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Exogenous sources of food insecurity in an open developing country

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Exogenous Sources of Food Insecurity in
an Open Developing Country *,+

by

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Exogenous Sources of Food Insecurity in an Open Developing Country

I. Introduction

The vagaries of nature and of world grain markets, causing domestic food production and food import prices to fluctuate, are commonly considered the major external sources of food insecurity in developing countries¹. The need for steady domestic food production, and for stable world grain prices or international assistance in meeting a fluctuating grain import bill, are accordingly emphasized by the authors. Food self-sufficiency and commodity reserves are also stressed, given barriers to trade. Recent events in Latin American and African countries seem to suggest that erratic capital flows and export earnings, supposedly caused by instabilities of world financial and world primary commodity markets, can be just as detrimental to the maintenance of appropriate food consumption levels. If these claims of additional exogenous sources are substantiated, the priorities of a food security strategy might need to be reconsidered.

It is not self-evident exactly what constitutes the problem of food insecurity and in which sense the instabilities of nature and of world markets can be called its source. In chapter II we argue first, that domestic capital market imperfections are a necessary condition for the transmission of these instabilities so that they do impair the ability of poor households to meet annual target food consumption

levels and, second, that the overall impact on food security depends not only on the size, but also the interaction of all sources of instability. Distortions and the dependence on nature and on world markets differ between countries. In the remaining chapters we report on a case study designed to explore the contribution of all exogenous sources of food insecurity in Botswana, given domestic market imperfections which facilitate their transmission. We stop short of discussing policies directed at the exogenous sources, however, as this would require us to establish their opportunity costs by also investigating alternatives directed at the domestic distortions. The study is therefore only a first step. What can be inferred from its results is the effect a costless stabilization of food production, food import prices or export earnings would have on food insecurity.

Botswana provides an interesting case for study, since it is acutely exposed to each of the instabilities mentioned: crop and livestock production seesaw due to extremely unreliable rainfall and to unforeseeable outbreaks of the foot-and-mouth disease; in a year of average domestic production, food imports are required to satisfy about one half of domestic demand; three commodities (diamonds, copper-nickel matte and beef) which are traded on volatile world markets, account for nine tenths of export earnings; aggregate exports and net capital inflows respectively amount to one half and one fifth of gross domestic product². So far the country has not experienced serious transport bottlenecks or sudden interruptions

of import supply channels although, given its border with the Republic of South Africa, this is not inconceivable. In this paper, we shall abstract from food trade barriers. The exogenous instability, in terms of the size and combination of instabilities of nature and of the world markets relevant to the country, is established from historical data in chapter III. Its impact on food insecurity is simulated with an economy-wide disaggregated quantitative model. The model is discussed in chapter IV. Results are presented and interpreted in chapter V. Conclusions are drawn in chapter VI.

II. The Problem of Food Insecurity

Following Valdés and Siamwalla (1981, p.2) we define food insecurity as the inability of households to meet target food consumption levels on a year-to-year basis, and use the trend level of consumption as the target³. This definition has the advantage of clearly distinguishing the cyclical aspects of the food problem from both the permanent aspect of malnutrition and the very short-run aspect of managing working stocks under conditions of unreliable information.

The ability of households to meet target consumption levels can be impaired only by fluctuations in real annual household income. A further condition is the occurrence of private costs of absorbing these income fluctuations in either the non-food consumption or the savings component of household expenditure. At a low income level,

the expenditure share of non-food consumption goods which have high short-term income elasticities of demand tends to be very small (Mellor 1978). Absorbing real income fluctuations through the savings component is costly under conditions of imperfect local capital markets (Howell 1980)⁴. As such costs reduce the average income available for food consumption, households are confronted with a choice between more security and a higher target level of consumption. Since reducing average food consumption below an already depressed level diminishes working abilities and survival probabilities, poor households tend to accept less security. In sum, food insecurity is a problem affecting poor households with fluctuating real incomes under conditions of a poorly developed capital market.

Given an imperfect capital market, food insecurity increases with the instability of real household income among the poor. Since the costs of removing or compensating for the market imperfection cannot be dismissed as negligible, the second-best solution of income stabilization deserves attention. In this sense, sources of real household income instability may also be considered as sources of food insecurity. When formulating food security strategy, however, this approach does not circumvent the necessity of examining the associated costs of the first-best solution.

