variance attributed to international price fluctuations is nonsignificant. For rice, the VAR estimated parameters suggest a rich dynamic structure. The Granger causality test provides sufficient evidence to suggest that the international price Granger-causes domestic prices. Decomposition of the divergence indicates that 29 per cent of the domestic price variability for rice can be attributed to international rice markets.

Table 6 presents the estimates of conditional agricultural income variability for Vietnam. As expected, the results suggest that the uncertainty of the households varies according to production diversification. Households producing a large share of rice and coffee, irrespective of the overall share of these crops in the agricultural income, are exposed to higher income volatility compared to households with less specialized production patterns. Coffee producers in the south and central region are subject to significant income variability. For the producers whose share of coffee in total agricultural income exceeds 60 per cent, irrespective of the share of agriculture in total income, the CV is around 50 per cent. This is much higher than the CVs of all other household groups. By contrast, even the highly specialized rice producers do not seem to incur a CV larger than 14 per cent.

The results also indicate that almost all of the agricultural income variability faced by the producers is due to domestic factors. Even in highly coffee-dependent households, most of the income variability appears to be due to domestic factors. Such substantial income variation suggests that poor agricultural households may experience serious food security problems *post* adverse coffee price shocks, because of the limited resources used for the production of food crops for own consumption.

The simulation of full exposure to international prices indicates that perfect market integration would increase the CV of agricultural income for almost all households in the urban and northern as well as in the Red River and north coast regions. During the period under examination, Vietnam has implemented a series of policies aimed at maintaining domestic rice prices at a certain level and to reduce its volatility. These included export management through a system of minimum export prices and quotas allocated to authorized export enterprises, both public and private. Minimum export prices were revised frequently in order to follow international prices. In 2001, export quantitative limits were removed, but the new arrangement allows responsibility for exports to be retained by the state trade enterprises (FAO 2001, 2002). Hence it is to be expected that if these policies were replaced with full international market exposure, producers' income variability would increase. This is confirmed by the analysis. In contrast, the results indicate that the highly specialized coffee households in the south and central regions would experience from international exposure a small decline in their overall CV, albeit not large. The remaining income variability would, nevertheless, still be substantial.

Table 4
Household classification and characteristics, Vietnam

	Share of agriculture in POOR household income						Share of agriculture in NONPOOR household income					
	<60%			>60%			<60%			>60%		
	Share of rice in agricultural income, %						Share of rice in agricultural income, %					
	<30	30-60	>60	<30	30-60	>60	<30	30-60	>60	<30	30-60	>60
	Urban and northern regions											
Estimated no. of households	164,061	193,203	77,569	316,921	684,132	125,460	1,264,246	179,788	179,154	356,599	223,382	76,235
Share of total households (%)	1.02	1.20	0.48	1.96	4.24	0.78	7.84	1.11	1.11	2.21	1.39	0.47
Total income per capita (dong)	2,662	2,293	1,905	1,546	1,173	745	8,115	5,201	8,121	2,672	1,638	1,886
Share of agriculture in total income (%)	24.97	38.07	30.16	91.98	91.34	94.85	9.90	29.04	13.32	88.14	90.45	93.37
	Red River and north coast											
Estimated no. of households	184,308	298,393	234,811	173,966	622,875	369,433	536,795	546,296	282,737	356,527	613,870	169,116
Share of total households (%)	1.14	1.85	1.46	1.08	3.86	2.29	3.33	3.39	1.75	2.21	3.81	1.05
Total income per capita (dong)	2,394	1,894	1,602	1,377	1,116	766	5,175	6,300	4,779	2,574	1,636	1,317
Share of agriculture in total income (%)	22.49	36.17	31.42	91.01	89.59	89.31	19.32	16.51	15.37	81.88	86.15	88.11
	Southern and central regions											
Estimated no. of households	412,373	1,168	5,633	1,171,145	26,151	32,370	1,211,060	11,555	24,905	1,559,728	39,217	102,592
Share of total households (%)	2.56	0.01	0.03	7.26	0.16	0.20	7.51	0.07	0.15	9.67	0.24	0.64
Total income per capita (dong)	2,437	4,758	2,896	1,155	1,508	1,676	5,727	5,278	6,448	2,778	2,691	5,445
Share of agriculture in total income (%)	22.00	17.12	35.08	92.47	93.52	95.20	16.96	31.55	24.93	90.80	84.97	92.80

Source: Computed by authors.

