

Speculative Price Bubbles in the Rice Market and the 1974 Bangladesh Famine

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This paper investigates the role played by speculative price bubbles in destabilizing food markets in Bangladesh during the 1974 famine. The hypothesis of speculative price bubbles in the rice market is tested using weekly price data. These tests are based on a theoretical model of storable food markets in which agents exhibit rational expectations. It is shown that such markets are susceptible to destabilizing trends by self-fulfilling expectations. While “explosive price bubbles” have received extensive attention in macroeconomics, they have not been used in development economics to explain famines. Amartya Sen has hypothesized that speculative forces are a possible source of instability in the food market. Our empirical tests based on techniques from the recent literature on price bubbles lend some credence to the hypothesis that excessive speculation may have produced price bubbles in the rice market which directly contributed to the Bangladesh famine in 1974.

I. Introduction

The view that excessive speculation can destabilize markets is now commonly accepted. An extensive literature exists on how destabilizing speculation can affect markets for foreign exchange and for assets such as gold. This paper considers the possibility that markets for storable food in developing countries also are vulnerable to forces of destabilizing speculation. The type of speculation we consider is caused by self-fulfilling expectations in the market, also known as price bubbles.

This thesis has critical policy implications for development economics, since in low-income economies destabilizing speculation may be responsible for a great deal of instability in the food markets. In fact, price bubbles in Third World countries may greatly disrupt individual food markets, resulting in widespread distress to poor households and even famines.

A central task of famine research involves explaining why similar stocks of food grains can generate vastly dissimilar outcomes in terms of widespread starvation and famine. This is the focus of the seminal work of Amartya Sen ((1977), (1981)), which distinguishes household food endowments from the aggregate availability of food. Unfavorable

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endowment changes can result from developments on either the supply or the demand side of the market. These changes can be further classified as being unrelated to expectations (the *fundamentals*) or driven primarily by expectations (the *bubble*). Speculative price bubbles have long been recognized as a potentially important contributor to famines.¹ Nonetheless, bubbles have not received adequate formal modeling or empirical examination in the context of famine research.²

Famines are frequently characterized by highly volatile food prices. During the 1974 famine in Bangladesh, the price of rice (the main food staple) rose by almost 300% during a three-month period, before declining rapidly. Such volatility is the hallmark of explosive price bubbles. It also is the main source of distress for low-income, non-farming households wholly dependent on markets for their food supply. Many of these households fell victim to the 1974 famine, a phenomenon noted by Sen (1981), Ravallion (1988) and others. More generally, one would expect speculative famines to occur most frequently in poor nations in which a large number of households are non-farming and in which private international trade in food is difficult or prohibited. The Bangladesh rice market, on which we focus, was indeed characterized by many of these conditions in 1974.

Sections II and III offer a brief description of the Bangladesh famine of 1974. Section IV discusses various theories of famine. This section also outlines the model of speculative famines. The formal model of food market with rational expectations is presented in Section V. Empirical tests are then presented in Section VI, while a concluding section contrasts the 1974 Bangladesh famine with a recent episode of food shortage in parts of Africa.

II. The Bangladesh Famine of 1974

1. The Setting

In 1974, Bangladesh was among the poorest nations in the world, with per capita income of roughly \$144 (in 1985 dollars).³ With a population density in excess of 1400 per square mile, per capita output was inevitably low in a country more than 90% rural with an economy based on subsistence agriculture. Life expectancy was between 47 and 49 years for both sexes. These averages overstate the well-being of the poorest at the time. Roughly 15% of all Bangladeshi children died before reaching age 5. Over 50% of households consumed less than the minimum calorie requirements suggested by international agencies, and 60%

1. The term “famine” should be distinguished from chronic hunger and malnutrition. Rather, we define a famine as a period characterized by abnormally high mortality, relative to long-run trends, for reasons unrelated to social and political upheavals or the spread of a contagious disease.
2. For example, Bhatia (1967) refers to price famines: “Thus, instead of absolute lack of food in one region, famine under the new conditions assumed the form of a sharp rise in prices. The process was helped by the emergence of “destructive” forms of speculation in food grains...the human and institutional factors were becoming more important than natural scarcity in causing distress and starvation.” For a recent and prominent economic analysis of famines, see Dreze and Sen ((1989) and (1990)).
3. The descriptive statistics provided in the following paragraphs are also taken from the World Bank ((1981) and (1987)).

suffered from protein deficiency. Agriculture produced 60% of GNP and employed roughly 80% of the labor force during the mid-1970s. Agricultural productivity was low and was growing very slowly. In addition, the nation of 75 million had just gone through a protracted civil war, and the state machinery was corrupt and incompetent.⁴

Under such dismal conditions, even minor shocks can induce starvation for a large number of households. A key characteristic of the rural poor is absence of land ownership, the major capital asset. Landlessness makes a household especially susceptible to a food crisis: landed peasants who own or sharecrop plots are at least able to eat their own produce, even if rising food prices reduce the purchasing power of the wages they use to supplement their own production.

2. The Famine

Between October 1973 and August 1974, Bangladesh was gripped by a severe food crisis that resulted in widespread loss of life. While precise figures are unknown, it seems likely that the loss in lives exceeded one million (Alamgir (1981)). The disaster clearly involved many factors. However, the striking finding of most researchers is that food grain availability during the crisis was adequate and did not “justify” a famine.

The 1974 famine began early in the year. This is somewhat surprising, as the new harvest (*aman*) was, relatively speaking, a good one. Nevertheless, the price of rice began rising in January at a rate of 14% per month (Table 1). This pattern persisted until May, when there was a brief interlude. Then came the floods of June and July, extensively damaging the spring (*boro*) crop.⁵ The floods also generated a severe employment crisis for farm workers, as little work is available when land is submerged.

The price of rice soared with the floods. By September, the government was forced to declare a state of famine. An estimated 4.35 million people (6% of the population) took refuge in public kitchens (*langarkhanas*) where free survival rations were supplied by the government. In November, the arrival of the winter harvest broke the upward trend in the price of rice, and harvest-related employment opportunities encouraged migrants to return to their villages. By the end of the month, most public kitchens were closed.