Shifts in domestic food production and in food import prices directly affect, respectively, the factor income of household members working in the agricultural sector and the prices paid by households pur-

chasing food in the market. Shifts in the domestic production and the export prices of other primary commodities directly bear on factor income in the originating agricultural or mineral sector. Since the households of the rural poor rely on agricultural output as a wage good and allocate but a small share of their budget to purchased food, their real income is, in an open economy, destabilized mainly by fluctuations in the domestic production and the export prices of agricultural commodities. Price swings for imported food and exported minerals, on the other hand, make themselves felt in the real household income of the urban poor. Indirect effects - working through the substitution between domestic and imported food products, through inter-industry linkages and through the tax and transfer system - redistribute part of the burden. In case of transport bottlenecks or sudden interruptions in supply channels, food imports may not arrive in time to compensate for shortfalls in domestic production⁵. Real household income in food deficit countries, especially in isolated rural areas, would then be further destabilized by the vagaries of nature and of world food markets.

If the domestic capital market were integrated into the world market, then this list of sources and channels of real household income instability in a developing country would be fairly complete. Fluctuations in the current account balance, caused by annual shifts in domestic production, export demand and import supply or by any other factor, would not matter because they could be absorbed through the capital account⁶. This mechanism, however, is weakened in many deve-

loping countries by controls aimed at securing a maximum net inflow of resources for development purposes and by autonomous distortions, both of which result in high or even prohibitive capital transactions costs. Fluctuations in the net current and capital account balance, unless they can be absorbed through foreign exchange reserves, then require short-term adjustments of the real exchange rate, which in turn destabilize factor incomes and consumer price indices and thus real household income. Any source of instability in either the current or the capital account balance is then also a potential source of food insecurity. Besides those sources already mentioned⁷, the instability of the world capital market (affecting debt service payments and availability of capital) and the fortunes of mineral prospecting (affecting direct foreign investment and lending to domestic companies) seem to be particularly relevant to developing countries.

III. Exogenous Instability in Botswana

We measure exogenous instability in Botswana by the historical variances and covariances of seven indicators for natural production conditions and for supply and demand on the world markets relevant to the country. For each indicator (y), an annual time-series covering 1964 to 1983 has been collected from historical data⁸. A systematic path has been calculated from each series by estimating with OLS the equations

$$(1) \quad y_t = a + b_1 t + b_2 t^2 + c_1 y_{t-1} + c_2 y_{t-2} + c_3 y_{t-3}$$

$$(2) \quad \ln y_t = d + e_1 t + e_2 t^2 + f_1 \ln y_{t-1} + f_2 \ln y_{t-2} + f_3 \ln y_{t-3}$$

$$(t = 1, \dots, 20)$$

choosing the equation with best fit, and picking independent and lagged dependent variables with coefficients significant at the 5 percent level. The systematic path captures not only the long-term trend but also medium-term (more than one year) cyclical swings. The instability measure which is based on the differences between observed and systematic path values then picks up only year-to-year shocks, as seems appropriate to the definition of food insecurity.

The time series of livestock and crop production in general reflect not only the impact of the instability of nature (rainfall, temperature, diseases) but also the effects of agricultural policy reactions to extreme drought or outbreaks of foot-and-mouth disease. Policy effects, however, might show after the year of the catastrophe and would then be captured by the systematic path. Adopting this assumption we use the indices of (1) livestock production (home slaughters and sales of cattle to Botswana Meat Commission) and of (2) crop production (sorghum, millets, maize - covering 79.3% of total production value in 1980) as indicators of natural shocks. Measuring world primary commodity market instability creates less of a problem as we can immediately use c.i.f.-import price and f.o.b.-export price indices as indicators. Quantity reactions of consumers and producers under the existing trade policy regime will be subsequently simulated by the model. For food imports we therefore con-

struct a (3) food import price index from c.i.f. prices of cereals, dairy and meat products, and sugar (covering 83.4% of total food import value in 1980). On the export side we use f.o.b. export price indices for (4) beef and (5) minerals (diamonds, copper and nickel - covering 98.7% of mineral export value in 1980).

A full account of the balance of payments becomes essential, once the fluctuations in the net capital inflow and the current account deficit are no longer assumed offsetting. With respect to trade in commodities, we assume that import prices and export demands are determined exogenously. Since the respective price indices can be shown to be stable, however, they are not included in our description of external instability. Import and export quantities will again be simulated by the model, as will dividends, profits and wages paid to foreigners. The net debt position is assumed to remain on its systematic path so that net servicing varies with the foreign interest rate. We use the (6) Euro-dollar rate as the indicator. All capital flows as well as remittances and unrequited transfers are thought of as being exogenously determined. The net inflow of these items - for short, the (7) net resource inflow - is used as the indicator of the exogenous sources. If it is the case that capital inflows have tended to maintain balance of payments equilibrium, this will be captured by the covariances between the net resource inflow and the other indicators.

The variation of and covariation between indicators are calculated from the percentage deviations of actual from systematic values.