Table 5
Decomposed coefficients of variation of domestic prices, Vietnam (per cent)*

	CV of domestic prices accounted for by:			World price coefficients of variation
	Domestic shocks	International shocks	Total	
Coffee	51.01	12.68	63.69	45.6
Maize	6.10	0.09	6.20	18.4
Sugarbeet	12.53	0.42	12.95	25.0
Rice	7.74	3.11	10.85	11.5
Beef	2.62	0.01	2.63	9.8
Pork	7.54	0.10	7.64	18.7

Note: * Conditional coefficients of variation projected for 12 months ahead.
Source: Authors' calculations.

Table 6
Coefficients of variation (CVs) of agricultural incomes, Vietnam (per cent)

	Share of agriculture in POOR household income						Share of agriculture in NONPOOR household income					
	<60%			>60%			<60%			>60%		
	% share of rice in agricultural income						% share of rice in agricultural income					
	<30	30-60	>60	<30	30-60	>60	<30	30-60	>60	<30	30-60	>60
	Urban and northern regions											
Actual CVs due to:												
Price and production shocks	3.56	8.09	10.64	5.58	7.73	10.38	3.71	8.07	12.00	5.05	7.49	11.53
Domestic market price and production shocks only	3.56	8.09	10.64	5.58	7.73	10.38	3.71	8.07	12.00	5.05	7.49	11.53
Simulated CVs due to world prices (in US$) and production shocks	4.91	9.74	12.39	7.23	9.13	12.11	5.40	9.67	14.02	6.88	9.04	13.44
	Red River and north coast											
Actual CVs due to:												
Price and production shocks	4.92	8.19	11.09	5.79	7.80	11.04	5.43	8.47	10.78	5.53	8.02	10.68
Domestic market price and production shocks only	4.92	8.19	11.09	5.79	7.80	11.04	5.43	8.47	10.78	5.53	8.02	10.68
Simulated CVs due to world prices (in US$) and production shocks	6.97	9.87	12.93	7.71	9.38	12.88	7.80	10.52	12.56	7.53	9.80	12.47
	South and central regions											
	% share of coffee in agricultural income						% share of coffee in agricultural income					
Actual CVs due to:												
Price and production shocks	5.77	19.32	48.92	7.12	27.67	52.45	6.36	26.88	54.28	7.03	27.78	53.19
Domestic market price and production shocks only	5.77	19.21	48.66	7.12	27.54	52.16	6.36	26.74	53.99	7.03	27.64	52.90
Simulated CVs due to world prices (in US$) and production shocks	6.71	18.25	46.26	8.22	26.32	49.55	7.50	25.51	51.31	8.13	26.42	50.28

Source: Computed by authors.

3.3 Peru

The household classifications for Peru are based on the 1994 LSMS dataset (Table 7).[11] The sample consists of a weighted 1.9 million producer households, representing 50 per cent of all households in the country, divided in three regions, namely: sierra, coast and selva. Households are classified as poor and nonpoor according to income-level thresholds that vary across regions.[12] The sample is further divided according to the contribution of agricultural activities in total income (i.e., households having contributions less than 60 per cent and those with contributions larger than 60 per cent of total) and according to the contribution of rice production in agricultural income (i.e., households with shares smaller than 30 per cent, with shares between 30-60 per cent or shares larger than 60 per cent).

Table 8 presents the analysis of agricultural price variability of the producers as well as shares of this variability that are accounted for by domestic and international shocks. For commodities like coffee, wheat, and chicken, the major share of the domestic price variability is due to international factors. For other commodities, most of the variability is due to domestic factors and the corresponding CVs of domestic prices do not follow a consistent pattern of instability *vis-à-vis* international prices.