There is little doubt as to the intensity of the famine. While the government announced a death toll of only 26,000, private estimates suggest a total excess mortality in 1974 and 1975 of one to 1.5 million (Alamgir (1980, pp.142-3)). The Bangladesh Institute of Development Studies collected abundant data during the course of the famine to document this tragic episode.

4. Perhaps the most telling statistic is that, despite the extraordinary labor intensity of production, rice output per hectare in 1974 in Bangladesh was less than half of that in Sri Lanka, and one quarter of that in Taiwan.

5. *Boro* output in the flood-affected area was about 18% below the 1973 level. In contrast, the 1973-74 winter *aman* crop was about 20% above the 1972-73 level. In terms of overall importance (based on 1971-76 averages), the *aman* rice crop harvested in November-January accounted for 56% of total output; the *boro* crop harvested in April-June accounted for 19%, and the *aus* crop harvested in July-August accounted for 25% of rice production (see Sen (1981, p.137)).

Table 1 Rice Prices and Agricultural Wages in Bangladesh, 1974

Month	Bangladesh Rice Price (1)	Monthly Rate of Increase (2)	World Price of Rice (3)	Agricultural Wage Rate (4)	Purchasing Power of Ag. Workers: (4)/(1)
January	92.11	14.0%	139	6.22	86
February	98	7.0%	139	6.36	82
March	117.33	19.0%	139	7.17	78
April	136.98	17.0%	139	8.22	77
May	135.68	- 1.0%	139	8.72	82
June	139.04	2.0%	116	8.26	76
July	141.78	2.0%	116	8.61	78
August	171.25	21.0%	107	8.82	66
September	212.80	24.0%	93	8.80	53
October	251.78	18.0%	86	8.64	44
November	213.73	- 15.0%	93	8.39	50
December	188.9	- 12.0%	96	8.70	59

Notes: Wage rates are in Taka/day; domestic rice prices (collected from Bangladesh Bank sources) and agricultural wages are indexed with December 1973 = 100; world rice price is taken to be southwest Louisiana wholesale price indexed with October 1973 = 100.

Sources: Sen (1981), U.S. Department of Commerce (1984).

These data indicate that most famine victims were landless peasants and farm workers. Rural households owning less than 0.5 acres of land were overrepresented in the *langarkhanas* by a factor of 2.5, comprising 81% of kitchen residents, but only 33% of the rural population. In contrast, while 17% of rural households owned more than 2.5 acres, only 1.3% of the *langarkhana* population was drawn from that group. Unlike the rural poor, the urban poor were cushioned from the famine, largely because of public distribution of subsidized food grains in urban areas.

III. Immediate Causes of the Famine in 1974

What factors were immediately responsible for the famine? The official position has been to blame crop losses from floods. Natural disasters certainly can cause a food crisis and, unlike droughts, floods damage existing food stocks as well as standing crops. The standing *aus* crop was extensively damaged in several regions, while the new *aman* crops could not be planted in time. Transportation channels also were disrupted, while employment opportunities suffered. Nevertheless, the floods did not occur until the end of June, while the famine, according to most observers, actually commenced in January. Thus, flood damage significantly aggravated the famine, but did not start it.⁶

6. Through May 1974, the purchasing power of agricultural wages (wage divided by price of rice) actually slightly exceeded the purchasing power in the previous year. Nonetheless, the observed wage and rice price structures prior to the floods do not seem to be purely seasonal, since (1) the 1973-74 *boro* crop was much better than the

Could the 216% rise in the price of rice between January and October have been generated by domestic inflation? Between January and December 1974, M2 increased by only 9.72%, hardly enough to provoke hyperinflation (or to worry about distinguishing real from nominal price trends). Even if one hypothesizes that money supply has a lagged effect on commodity prices, a story based on the printing of money is implausible: M2 rose only 39% between January 1973 and December 1974. In any event, the dramatic and sustained declines in the purchasing power of the non-food producing poor is easily documented.

Nor is it plausible that world price trends were primarily responsible for the famine. As numbers and notes in Table 1 indicate, there was a substantial jump in the world price of rice during the early months of 1974 (See notes to Table 1. The index for the world price of rice rose from 100 in October 1973 to 139 in January 1974). This increase reflected poor crops in the major grain producing parts of the world. The world rice price also had risen by 119% during the previous year. The period as a whole also was characterized by inflation in raw materials markets.

But while this inflation cannot be ignored, its direct influence should be discounted. Bangladeshi food markets were insulated from world markets by the government policy of prohibiting private food trading, while state purchases were distributed through the public distribution system at fixed prices. Consequently, an increase in the world price of rice mainly meant an increase in the size of food subsidies, and the large 1974 government budget deficit mostly reflected this rise. It is true that trade in smuggled foodgrains to India existed, suggesting that Indian conditions could be expected to have some effect on Bangladeshi food supply. But while food prices in India during the early 1970s were high relative to their long-term trends, they did not exhibit dramatic jumps (see Becker, Mills and Williamson (1986)).

IV. A Theory of Destabilizing Speculation and Famine

1. An Overview of Alternative Theories of Famine

The theory of famines dominant in popular accounts and policy circles is that of a decline in food availability. The food availability decline (FAD) view attributes famines primarily to a food scarcity and high food prices.

A careful study of food grain availability, however, does not support this explanation for the Bangladesh famine. As Sen (1981) has documented, from the conventional perspective, 1974 actually was the least likely year in the 1971-1975 period for a FAD famine. Per capita food grain availability in 1974 was 15.9 oz./day, in contrast with 15.3 oz./day in each of the two preceding years and 14.9 oz./day both in 1971 and 1975.