In Table 1 we report the standard deviations and coefficients of pairwise correlation. The extreme instability of crop production in Botswana is revealed by a standard deviation of almost 70%. Under the assumption of normal distribution this means, for example, that Botswana crop farmers are confronted with a probability of 39% that their next crop harvest will fall 20% or more below trend. A smaller, though still substantial, instability of livestock production is reported. A standard deviation of nearly 13%, under the assumption of normality, implies that Botswana cattle owners face a chance of 6% that production next year falls 20% or more below trend. Beef export prices are somewhat less stable than livestock production, while mineral export and food import prices are slightly more stable.

The pattern of pairwise correlations between the food production and price variables deserves attention. The coefficient of correlation between crop and livestock production is near zero: foot-and-mouth disease scarcely impinges on crop production and drought affects livestock production with a time-lag. The strong positive correlation between domestic livestock production and beef export demand - making for volatile beef export earnings - is mainly due to the behaviour of major customers like the European Community, who block beef imports during outbreaks of foot-and-mouth disease. The crop production index is only weakly correlated with the price index of imported food, hardly surprising in view of the subsistence character of crop production in Botswana. The interdependence of world food markets shows rather in the strong positive correlation between

Table 1 Standard Deviation and Pairwise Correlation* of Indicators for External Instability in Botswana

	Livestock Production ^a	Crop Produc- tion Index ^b	Food Import Price Index (cif) ^c	Beef Export Price (fob) ^d	Mineral Export Price Index (fob) ^e	Foreign Interest Rate ^f	Net Re- source In- flow ^g
Standard Deviation (percent) (mean = 0 percent)	12.93	69.45	10.88	16.21	12.45	18.99	46.56
Livestock Production	1.00						
Crop Production Index	-0.01 (0.51)	1.00					
Food Import Price Index (cif)	0.30 (0.39)	0.13 (0.69)	1.00				
Beef Export Price (fob)	0.57 (0.99)	-0.08 (0.63)	0.55 (0.99)	1.00			
Mineral Export Price Index (fob)	-0.16 (0.74)	-0.07 (0.61)	0.34 (0.92)	-0.02 (0.54)	1.00		
Foreign Interest Rate	-0.16 (0.74)	-0.23 (0.82)	-0.03 (0.54)	-0.08 (0.63)	0.30 (0.89)	1.00	
Net Resource Inflow	-0.24 (0.83)	0.00 (-)	0.12 (0.68)	-0.09 (0.37)	-0.17 (0.67)	0.29 (0.88)	1.00

^a Head of cattle slaughtered. Data for 1964 and 1965 are taken from Lamberto, Quinn, Wohlgenuth (1970, p. 132), for 1966 to 1981 from Central Statistics Office (1983a, p. 47) and for 1982 and 1983 from Ministry of Agriculture (1983, p. 10). -

^b Metric tonnes of cereals. Numbers are from FAO (a, various issues). - ^c US-Dollar. Index (1980 value weights follow in brackets) computed from cereals unit values (45.4%), FAO (b, various issues), and prices of butter (24.1%), beef (13.0%) and sugar (16.5%) IMF (various issues). - ^d US-Dollar per kg beef. Numbers for 1964 and 1965 are taken from Colclough and Mc Carthy (1980, p.70) and for 1966 to 1983 from Botswana Meat Commission (various issues). - ^e US-Dollar. Index (1980 value weights follow in brackets) computed from unit values of diamonds (76.6%), De Beers (various issues), Department of Mines (1981, p. 17), Central Statistics Office (b, various issues) and prices of copper (5.8%) and nickel (19.6%) IMF (various issues). - ^f Euro-Dollar Rate in London, IMF (various issues). - ^g Computed as the change in the net foreign assets of the Botswanan banking system minus the net trade surplus, IMF (various issues), Central Statistics Office (1983a) and Republic of Botswana (1968).

* Values in parentheses indicate the probability in a one-tailed t test.

Source: Own calculations.

the food import and the beef export price index. The current account impacts of beef export earnings and food import expenditure, therefore, tend to be offsetting. The degree, of course, also depends on the substitution between crops, livestock products and imported food in domestic consumption as well as other indirect effects represented in the model.

The mineral export price index and the foreign interest rate are both rather unstable, though they are positively correlated. Since the price indices of mineral exports and food imports are also positively correlated, the destabilizing effect of world market fluctuations on Botswana's current account is to some extent mitigated. The net resource inflow, finally, is shown to be extremely volatile, with standard deviation measured at more than 45%. There is no correlation at all with the crop production index. The correlation coefficients with the other indicators - negative with livestock production and export price indices, positive with the food import price index and the foreign interest rate - point to merely a weak offsetting effect of net resource flows on the balance of payments.