In more detail, the VARs estimated for the domestic and international prices of beef, in conjunction with the Granger causality tests indicated that these prices are related, albeit weakly, with the causality being manifested from the international to the domestic market. In a similar vein, the variance decomposition suggests that most of the variation in domestic prices is attributed to domestic shocks. The estimated VAR parameters and the causality tests provide evidence that on the part of poultry domestic prices are closely related to, and Granger-caused by, international prices. The undertaken variance decomposition indicated that, although domestic prices are highly volatile with a coefficient of variation equal to 0.41, most of this divergence is attributable to international prices. The VAR analysis for domestic and international banana prices reveals that these prices are not determined in parallel. This suggests that international banana prices may not be an appropriate proxy for explaining price fluctuations for plantains in Peru. The VAR for the domestic and international prices for rice revealed that for the period under examination, price shocks in the international market are reflected in the domestic market and *vice versa*, although not to the full extent. The Peruvian government intervenes through tax restitutions on exports and a variable tariff imposed on rice imports. Rice imports originating from non-member countries of the Andean Pact, are subject to a 20 per cent tariff plus a supplementary tax of 5 per cent. In the mid-2001, the country introduced a price band mechanism based on an external reference price and a basic floor price to be set twice a year. In spite of the existing tariff, the implementation of these policies may have resulted in isolating the domestic market prices from shocks in the international markets, at least during the period covered by the sample.

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11 Further information on the Peru LSMS 1994 dataset is available at: www.internationalbank.org/lsms/country/pe94/docs/i-basica.pdf .

12 Poverty thresholds in Peru vary across the 12 subregions examined in the LSMS dataset and are calculated according to the cost of a commodity basket. For the purpose of this research, region thresholds are estimated as weighted averages of the constituent subregions. The average exchange rate for the period of the survey was 2.2 nuevo sol per US$.

Table 7
Household classification and characteristics, Peru

	Share of agriculture in POOR household income						Share of agriculture in NONPOOR household income					
	<60%			>60%			<60%			>60%		
	Share of rice in agricultural income, %						Share of rice in agricultural income, %					
	<30	30-60	>60	<30	30-60	>60	<30	30-60	>60	<30	30-60	>60
	Coast											
Estimated no. of households	136,109	3,886	5,505	18,674	1,481	6,085	315,603	9,855	5,344	31,843	2,222	12,170
Share of total households (%)	3.07	0.09	0.12	0.42	0.03	0.14	7.13	0.22	0.12	0.72	0.05	0.27
Total income per capita (nuevo sol)	996	1,095	1,037	482	305	815	4,237	3,300	3,334	4,090	2,181	3,416
Share of agriculture in total income (%)	13.48	11.06	11.67	87.01	90.79	81.97	11.34	16.38	30.82	83.26	76.42	93.33
	Sierra											
Estimated no. of households	212,039	2,637	1,195	261,885	1,195	1,195	332,162	8,158	1,195	205,907	2,391	10,759
Share of total households (%)	4.79	0.06	0.03	5.91	0.03	0.03	7.50	0.18	0.03	4.65	0.05	0.24
Total income per capita (nuevo sol)	622	824	116	467	102	676	4,897	2,801	1,207	2,172	1,647	1,947
Share of agriculture in total income (%)	27.65	18.26	36.81	86.47	100.00	93.92	21.16	14.93	43.61	86.77	93.11	89.91
	Selva											
Estimated no. of households	69,458	3,364	8,827	61,341	6,835	6,835	120,961	6,128	6,085	51,850	8,228	6,171
Share of total households (%)	1.57	0.08	0.20	1.39	0.15	0.15	2.73	0.14	0.14	1.17	0.19	0.14
Total income per capita (nuevo sol)	681	593	573	618	514	457	3,270	3,411	2,629	2,436	1,407	1,690
Average share of agriculture in total income (%)	24.47	41.69	39.34	86.79	77.91	84.45	20.53	27.18	35.08	86.47	94.19	85.15

Source: Computed by authors.