Sen's alternative framework is built on the investigation of a decline in food

poor 1972-73 one, (2) real wage deterioration relative to 1973 began prior to the floods, and (3) accounts of abnormal hunger began in January. In addition, Assaduzzaman (1973, pp.213-220) has found, empirically, that seasonal factors largely explain rice price fluctuations. But Alamgir (1980, p.291) found 1974 seasonal trends to be quite abnormal, with a 1974 fluctuation index 3.5 times greater than average.

entitlements of individual households. In a society characterized by widespread poverty, a necessary and sufficient condition for famine is a decline in “food entitlements.” This is defined as the stock of food a household is able to procure from all possible sources. Such a decline *may* reflect a decline in overall food production that drives up the relative food price (the FAD view). But it is more likely to result from forces such as a sudden increase in the demand for food, or an unexpected decline in employment opportunities. The entitlement approach goes beyond a simple accounting identity in claiming that availability decline is often of minor importance or even largely irrelevant in some famine episodes.⁷

The entitlement view holds up well for the 1974 Bangladesh famine. Food availability did not decline dramatically, but real wages for agricultural workers declined by more than 50%, due to a sharp increase in the price of rice. Real income declines for other unskilled occupations also were dramatic.

However, the entitlement view fails to identify the ultimate cause of the crisis. *Why* did the real food price increase dramatically, if availability was adequate? That is the crux of the puzzle. In particular, it is critical to distinguish famines in which the fundamentals (normal forces of demand and supply) do not give rise to a crisis from those in which they do. An understanding of the ultimate causal factor is essential for effective famine prevention and control.

2. The Speculative Bubble Theory of Famine

This paper examines the hypothesis that the 1974 Bangladesh famine was caused primarily by explosive price bubbles in the rice market that destabilized food markets. The higher world food prices in 1973 provided an unsettling background. There were concerns about price controls, quotas, imported food arriving on time, and about the low levels of the food in public storage. The political and the law and order situation had rapidly deteriorated with the power of the state looking increasingly shaky. The market psychology was ripe for an overreaction to unfavorable news due to the state of enhanced uncertainty.

A second precondition for price bubbles also was present. Expectations-driven price volatility requires the substantial hoarding of food grains. Poor peasants themselves lack the resources to withhold their surplus for any length of time. The rice market in Bangladesh did have substantial oligopolistic elements at the wholesale level. Faruk (1972) found that storage costs were far lower than the short-term profit rate due to seasonal price differences. He also found that transport costs could not explain the substantial gaps between the prices at the farm gate and in the markets.

Faruk’s findings are consistent with evidence provided by others (in particular, Alamgir (1980, p.294) and Ravallion (1988, p.102)). Many factors served as barriers to entry in the rice trade; most notable were lack of access to capital, lack of adequate storage facilities, and the importance of political connections. Only a few wholesale markets existed in the distribution chain of rice in 1974. Prominent among these were the Badamtolighat and

7. During the great Bengal famine of 1943, non-food producing Calcutta was well-stocked, while farmers in the countryside starved. See Greenough (1982).

QUDDUS AND BECKER: SPECULATIVE PRICE BUBBLES IN THE RICE MARKET

Narayanganj centers near the capital, Dhaka. Popular media and some researchers have suggested that collusion does exist in these markets. Especially when market supply is weak, inflationary fears already latent, and spatial arbitrage rather ineffective, collusive speculation has enormous potential payoff, and can cause excessive price volatility.

A critical fact in this story is that the Bangladesh government had a policy of purchasing rice for public storage after the *aman* harvest at below-market prices. Part of this procurement was mandatory, designed to compel surplus producers to give up part of their output, while part was voluntary.⁸ Failure to achieve adequate procurement signaled the market that government lacked the resources to conduct an effective stabilization policy.

The rice procurement scheme in 1974 was a dismal failure. The government announced a target of 400,000 tons (about 3.5% of the 11.7 million ton output) but was able to acquire only 71,000 tons. This failure appears to have stemmed from mismanagement, and from the corruption invited by mandatory sales at below-market prices.

At the same time, rice imports, a public sector monopoly, were utilized to fulfill obligations to ration card holders. Ration recipients tended to be the urban households, a potential threat to the political stability of the government. Thus, while the ration recipients were a small part of the population and food imports were not vast (about 1.7 million tons, or 15% of the total harvest in 1974), they were extremely important for their information content. In particular, low imports and reductions in state orders provide signals to consumers and speculators that supplies are low, and that the state is unable to defend a price ceiling from a determined speculative attack.

Table 2 Imports of Food Grains Into Bangladesh and Distribution (000 Tons)

Month	Foodgrain Imports		% Change over 1973	Public Foodgrain Distribution		% Change over 1973
	1973	1974		1973	1974	
January	228	38	- 83.0	143	127	- 11.18
February	194	90	- 53.6	157	121	- 22.92
March	467	99	- 78.8	175	131	- 25.14
April	212	147	- 30.7	206	137	- 33.49
May	179	224	+ 25.1	253	130	- 48.61
June	126	135	+ 7.2	214	162	- 24.29
July	83	291	+ 250.6	151	152	- 0.66
August	159	225	+ 41.5	153	182	18.95
September	263	29	- 89.0	170	177	+ 4.11
October	287	76	- 73.5	187	151	- 19.25
November	59	190	+ 222.0	145	148	+ 2.06
December	53	149	+ 181.0	123	109	- 11.38

Source: Alamgir (1980, p.223, p.226) and author's estimates.

8. The latter purchases were targeted at small farmers who tended to sell off much of their crop immediately following the harvest to middlemen at prices far below retail averages. The government thus sought to increase small farmer incomes, siphon off a portion of the surplus to prevent it from being held by traders and surplus farmers for speculative purposes, and build up stocks requisite for carrying out a price stabilization scheme.

These signals do appear to have been provided in November 1973-March 1974 (Table 2), when government imported only a small amount of grain. Combined with the failure in the domestic procurement, this reduced the state's ability to stabilize prices, and sent signals to that effect. The drop in imports compared with 1973 was far less than the increase in production from the superior *aman* crop, but the impact on expectations from this highly visible failure could have led to a self-fulfilling price bubble. The procurement failure and the decline in imports, though only marginally significant for the market fundamentals, were nevertheless greatly significant for formation of price bubbles.