IV. Computing the Impact on Households

In this chapter we describe a model for computing the impact of exogenous instability on real household income of the urban and rural poor in Botswana. We consider a detailed presentation to be outside the scope of the present paper⁹. Instead, we describe the

disaggregation of the economy-wide general equilibrium model and sketch salient causal features using a flow diagram.

The model is constructed around a Social Account Matrix which contains fully recorded accounts for production activities, primary factors, institutions (i.e. various classes of households, enterprises and the government) and the rest of the world. The Botswana Social Account Matrix (Hayden 1981) has been condensed to the bare minimum of household classes, production sectors and factors required for the purpose of the investigation. Income and consumption price indices are computed separately for poor urban and poor rural households identified, respectively, by urban settlement area (peri-urban, high-density urban and servants quarters) and by ownership of cattle (less than 80 head). The commodities distinguished are livestock, other food, minerals and other non-food, with processing attributed to the primary products. Imported commodities are treated as imperfect substitutes for commodities of the same category produced locally, non-marketed (subsistence) commodities as perfect substitutes for marketed commodities of domestic origin. A 1:1 relationship between domestic commodities and producing sectors is maintained. Hired unskilled labour is employed in all sectors. Each sector also employs a sector-specific fixed factor. Factor demand variations thus result in factor rent variations. This reflects the assumption that, in the short-term (one-year), not only land but also the cattle herd, other fixed capital, family and skilled hired labour is immobile between sectors. The rents accrue to households and, in the case of minerals and other non-food sectors, also to the rest of the world.

The model belongs to the Walras-Johansen class of computable general equilibrium models¹⁰. The model incorporates commodity and factor markets but not, since the net inflow of resources is determined exogenously, asset markets. Commodity flows (from domestic and imported sources to current production, capital creation, households, government and exports) and factor flows (from households and the rest of the world to current production) are determined by prices and substitution possibilities. The major behavioural postulates underlying the structural equations are that:

(1) Producers choose inputs to minimize production costs of planned output subject to two-level constant returns to scale sector production functions. At the first level is the Leontief assumption of no substitution between domestic and imported inputs, between input categories or between them and an aggregate of the primary factors. At the second are CES functions describing substitution between primary factors.

(2) Households choose marketed and own-produced commodities to maximize an additive nested utility function subject to an aggregate budget constraint. The nests of commodity categories contain CES functions describing substitution prospects in consumption between domestic and imported sources of each category.

Since the model is used to compute the impact of annual fluctuations, it has been specified numerically with substitution and demand elasticities reflecting the short-term response to price or shadow-price incentives. Note that finite price elasticities of export demand

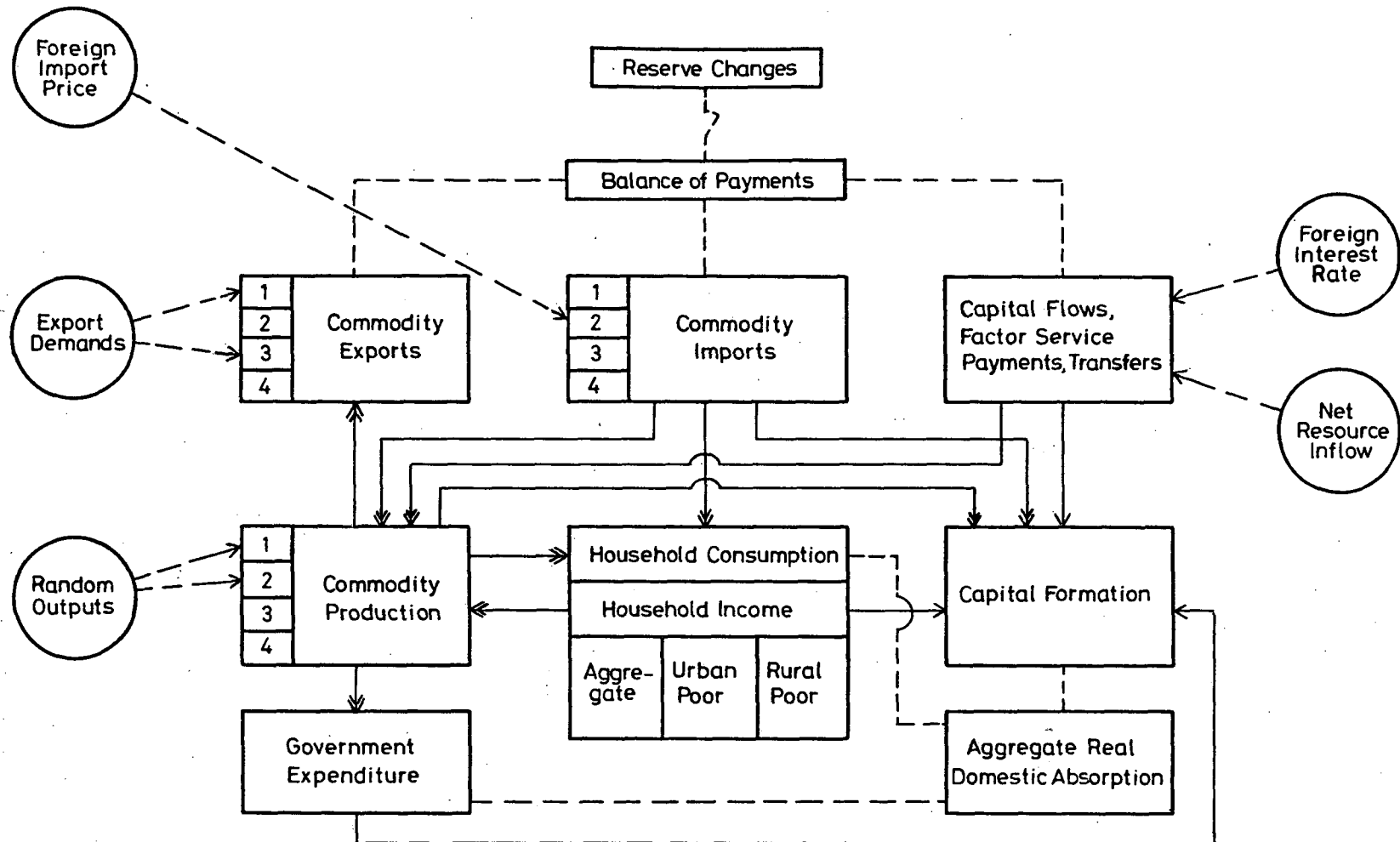
have been chosen. Foreign currency prices of export commodities thus react to both shifts in export demand and in export supply.