Table 8
Decomposed coefficients of variation of domestic prices, Peru (per cent)*

	CV of domestic prices accounted for by:			World price coefficients of variation
	Domestic shocks	International shocks	Total	
Coffee	10.85	64.65	75.51	45.6
Maize	19.94	0.00	19.94	18.4
Wheat	6.71	11.74	18.44	17.7
Rice	16.20	11.57	27.77	11.5
Beef	16.71	0.00	16.71	9.8
Pork	8.31	0.00	8.31	18.7
Chicken	7.04	34.27	41.31	10.6
Plantains	16.46	0.00	16.46	14.9

Note: * Conditional coefficients of variation projected for 12 months ahead.

Source: Authors' calculations.

Table 9
Coefficients of variation (CVs) of agricultural incomes, Peru (per cent)

	Share of agriculture in POOR household income						Share of agriculture in NONPOOR household income					
	<60%			>60%			<60%			>60%		
	% share of rice in agricultural income						% share of rice in agricultural income					
	<30	30-60	>60	<30	30-60	>60	<30	30-60	>60	<30	30-60	>60
	Coast											
Actual CVs due to:												
Price and production shocks	4.36	8.65	15.09	8.60	11.64	16.96	3.19	8.00	16.33	8.96	11.58	15.63
Domestic market price and production shocks only	4.35	8.60	14.98	8.60	11.60	16.83	3.16	7.92	16.22	8.95	11.52	15.52
Simulated CVs due to world prices (in US$) and production shocks	2.64	6.95	11.44	6.05	8.48	12.90	2.06	6.36	12.50	6.10	8.96	11.89
	Sierra											
Actual CVs due to:												
Price and production shocks	9.92	6.88	15.41	11.71	8.56	12.86	7.16	6.69	17.65	12.24	11.17	14.61
Domestic market price and production shocks only	9.91	6.82	15.32	11.68	8.52	12.77	7.14	6.61	17.52	12.23	11.11	14.50
Simulated CVs due to world prices (in US$) and production shocks	4.40	5.22	11.69	5.43	6.17	9.85	4.02	5.23	13.30	6.13	8.97	11.23
	Selva											
Actual CVs due to:												
Price and production shocks	6.13	9.24	14.98	9.25	10.13	14.29	5.04	11.10	13.70	8.85	10.14	14.70
Domestic market price and production shocks only	6.12	9.18	14.87	9.15	10.07	14.19	4.99	11.05	13.60	8.47	10.09	14.60
Simulated CVs due to world prices (in US$) and production shocks	3.55	7.13	11.59	6.44	7.57	11.03	3.52	7.77	10.38	9.17	7.50	11.04

Source: Computed by authors.

Table 9 gives the results for Peru, which in general suggest that households with relatively less diversified production patterns face higher income uncertainty. In the coast and selva regions, the agricultural income CVs for the predominantly agricultural households with rice production constituting of more than 60 per cent of their agricultural income, is estimated to be around 14-17 per cent. This is considerably higher than the CV of farm households that earn 30-60 per cent of their income from rice. In the sierra, the analysis appears to suggest that lower dependence on rice may not result in a significant income-risk reduction, as households generating less than 30 per cent of their agricultural income from rice cultivation are characterized by higher CVs compared to households with similar characteristics in other regions.

The finding that domestic price and quantity variations are the overwhelming determinants affecting producer incomes is obtained here as well for all income classes.

The CVs for the scenario of full exposure to international markets are reported in the last rows of Table 9. The results suggest that increasing exposure to international markets would lead to a considerable reduction in all agricultural income CVs (with the exception of one case in the selva region). In general, the reductions in the CVs for most household classifications would be several percentage points. This finding suggests that the domestic price policies aiming to stabilize rice prices may not have resulted in reducing agricultural income volatility. Exposure to international markets would induce an increased income volatility of about 0.4 percentage points for the predominantly agricultural households in the selva region that generate less than 30 per cent of their income from rice, possibly because a higher share of income is accrued from poultry and related meat-production.