This is not to deny that the subsequent floods contributed to a worsening of the famine. Rather, we focus on events that set the famine in motion prior to the floods. Indeed, beyond reducing supplies, it is likely that the floods had an important impact on expectations as well. As Table 1 shows, rice prices stabilized in May and increased only moderately in June-July 1974. After recognition of the extent of damage became clear though, prices again began rising rapidly after July 1974. To the extent that the actual damage caused by the flood was interpreted as negative news (in an already sensitive environment), speculative withholding would have greatly aggravated its effects. That much of its effect was through expectations is supported by Alamgir's (1980) data, which show the output loss to have been relatively minor.⁹ The floods were confined to certain parts of the country but food inflation was a countrywide phenomenon.

To summarize, we believe that the immediate factor responsible for the 1974 famine was the steep increase in the price of the staple food, rice. We also hypothesize that the primary explanation for this price hike is to be found in the way self-fulfilling expectations encouraged speculation and hoarding in these markets.

Free market prices reflect both fundamentals and expectations of economic agents. In the absence of speculative elements, prices are largely determined by fundamentals. However, if speculative forces do operate, a market may come "unhinged" from its fundamental-based equilibrium, causing substantial instability. If expectations regarding future prices become self-fulfilling, prices may either rise or fall steeply. We hypothesize that the 1974 crisis was primarily the result of a food market caught up in self-fulfilling chains of expectations. When price bubbles cause food prices to rise rapidly, dramatic declines in food entitlements may result for groups dependent on the market for their food supply. Thus, a price bubble can create a famine.

V. A Rational Bubble Model of Famines

This section presents a model for storable food market that is used to test the hypothesis of the existence of price bubbles. The model is an asset-pricing model assuming rational expectations, adjusted to include consumption demand. While not every famine is caused by speculative elements, self-fulfilling expectations have played an important role in some famines. Our model addresses the class of famines that we call "market famines".¹⁰

9. Floods need not kill rice seedlings, which are able to live in inundated conditions for a limited period.

10. The idea that expectations forces are important is hardly original--and may have more currency in the popular

QUDDUS AND BECKER: SPECULATIVE PRICE BUBBLES IN THE RICE MARKET

This model enables us to support the entitlement theory of famine with a more rigorous analysis than is presently available.

We begin by assuming that demand for rice (storable food) may be represented by:

$$D_t = \mathbf{a}_0 - \mathbf{a}_1 P_t + \mathbf{a}_2 E_t P_{t+1} - \mathbf{a}_3 r_t + \mathbf{a}_4 Y_t + u_t, \quad (1)$$

where all \mathbf{a} terms are ≥ 0 , $E(u_t) = 0$, $E(u_t^2) = \mathbf{S}_u^2$, $E(u_t, u_{t-1}) = 0$.

D_t is demand in period t , P_t is price level in period t , $E_t P_{t+1}$ is the expected price in period $t+1$ formed at time t , E_t is the conditional expectations operator, r_t the nominal interest rate at time t , Y_t the nominal income level at t . The terms \mathbf{a}_0 , \mathbf{a}_1 , \mathbf{a}_2 , \mathbf{a}_3 , \mathbf{a}_4 are positive constants and u_t is the zero-mean, finite-variance, serially uncorrelated disturbance term. Demand is inversely related to current price and storage costs, and positively related to expected future prices and current income.

Since the commodity under consideration is storable, Equation (1) states that demand arises from two sources, current consumption and portfolio considerations. Expectations about future price behavior are assumed to be formed rationally in the sense of Muth (1961). The interest rate term reflects the opportunity cost of hoarding food in one's asset portfolio. The random disturbance term is for unaccounted variables such as income shocks, weather changes, and policy shifts.

Market supply is expressed as:

$$S_t = \mathbf{b}_0 + \mathbf{b}_1 P_t - \mathbf{b}_2 E_t P_{t+1} - \mathbf{b}_3 r_t + v_t, \quad (2)$$

where all \mathbf{b} terms are ≥ 0 , $E(v_t) = 0$, $E(v_t^2) = \mathbf{S}_v^2$, $E(v_t, v_{t-1}) = 0$.

S_t is supply in period t , $E_t P_{t+1}$, P_t , r_t are used as before. \mathbf{b}_0 , \mathbf{b}_1 , \mathbf{b}_2 , \mathbf{b}_3 are constants. v_t is a zero-mean, finite variance, serially uncorrelated disturbance term.

Since the commodity under consideration is storable, current supply is related positively to current price but negatively to future expected price. Farmers and traders are expected to withhold supply for speculative considerations if they expect future prices to be sufficiently high: r_t measures the opportunity cost of such withholding and therefore has a negative sign. The disturbance term is included to account for random elements on the supply side. While one might imagine more sophisticated model formulations, data limitations prevent greater complexity from being fruitful. For analytical convenience, the demand and supply schedules are specified linearly. The random term is to take into account unanticipated changes. Demand and supply are then equated in a flex-price framework to get a stock equilibrium. That is, the spot price moves to clear the stock present in the market, ensuring portfolio balance at each point in time.

press than in the economics literature. For example, the *Wall Street Journal* in an editorial said "A famine...almost never starts from an absence of food; it comes from market distortion....The quickest way to break this cycle of expectations is to break the market expectations." (1/21/85:20).