The flow diagram (Figure 1) allows for an understanding of the salient causal chains between exogenous shocks and real household income in the model. The very last link of each chain is either the flow of factor rents from commodity production to (nominal) household income or the change of the price index of commodities flowing from domestic production or imports to household consumption. The degree to which variations of factor rents and commodity prices affect the real household income of, respectively, the urban and the rural poor is determined by the different source-structures of their nominal income and by the different commodity-structures of their consumption. Nominal household income of the rural poor naturally is dominated, though not exhausted, by factor rents earned in livestock and other food production, whereas factor rents earned in the other sectors play a prominent, though not an exclusive, role in the nominal household income of the urban poor. Rural-urban household income flows are modelled by assuming that urban and rural households have some control over factors employed in, respectively, the agricultural and the non-agricultural sectors. Domestic (own-produced) and imported commodities, respectively, have a large weight in the specific consumption-price index of the rural and the urban poor.

The model simulates both a non-binding and a binding foreign exchange constraint. In the non-binding case, which we consider first, reserve changes absorb positive or negative balances in either the

Figure 1

Causal Features in the Botswana Model



Commodity number: 1 livestock 2 other food 3 minerals 4 other non-food

current or capital account. (In the diagram, this is depicted by a connected line between the balance of payments and reserve changes.) The authorities in such case have one instrument of macroeconomic policy (the domestic component of the money supply) free. We assume that they use it to keep aggregate real domestic absorption on its systematic path. Since real government consumption and real investment are determined independently in the model¹¹, this in effect puts a constraint on real aggregate household consumption. Main lines of causation run from

- random deviations from planned output of livestock and other food to rents of sector-specific factors owned by households. In the case of livestock output, a line also runs to export supply and, following the export price reaction, back to the local price of domestic production and from there to both the consumption price indices and the rents earned by hired labour and the sector-specific factors.
- export demands for beef and minerals via export prices and local prices of domestic commodities to consumption price indices and factor rents.
- the foreign import price of food to the local price of imported food and the consumption price indices, then further through household demand for domestically produced food substitutes to local prices and again to consumption price indices and factor rents.
- the net resource inflow to capital formation, demand for domestically produced investment goods, the local prices of domestic commodities and the consumption indices and factor rents.

In the case of a binding foreign exchange constraint, any change in export earnings, import expenditures, factor service payments, transfers or capital flows must be accommodated without changing the balance of payments. (In the diagram this is symbolized by disconnecting the line between reserve changes and the balance of payments.) The accommodation is brought about by real exchange rate changes. An appreciation results from positive shocks to output, export demand or net resource inflow or from a lower food import price or foreign interest rate. With local prices of all import commodities falling, real household income is enhanced and aggregate real domestic absorption increases. The reverse process occurs in cases of negative shocks to output, export demand or net resource inflow or a higher food import price or foreign interest rate.