4 Conclusions

In this paper we attempt to answer the question of whether increased exposure to international markets reduces the volatility of domestic market prices and improves the welfare of agricultural commodity households. We develop a theoretical framework that leads to explicit formulae for household income variance on the basis of such covariate shocks as commodity price and yield uncertainties. The empirical work focuses on the estimation of household income uncertainties by linking household microclassifications for a number of different household types in Ghana, Vietnam and Peru, and time-series analysis. We estimate the household-specific income variability that emanates from market uncertainties, both price and production related, and use this empirical framework in order to conduct simulation experiments on the extent to which full exposure, rather than partial or no exposure, to international market-signals affects commodity prices and thereby agricultural income volatility.

One major result of the paper is that almost all of the agricultural income variability of producers seems to result from domestic factors. While domestic prices for tradable commodities exhibit diverse patterns of price transmission from international prices, the impact of international prices on farmer income variability seems to be small, either because of small transmission, or because the relevant price constitutes only a minimal share of farm income.

This empirical work finds mixed results of the impact on producer variability from total exposure to international prices. In general, in the countries examined, the results suggest that in the absence of effective price stabilization policies, increased exposure to international markets may result in a reduction in agricultural income volatility, as international markets may act as 'buffers' absorbing large domestic supply or demand shocks in domestic markets. However, with the exception of coffee-producing households in Vietnam, improvements in income variability resulting from increased exposure to international markets are very small. In countries where price stabilization schemes are in place—as in the case of cocoa in Ghana and rice in Vietnam—wider exposure to international markets may result in relatively greater income uncertainty, suggesting that domestic policies in these countries are effective in reducing the uncertainty that emanates from both domestic and international factors.

The extent to which households diversify their income sources and production patterns is noted to affect income uncertainty. As expected, households that rely largely on a single commodity for their earnings face higher income volatility than households adopting a more extensive diversification pattern. For example, the results suggest that the household categories in Vietnam that depend predominantly on rice and coffee experience considerably higher income uncertainty, particularly if opportunities for off-farm earnings do not exist. Similarly, households in Peru depending on rice and cereals face greater uncertainties than those that have a more diversified production pattern. Nevertheless, there are cases where both cash and food crops are subject to high prices and yield volatility, as for example Ghana, implying that crop diversification strategies on their own or as self-insurance may not be sufficient in shielding producers from large income fluctuations. It is, therefore, important that governments intervene in order to establish a mechanism through which commodity insurance can be provided.

Annex Table
Shares of included agricultural income in total household income

	Share of agriculture in POOR household income						Share of agriculture in NONPOOR household income					
	<60%			>60%			<60%			>60%		
	Share of main commodity in agricultural income			Share of main commodity in agricultural income			Share of main commodity in agricultural income			Share of main commodity in agricultural income		
	<30%	30-60 %	>60%	<30%	30-60 %	>60%	<30%	30-60 %	>60%	<30%	30-60 %	>60%
GHANA												
Coast	0.115	0.122	0.137	0.542	0.616	0.574	0.100	0.319	0.044	0.471		
Forest	0.184	0.312	0.324	0.601	0.622	0.643	0.173	0.291	0.390	0.621	0.625	0.666
Savannah	0.182	0.419		0.504	0.569	0.731	0.199			0.539	0.727	
VIETNAM												
Urban & northern regions	0.093	0.282	0.254	0.588	0.655	0.794	0.034	0.209	0.121	0.474	0.625	0.864
Red River & north coast	0.130	0.300	0.290	0.593	0.676	0.797	0.139	0.256	0.221	0.470	0.647	0.770
South & central regions	0.124	0.054	0.339	0.623	0.789	0.888	0.137	0.296	0.268	0.568	0.632	0.875
PERU												
Coast	0.041	0.065	0.083	0.468	0.824	0.794	0.026	0.064	0.322	0.444	0.630	0.821
Sierra	0.135	0.075	0.368	0.590	0.606	0.717	0.068	0.066	0.427	0.595	0.798	0.810
Selva	0.113	0.263	0.355	0.541	0.582	0.754	0.068	0.148	0.222	0.589	0.738	0.785

Source: Computed by authors.

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