The market clearing condition is

$$D_t = S_t. \quad (3)$$

This equation implies that in each period, price moves to clear the market. The solution to this flex-price model can be obtained by combining (1) - (3); rearranging and solving for P_t ,

$$P_t = a + bE_t P_{t+1} - cr_t + fY_t + dZ_t, \quad (4)$$

$$\begin{aligned} \text{where } a &= (\mathbf{a}_0 - \mathbf{b}_0)/(\mathbf{a}_1 + \mathbf{b}_1) \\ b &= (\mathbf{a}_2 + \mathbf{b}_2)/(\mathbf{a}_1 + \mathbf{b}_1) \\ c &= (\mathbf{a}_3 + \mathbf{b}_3)/(\mathbf{a}_1 + \mathbf{b}_1) \\ f &= \mathbf{a}_4/(\mathbf{a}_1 + \mathbf{b}_1) \\ d &= 1/(\mathbf{a}_1 + \mathbf{b}_1), \text{ and} \\ Z_t &= (u_t - v_t). \end{aligned}$$

The root of this system can be obtained by solving (4). The root's value has important implications for the time path of a linear rational expectations model. Rearranging (4) to express the solution in terms of expected future price,

$$E_t P_{t+1} = -ab^{-1} + b^{-1}P_t + b^{-1}cr_t - b^{-1}fY_t - b^{-1}dZ_t, \quad (5)$$

we see the eigenvalue of the system is $b^{-1} = (\mathbf{a}_1 + \mathbf{b}_1)(\mathbf{a}_2 + \mathbf{b}_2)^{-1} \gtrless 1$ as $(\mathbf{a}_1 + \mathbf{b}_1) \gtrless (\mathbf{a}_2 + \mathbf{b}_2)$. In our model it seems reasonable to assume that $\mathbf{a}_1 > \mathbf{a}_2$ and $\mathbf{b}_1 > \mathbf{b}_2$: current demand and supply are more sensitive to changes in current prices than to changes in expected future prices. Hence, $b^{-1} > 1$, and the forward-looking particular solution for P_t will involve a convergent sum (Sargent (1979, pp.171-183)). A more complete solution of this equation is provided in the appendix.

Hoarding includes private storage by consumers for future consumption, withholding by surplus farmers for future sales, and speculative buying by middlemen. The desire to hold inventories comes from a desire to maximize profits and to diversify risk. In the absence of a futures market, inventories become the sole channel for dealing with risk and uncertainty due to price variability. We further assume that information is incomplete and not distributed asymmetrically. Finally, agents' behavior is subject to a wealth constraint.

A food market such as the one described in this model contains the seeds of a famine, given other preconditions such as widespread poverty and state monopoly in food imports. There will be instances when market forces are driven by expectations to produce "perverse" results. The phenomenon of destabilizing speculation is popularly called a "bubble," presumably because participants are aware of the transitory nature of the speculative boom, but still choose to participate. Moreover, such expectations-driven bubbles are consistent

with the assumption of rational expectations.¹¹

Once the cause of a price bubble is identified, the policy response is not difficult to find. Clearly, the market needs help when caught in a self-fulfilling expectations chain. Even if it is inevitable that the market should diverge from its long-term non-stochastic path (the fundamental solution) periodically, a disaster is not unavoidable. Policies can be implemented to rescue the market in such critical moments. However, policymakers must correctly diagnose the malaise affecting food markets.

An expectations-based model need not choose a single factor as the source of disentanglement. Availability reductions and events such as news and political events all can be simultaneously incorporated as relevant factors. The distinction between the availability and entitlement factors is rejected. An availability reduction, not large enough to cause a famine by itself, may result in a famine by generating forces of self-fulfilling expectations. The model also focuses on what causes the expectations chain to unravel, thereby addressing the question of first cause. Finally, it provides us with testable hypotheses that can be investigated using statistical tools.

Several assumptions merit elaboration. First, the model is essentially a short-run, exchange-type framework. Famines caused by food price bubbles tend to be short-run phenomena, where a price bubble emerges and disappears within the production lag period. The periodicity is thus defined in consumption or exchange terms. In Bangladesh in 1974, these may be best interpreted as daily or weekly market periods.

Secondly, many misinterpret the assumption of rational expectations as implying complete information for every agent--unrealistic in a setting of underdeveloped markets. In fact, rational expectations implies only that information is collected and utilized efficiently, not that it is freely or equally available. Employment of this assumption has the further advantage of providing testable hypotheses.¹²

A third assumption is that of a competitive food market. It is true that destabilizing speculation may be caused by monopolistic elements in the market, but for analytical simplicity the discussion is limited to the competitive model. Assuming imperfect competition would not qualitatively alter the model, but would add needless complexity to the equations. A fourth assumption is that of partial equilibrium. Since we concentrate only on the food market, we may obtain conclusions that are only partially valid in a general equilibrium setting. However, recalling that agriculture, which was overwhelmingly rice farming, accounted for roughly 60% of GDP, ignoring other markets is hardly a wild assumption.¹³

11. There has been an explosion of research on rational bubbles in the modern macroeconomics and international finance literature. The seminal work is Flood and Garber (1980); other major works include Diba and Grossman (1988a) and (1988b), Blanchard (1979), Blanchard and Watson (1982), Flood, Garber and Scott (1984), Okina (1984), Woo (1984), Hamilton (1986), West (1987), Driskill, Mccferty and Sheffrin (1991) and Froot and Obstfeld (1991).

12. O.J. Blanchard and M.W. Watson (1982).

13. For Bangladesh in 1974, rice output alone represented 50% of GNP; the entire rural economy was responsible for 85% of GNP and 90-95% of the population. See J. Faaland and J.R. Parkinson (1976, pp.126-7).

Finally, our model is cast in real terms, and analyzes relative price movements. Our empirical work, however, focuses on nominal prices, since food was the dominant sector, and since changes in its price are felt quickly in other parts of the economy. The ideal price measure would be a food price deflated by a weighted factor price index, but that is unavailable.

VI Empirical Investigation of Rational Price Bubbles

There are essentially three approaches to empirical testing of rational bubbles:

1. Assuming away the existence of explosive bubbles *a priori*, and comparing the actual distribution of prices with the distribution anticipated based on fundamentals. This is known as a test of the efficient market hypothesis.
2. Direct estimation of a bubble component, assuming *a priori* a particular expansion path.
3. Seeking bubbles from the properties of the distribution of asset price data.