The model is linear in all growth rates. The seven indicators of exogenous instability are also exogenous variables in the model. The variance-covariance matrix underlying Table 1 is then used directly as the variance-covariance matrix of the exogenous variables. The model is solved by matrix operations. From the solution matrix we can read off both the separate impact of each source of exogenous instability (as represented by the variance of the respective indicator) and the total impact of all sources (taking into account also the covariances). With non-zero covariances the impacts of different sources may either offset or reinforce each other.

V. Real Household Income Instability in Botswana

The impact of the instability of nature and of world markets on real household income of the urban and the rural poor in Botswana have been simulated for the cases of a non-binding and a binding foreign exchange constraint. Results are reported in Tables 2 and 3 separately for each source and for total exogenous instability. In Table 2 we report the standard deviations of real household income for the urban and rural poor as well as the standard deviation of either foreign exchange reserves or real aggregate domestic absorption. The standard deviations have been transformed into useful probability values in Table 3.

V.1 The Case of a Non-Binding Foreign Exchange Constraint

In the first experiment, balance of payments fluctuations are absorbed through foreign exchange reserves, while macroeconomic policy instruments are assumed to be directed at maintaining constant aggregate real domestic absorption. The results reveal immediately the devastating effect of crop production instability through unreliable rainfall on the rural poor. These households are confronted with a probability of 32% that next year's real income will fall 10% or more below target or, expressed differently, a probability of 5% that it will fall by 34% or more. This result is obtained even though the target, i.e. the systematic level, allows for midterm swings, and even though indirect effects through inter-industry linkages and the tax system have been taken into account.

Table 2 Effects of External Instability on Food Insecurity in Botswana, Percentage Standard Deviations^a

Indicators of food instability	Domestic production		Food import price	Export demand		Foreign interest rate	Net resource inflow	Total
	livestock	crops		live-stock	mine-rals			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(1)-(7)
<u>1. Macroeconomic stability</u>								
Real household income								
urban poor (in %)	0.44	1.70	3.03	1.35	6.03	0.00	8.32	10.92
rural poor (in %)	4.20	20.97	2.84	6.05	0.07	0.00	0.32	20.39
Change in reserves (in Mill. Pula)	9	49	7	9	32	7	136	144
<u>2. Binding foreign exchange reserves</u>								
Real household income								
urban poor (in %)	3.27	14.24	5.78	4.33	16.49	2.36	36.20	38.71
rural poor (in %)	4.27	21.35	2.90	6.13	0.18	0.05	1.41	20.68
Aggregate real domestic absorption (in %)	2.27	12.80	1.80	2.38	8.40	1.89	35.74	37.57

^a Simulation results, basis 1980.

Source: Own calculations.

Table 2 Effects of External Instability on Food Insecurity in Botswana, Percentage Standard Deviations^a

Indicators of food instability	Domestic production		Food import price	Export demand		Foreign interest rate	Net resource inflow	Total
	livestock	crops		live- stock	mine- rals			
	(1)	(2)		(4)	(5)			
			(3)			(6)	(7)	(1)-(7)
<u>1. Non-binding foreign exchange constraint</u>								
Real household income								
urban poor $P \leq -10\%^b$	0	0	0	0	5	0	12	18
rural poor $P \leq -10\%^b$	1	32	0	5	0	0	0	31
Changes in reserves $P \geq 1$ month import bill ^c	0	16	0	0	6	0	36	37
<u>2. Binding foreign exchange constraint</u>								
Real household income								
urban poor $P \leq -10\%^b$	0	24	4	1	27	0	39	40
rural poor $P \leq -10\%^b$	1	32	0	5	0	0	0	32
Aggregate real domestic absorption $P \leq -10\%^d$	0	22	0	0	12	0	39	39

^a Calculated from Table 2 using the table on areas under the normal curve. - ^b Probability of real household income falling 10% or more below trend. - ^c Probability of reserve requirements equalling average 1 month import bill or more. - ^d Probability of aggregate domestic absorption falling 10% or more below trend.

Source: Own calculations.

The instabilities of livestock production (due to outbreaks of foot-and-mouth disease) and of beef prices (due to export demand shifts) also cause noticeable fluctuations in rural household income. The effect is relatively moderate, however, because these external instabilities are smaller and because volatile livestock earnings are felt more by large cattle-owners who are not counted among the rural poor. The other sources of exogenous instability contribute little if anything to insecurity among the rural poor. This applies in particular to food import price fluctuations. Since Botswana crop farmers produce little marketable surplus, changes in their shadow product price and thus shadow factor rents are largely offset by changes in their specific consumer price index.