Storable food markets may generate deterministic or stochastic price bubbles. To track a deterministic bubble, we need to perform a *direct* test by estimating the coefficient(s) of the bubble component. This requires a well-defined model for the market, and hence data on fundamentals. Such data are not available for food markets in Bangladesh. We are therefore limited to indirect testing of stochastic bubbles. Specifically, we are limited to the third approach, testing a no-bubble hypothesis.

The data are taken from the rice markets in Bangladesh during the 1974 famine period. Data on prices were collected from a retail market in Dhaka each Monday between October 1973 and October 1974.

To test the no-bubble hypothesis, we need to estimate the fundamental rate of return (*ROR*) in the food market. We use data on other asset markets (gold and foreign exchange) to determine their fundamental rates of return. Since these rates of return must reflect the opportunity cost of funds in the food market, at the margin, *in equilibrium* they should be equal to the *ROR* in the food market. We consider three different options, based partly on theoretical merit and partly on data availability. Specifically, the food price fundamental *ROR* is alternately assumed to equal (i) the current gold market fundamental *ROR*; (ii) the current fundamental *ROR* in black markets for foreign exchange; and, lastly, (iii) the normal (lagged) *ROR* in the rice market itself.

1. Empirical Tests

Following Diba and Grossman (1988, p.522), if we assume the first difference of U_t , the disturbance term, is stationary, then if rational bubbles do exist, asset prices will be nonstationary in levels but stationary in their first differences. On the other hand, if asset prices do not contain a rational bubble, then for simple specifications of the process

generating Z_t , differencing asset prices a finite number of times would not yield a stationary process.

We examine the properties of the price data by studying the ACF and PACF of rice price and its first difference. We then use the sample autocorrelations and the unit root test to identify whether the undifferenced price series and the differenced series are nonstationary.

a. Sample Autocorrelations

Table 3 presents the sample autocorrelations of daily rice prices for the period July 2, 1973 to June 30, 1975. Also included in the table are the sample autocorrelations of the first difference of price series. For both autocorrelations, lag lengths from 1 to 10 are used.

Table 3 Sample Autocorrelations of Rice Price and Their First Difference (July 2, 1973 to June 30, 1975)

Series	Number of Lags									
	1	2	3	4	5	6	7	8	9	10
P_t	.997	.994	.990	.985	.981	.976	.972	.968	.964	.961
AP_t	.165	.306	.089	.018	-.074	-.029	-.102	-.041	-.114	-.054

Source: Author's estimates based on domestic rice price data (collected from Bangladesh Bank sources); P_t and AP_t represents the autocorrelations of the price of rice and of their first difference, respectively.

Table 3 also shows the autocorrelations of undifferenced price series drop off slowly as the lag length increases, suggesting nonstationary means. This pattern closely resembles that of an integrated moving average process of order (1). The conclusion holds even when the lag length is increased to 20.

In contrast, autocorrelations of differenced series of prices exhibit less temporal dependence over the shorter sample period. This is evident from both Table 3, and Table 4 which shows the autocorrelation of the first difference of prices for the period September 10, 1974 to December 20, 1974. This period coincides with the period of significant price volatility.

Table 4 Sample Autocorrelations of Rice Prices and Their First Difference (September 10 - December 20, 1974)

Series	Number of Lags									
	1	2	3	4	5	6	7	8	9	10
P_t	.962	.919	.867	.811	.761	.717	.678	.646	.617	.595
AP_t	.195	.315	.090	-.032	-.145	-.059	-.133	-.061	-.163	-.062

Source: Author's estimates

The indication is that the undifferenced price series is nonstationary, but the differenced price series exhibits less time dependence.

b. Unit Root Test

To test nonstationarity we perform the unit root tests on the two series. The null hypothesis is that the series has a unit root, that is, it is nonstationary. When we fail to accept this hypothesis, we conclude the series is stationary. As Table 5 shows, the (negative) Dickey-Fuller statistic of price is smaller than the critical values at 1%, 5% and 10%. Thus the hypothesis of nonstationarity cannot be rejected for the price series for the entire sample period.

**Table 5 Rice Price Augmented Dickey-Fuller Unit Root Test Results
(10 lags; July 2, 1973 - June 30, 1975)**

Dickey-Fuller <i>t</i> -Statistic		- 1.1464
McKinnon Critical Values	1%	- 3.4391
	5%	- 2.8651
	10%	- 2.5687

Source: Author's estimates

The Dickey-Fuller statistic for the first differenced series with a lag of 10, for the entire sample period, is larger than the critical values at 1%, 5% and 10%. Thus the null hypothesis of nonstationarity is rejected.

However, for the period with the greatest volatility, September 10, 1974 to December 20, 1974, we find the Dickey-Fuller statistic to be - 2.8711, smaller than the critical values at 1%, 5% and 10% (Table 6). Thus, for this sample size, the first difference of price series is found to be nonstationary, thereby contradicting the hypothesis of no bubble. The volatility in price during this period may have been the result of self-fulfilling expectations—a price bubble.

**Table 6 Rice Price Augmented Dickey-Fuller Unit Root Test Results
(10 lags; September 10, 1974 - December 20, 1974)**

Dickey-Fuller <i>t</i> -Statistic		- 2.8711
McKinnon Critical Values	1%	- 4.0742
	5%	- 3.4652
	10%	- 3.1589

Source: Author's estimates

c. The Tails Test

Blanchard and Watson (1982) use a non-parametric test when only price data are available. The validity of this test is based on certain assumptions about market fundamentals and information-generating mechanisms; namely, that innovations in market fundamentals are normally distributed, and that information arrives in a continuous stream.

The intuition here is that stochastic bubbles will at times “pop” or crash. In the explosive phase, the excess returns to holding the asset in question will be positive; when the bubble pops, these returns will decrease dramatically and will become negative. Therefore,

the distribution of excess returns in such markets will be leptokurtic. The coefficient of kurtosis will be typically much greater than zero, its value in a normal distribution.

The coefficient of kurtosis using gold market fundamentals *ROR* for generating excess returns in food holding is found to be 8.14--substantially bigger than zero, the value for the normal distribution. The coefficient is also substantially higher than the coefficient of kurtosis for the distribution of gold fundamentals (the long-run rate of return to holding gold in Bangladesh), which is - 1.27.

For excess returns using black market foreign exchange *ROR*, the results are equally striking. The coefficient of kurtosis is 6.1--again much bigger than is expected for a normal distribution. For previous period rice market *ROR*, the coefficient of kurtosis for distribution of excess returns is 8.73.

These results are found to be robust with respect to several factors, including deseasonalizing the data, and small changes in starting and ending dates for the period surrounding the famine. In summary, our investigation suggests that excess returns in the rice market during the famine did have a leptokurtic distribution--an indicator of the presence of stochastic bubbles.¹⁴

In each case, a large negative outlier - expected when a stochastic bubble crashes - seems to be mainly responsible for a high value of the coefficient of kurtosis. It turns out that this value of the innovation occurred around the last week of October 1974, when the price of rice fell by almost 30%. Was this caused by the bursting of a price bubble? Possibly. Newspaper reports from that week offered two critical pieces of information relevant to rice market participants. First, it was reported that a large shipment of food from abroad had reached the port city of Chittagong. Second, news of a good *aman* harvest reached the market. These pieces of information satisfy our criteria of news that could cause price bubbles to pop.

VII. Concluding Remarks and Policy Implications

We have suggested that the 1974 Bangladesh famine was in large part caused by food market price bubbles, and we have searched for statistical evidence of such bubbles. These bubbles are generated by underlying speculative forces and can destabilize the market.

There are several reasons to anticipate that different food markets in developing countries may be highly susceptible to price bubbles. First, food is a necessity, making consumers extremely risk averse in their purchase and storage decisions. Second, food is generally storable at low cost, allowing it to become an asset in investors' portfolios, along with gold, jewelry, real estate, equipment and implements, and liquid financial assets. Third,

14. We have also conducted a second series of exercises known as "runs tests" (see Blanchard and Watson (1982)).

Intuitively, run may be defined as a sequence of identical events followed by a different sequence of events. If a series is random, it will have neither too many nor too few runs. But in the presence of a bubble, the innovation in prices will have a skewed distribution and the number of runs will be fewer than otherwise. Therefore, if we find the number of runs in our sample to be less than those expected for a random variable, it points to the presence of price bubbles. Results from this exercise yield mixed results.

the short-run food supply elasticity is virtually zero, given production lags and nearly closed markets. Moreover, future supply is characterized by a great deal of uncertainty as a result of weather variability; at the same time, futures markets are nonexistent in Bangladesh and other very poor countries, making hedging impossible. Households are thus restricted to self-insurance in the form of private storage. Finally, public foodgrain stocks are small, resulting in a lack of faith in government price stabilization schemes.

In short, rational, stochastic food market bubbles may well have been the driving force in the 1974 famine. If so, the finding is a critical one, for more astute public policy may well have defused the crisis. The simple moral is that careful management of price expectations is a critical task in poor countries where food shortages are frequent. To prevent food-sector related disasters, public officials must closely monitor food prices to quickly detect the presence of “excessive” and destabilizing speculation. Policies can then be put in place to deflate these price bubbles in their early stages. Long-term structural policies, such as opening up domestic food markets to free international trade and building stockpiles sufficient to make price stabilization policies credible, also must be pursued. On the other hand, announcing ambitious unachievable programs serves only to undermine confidence in government, possibly making matters far worse than in the absence of any intervention.

Expectations famines can be prevented if government holds large stocks. India has done this successfully, as its apparent avoidance of famine following the 1986 crop failure has shown. But maintaining large stocks is expensive, and may not be a completely viable alternative for a country as poor as Bangladesh.

A contrasting success story in managing a potential crisis exists in the Kenyan response to widespread crop failure in 1984 (see Cohen and Lewis (1987)). Although 1984 was the year of Kenya’s worst drought in a century, resulting in less than half the anticipated maize crop during the main March-May rains, no major famine developed. The Kenyan government took prompt action to deal with the crisis. Briefly, the government acknowledged a severe shortage situation but reassured the nation that the food situation was under control. The government then swiftly drew down its own stocks, ordered commercial food imports that were to arrive as domestic public stocks were exhausted, and arranged for aid shipments to arrive when the nation’s capacity to purchase imports was exhausted. Most importantly, the Kenyan government designed coordinated stock depletion, commercial import and aid plans very rapidly once the extent of the drought was known. By securing these arrangements, proceeding with confidence and fulfilling its commitments, the Kenyan government greatly reduced incentives to hoard--thereby making its own task easier.

It remains uncertain whether the early post-Independence Bangladesh government could have intervened successfully, as Kenya is a considerably richer, more creditworthy country, as well as being more important geopolitically (making aid more forthcoming). Nonetheless, effectiveness of government response undoubtedly had something to do with the different outcomes.

The Kenyan experience is also useful to reinforce another point. Many (potential) famines do not commence as the result of a price bubble. Virtually none of those experienced in Africa in the past two decades have been attributed to excessive speculation alone, and we have no new evidence to change that record. However, once a shortage begins, many famines have the potential to be exacerbated by expectations-induced hoarding, and this is true in

Africa as well. As Cohen and Lewis (1987, pp.277-8) emphasize, the Kenyan government's alert but "low-profile" policy was efficient not only in terms of directing supplies; it also contributed to keeping the level of public concern in check.

The contrast between the 1974 Bangladesh famine and the 1984 Kenyan non-famine serves as a clear reminder of the importance of management of expectations. Food prices are only one area in which expectations tend to be rapidly self-fulfilling - capital flows and exchange rates are extremely sensitive, as is tax compliance and a host of other forces whose outcomes are jointly determined by actions of government and its citizenry. Public management in these cases must start by creating confidence: even excellent policies are largely doomed to failure if they are not accepted by a country's citizens.