The simultaneous impact of all sources of instability on the real household income of the rural poor is about equal to the separate impact of rainfall. Since the index of domestic crop production is barely correlated with the other indicators (see Table 1), we conclude that the instabilities of livestock production, beef export demand and food import price neutralize each other's impact. For the case of a non-binding foreign exchange constraint, therefore the simulation results indicate that (a) exogenous stability in all but domestic crop production would not lower the level of household income instability among the rural poor, (b) stable food import and beef export prices would only change the source-composition of household income instability, and (c) stable domestic crop production would go a long way to alleviate the problem of the rural poor.

With a non-binding foreign exchange constraint, so that food trade is not inhibited, fluctuations in domestic food production scarcely affect the urban poor. More surprising seems to be the moderate impact of unstable food import prices. In an environment of macroeconomic stability, the exchange rate is also rather stable. Food price fluctuations are no higher in domestic than in foreign currency. The standard deviation of the foreign currency food import price index, however, was not found to be particularly high in the case of Botswana (see Table 1). This is an implication of including not only cereals but also sugar, dairy and meat products in the index, the fluctuations of which tend partially to offset each other. Since the product-composition of food consumption by household classes has as yet not been published, the index weights taken are those of external trade. The indicator may understate this source of instability.

More relevant to the urban poor are fluctuations in mineral export demand, with its effects on sectoral labour demand, but also the swings in net resource inflow. Even with aggregate real domestic absorption stabilized, changes in the net resource inflow affect the level of real investment. The larger part of domestic investment goods originates in the "other non-food" sector, which employs most of the urban poor. The simulation result for the simultaneous impact of all exogenous instability shows further that the various sources are only weakly offsetting. Poor urban households are confronted with a probability of 18% that their real household income may fall by 10% or more below trend, even when the authorities suc-

ceed in stabilizing real domestic absorption. This instability would, according to the simulation results, not be reduced by stable domestic food production or food import prices.

The assumption of a non-binding foreign exchange constraint is exposed as a daring one according to the simulation results on the reserve changes required. There is a 37% probability that funds equalling a one month's bill will be exhausted. The authorities could plan for more reserves or for international balance of payments assistance. To reduce the probability of exhausting reserves to 5%, for example, funds covering roughly half a year of import expenditure would be required. The costs of obtaining them - such as interest earnings foregone, policy conditions imposed by foreign agencies, the risk of stabilizing aggregate absorption around an ill-conceived systematic path - are not the subject matter of this study. The results on reserve changes, however, elicit doubts as to whether a policy of macroeconomic stabilization is at all possible.

V.2 The Case of a Binding Foreign Exchange Constraint.

A binding foreign exchange constraint is assumed in the second experiment. Higher import bills, lower export earnings or smaller net resource inflows now depreciate the real exchange rate to rekindle export volumes, diminish import volumes and reduce the volume of goods and services absorbed domestically. Tables 2 and 3 report the simulation results for aggregate real domestic absorption.

Not surprisingly, the source-composition of absorption instability mirrors that of foreign exchange reserves in experiment 1.

Comparing results on real household income instability among the rural poor, we find little difference between the two experiments. For this household class the balance of payments constraint turns out to be of little consequence. As an example, consider a shortfall in domestic crop production. If reserves are not available for meeting the extra food import bill, the real exchange rate depreciates and aggregate absorption shrinks. Higher import prices and reduced demand for labour services outside of agriculture and mining diminish, to some extent, real household income of the rural poor. Higher domestic prices for the marketed agricultural surplus are transmitted to rents for factors owned by poor rural households and compensate for the loss, leaving but a small net effect.

For the urban poor, in contrast, the real household income effects of movements in the consumer price index and in factor incomes tend not to compensate but to reinforce each other. Since members of poor urban households earn the larger part of their income in sectors mainly serving domestic demand, their factor income tends to be depressed at a time when food prices are high, and vice versa. The simulation results indicate that the instabilities of external finance, export demand and of domestic food supply all substantially contribute to food insecurity among the urban poor. They indicate, however, that the contributions partly offset each other. The simultaneous impact of all sources of insecurity is barely stronger than the separate impact of net resource inflow instability.

Within the narrow limits of our study, we may infer from the second experiment, that (a) the balance of payments constraint matters for food insecurity among the urban poor, not the rural poor; (b) stable world primary commodity prices would not make for a lower level of food insecurity among either the urban or the rural poor, but would only alter the source-structure; (c) a steady domestic crop production would alleviate the problem among the rural poor, not the urban poor.

VI. Summary and Conclusions

In this paper we have formulated the problem of food insecurity as one of real household income instability among the poor under the condition of an imperfect local capital market. We then investigate the contributions of the vagaries of nature and of world markets (exogenous instability) to annual household income instability of the urban and the rural poor in Botswana. Such country-specific information seems to be indispensable for evaluating food security policy. We measure exogenous instability by calculating the variations and covariations of seven indicators. We find an extremely high instability of domestic crop production and of net resource inflow in Botswana, but also substantial instabilities of livestock production, livestock and mineral export prices, food import prices and the foreign interest rate. Domestic crop production shows little relation to other variables, whereas the pattern of correlations between these indicate partly compensating balance of payments effects.

The impact of external instability on real household income instability is simulated with a general equilibrium model of Botswana. In a first experiment we allowed for changes in foreign exchange reserves and for macroeconomic stability, characterized by stable aggregate real domestic absorption. In the second experiment, the balance of payments constraint was made binding, thus forcing aggregate real domestic absorption to adjust to year-by-year external shocks. The simulation results from both experiments reveal the dominant impact of domestic crop production instability on real household income instability among the rural poor. Instability in livestock production and export prices as well as in food import prices have a small influence, other sources almost none. The simultaneous impact of all sources is about as high as the separate impact of domestic crop production instability, i.e. the effects are neither reinforcing nor totally compensating. With respect to the urban poor, simulation results differ between experiments. In the case of variable reserves, the instability of domestic food production (crops and livestock) and of world food prices (imported food and exported beef) has scarcely any influence. Fluctuations in mineral export prices or in net resource inflows, by contrast, do have adverse consequences for the urban poor. In case of a binding foreign exchange constraint, these detrimental effects are much worse, while through the trade account, instability of domestic food production and of world food prices also adversely affects the urban poor. The simultaneous impact of all sources is, however, no higher than the separate impact of net resource inflow instability.

The simulation results indicate

(1) The balance of payments constraint or, for that matter, international general balance of payments assistance, is of little consequence for real household income instability among the rural poor, yet of crucial importance for the urban poor¹². The same applies to the instability of the net resource inflow, which operates mainly through the balance of payments.

(2) Neither stable world market prices for food imported and livestock exported, nor stable livestock production would contribute to income stability among the urban or rural poor, but would merely change the source-composition of income instability. The same applies to stable domestic crop production in the case of the urban poor and to stable world market prices for the minerals exported by the country in the case of the rural poor.

(3) Stable domestic crop production would go a long way to alleviate the insecurity problem among the rural poor.

(4) A stabilization of domestic crop production and an easing of the foreign exchange constraint would result in food security among the rural and urban poor, respectively. However, both policies are costly, if not impossible. Policy research must establish these costs by investigating not only alternative ways of stabilizing real household income, but also the first-best solution of removing or compensating for the domestic capital market distortion.

Footnotes

- 1 See the contributions in Valdés (1981) and in Chisholm and Tyers (1982).
- 2 Figures are for 1980/81 (Central Statistics Office 1983).
- 3 Valdés and Siamwalla distinguish between security on the national, the regional and the household level. The ability of households to meet target consumption levels entails the ability of countries and regions, but not vice versa.
- 4 Assets possessing the optimal degree of liquidity for stabilizing annual food consumption (medium-term monetary instruments including debt instruments) are often not available or their real return is repressed by policy interventions. Commodity stocks, cash money and other highly liquid assets have negative real returns due to, i.a., physical shrinkage and inflation. Using cattle or other illiquid assets causes transaction costs in times of need.
- 5 This aspect is of prime importance in the food security programmes developed in the countries of the Sudano-Sahel (Brandt 1984).
- 6 A transitory increase in the current account deficit, by reducing the foreign component of money supply, would tend to increase the covered spread between domestic and foreign interest rates. Both foreign holders of domestic assets and domestic holders of foreign assets could be expected to take advantage of the spread.
- 7 The recognition of the balance of payments link led to the successful proposal for expanding the compensatory financing facility of the IMF from merchandise exports to cereal import expenditure. Goreux 1981.
- 8 For sources see footnotes in Table 1.
- 9 See Dick and Gerken (1984) for a complete documentation of the structural equation system and the data base.
- 10 See Powell (1981) for a discussion of the major features of this and other types of economy-wide models. Dixon et al. (1982) give a full outline of the model theory and solution procedure.
- 11 The determination of nominal investment and the appropriate price index is indicated by, respectively, the one-arrow and the two-arrow lines. The diagram does not show that, in the model, government expenditure is constrained by revenue from taxes on production, imports and factor rents.

- ¹² This does not automatically apply to partial assistance, such as compensatory financing of deviations in the balance of merchandise export earnings and import expenditure. Used indiscriminately, such assistance might even enlarge the instability of urban household income. With domestically held foreign exchange reserves fixed, an additional net capital inflow, for example, would raise domestic food consumption and discourage commodity exports, thus inducing assistance payments and a further appreciation of the real exchange rate.

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