Creating positive expectations that lead to virtuous rather than vicious expectations' cycles need not be mysteriously difficult. Game theory and strategic behavior models provide a sound framework for policy choice in most circumstances, and a review of the literature is unnecessary here. Rather, we will emphasize the Bangladeshi Government's clear policy mistakes - namely, that it was excessively optimistic, made commitments that it could not honor under all circumstances, and foreclosed options that would have enabled it to meet its obligations in the event of difficulties. Put differently, while hedging was impossible for most Bangladeshi citizens, it was not impossible for the Government - but the Bangladeshi Government itself took steps to prevent imports of food. This policy was highly risky, and appears to have been interpreted as so by Bangladeshi citizens, thus frightening them further and possibly fueling the bubble. Government's failure to insure itself against possible policy failure, by scheduling some imports in the event of a poor harvest or poor collection of public stocks, appears likely to have been caused by over-optimism. The outcome was a stark demonstration of the Government's incapacity, followed by collapse in its credibility.

In short, the 1974 Bangladesh famine need not have occurred. In the long run, capacity-building policies that ensure abundant food supply are necessary to permanently reduce the risk of famine. However, for countries that have not yet attained comfortable productivity levels and lack large grain stocks, public foodgrain management is of immense importance. Millions of lives lost during the Bangladesh famine could have been saved had public policy been more aware of the possibility of speculative bubbles in rice markets that may serve to exacerbate market conditions during a crisis.

Appendix

A Formal Model of Rice Markets in Bangladesh

Equation (4) is a first order stochastic difference equation which can be solved in alternate ways. An iterative procedure is used to get the following solution:

$$P_t^* = \frac{a}{(1-b)} = c \sum_{i=0}^4 b^i E_t r_{t+i} + f \sum_{i=0}^4 b^i E_t Y_{t+i} + dZ_t, \quad (6)$$

where the asterisk denotes a “particular” solution. This solution may be interpreted as the intertemporal equilibrium component of the “complete” solution. To get the complete solution, we need to add the solution of the homogeneous equation to the above solution.

The solution in (6) can be written in expanded form as:

$$\begin{aligned}
 P_t^* &= (\mathbf{a}_0 - \mathbf{b}_0)[(\mathbf{a}_1 + \mathbf{b}_1) - (\mathbf{a}_2 + \mathbf{b}_2)]^{-1} - (\mathbf{a}_1 + \mathbf{b}_1)^{-1}[\mathbf{a}_3 r_t - \mathbf{a}_4 Y_t] \\
 &\quad - (\mathbf{a}_1 + \mathbf{b}_1)^{-1} \sum_{i=0}^4 (\mathbf{a}_2 + \mathbf{b}_2)^i (\mathbf{a}_1 + \mathbf{b}_1)^{-i} [\mathbf{a}_3 E_t r_{t+i} - \mathbf{a}_4 E_t Y_{t+i}] \\
 &\quad + (\mathbf{a}_1 + \mathbf{b}_1)^{-1} (u_t - v_t). \tag{7}
 \end{aligned}$$

This is also called the “market fundamental” solution of the system. Notice that (7) does not contain a future expected price term. This term has been replaced by the future expected values of the exogenous variables and model parameters. In summary, the **fundamental component (FC)** of the complete solution involves demand and supply parameters that are related to behavioral parameters in the objective function of rational agents, the current value of the rate of return on other assets, current income, and the future expected values of these exogenous variables.

The exact form of the fundamental component will depend on the nature of the process determining the exogenous variables. Under perfect foresight

$$P_t^* = \frac{a}{(1-b)} - c \sum_{i=0}^4 b^i r_{t+i} + f \sum_{i=0}^4 b^i Y_{t+i} + dZ_t. \tag{8}$$

If U_t and V_t are nonstochastic, then P_t becomes deterministic.

If we assume r_t and y_t follow a random walk, $E_t r_{t+i} = r_t = r$, and $E_t y_{t+i} = y_t = \bar{y}$, $i > 0$ then the FC can be written simply as

$$P_t^* = (1-b)^{-1} [a - c\hat{r} + f\hat{Y}] + d\hat{Z}. \tag{9}$$

The homogeneous equation may be obtained from

$$D_t = P_t - P_t^*, \tag{10}$$

where P_t is the complete solution, and D_t measures the deviation from intertemporal equilibrium -- the fundamental component. The homogeneous equation is:

$$P_t = bE_t P_{t+1}. \tag{11}$$

It follows that

$$E_t D_{t+1} - b^{-1} D_t = 0. \quad (12)$$

A simple solution to the above equation obtained using an iterative procedure is

$$D_t = [b^{-1}]^t D_0, \quad (13)$$

where D_0 is a constant whose value is determined by the initial and terminal conditions. Equation (13) is the bubble term, and has a straightforward interpretation. The deviation of the market price from the fundamental component at time t equals the eigenvalue of the model raised to the power t , times a constant. Since in our model the root exceeds one, the deviation from equilibrium becomes larger over time, causing the market price to chart a nonoscillatory explosive path:

$$\lim_{t \rightarrow \infty} D_t = [b^{-1}]^t D_0 = \infty \quad (14)$$

The homogeneous component of market price is called a price bubble. It is based solely on forces of expectations in the market. The bubble component has nothing to do with model fundamentals, but rather feeds on the self-fulfilling dynamics of market expectations. A speculative bubble can take many different forms. The specific form in (13) is called a deterministic bubble, as its origin is determined by initial conditions, and its presence in any period is non-stochastic.

The complete solution of our system is obtained from the addition of the fundamental and bubble components

$$\begin{aligned} P_t^* &= (\mathbf{a}_0 - \mathbf{b}_0)[(\mathbf{a}_1 + \mathbf{b}_1) - (\hat{a}_2 + \mathbf{b}_2)]^{-1} - (\mathbf{a}_1 + \mathbf{b}_1)^{-1}[\hat{a}_3 r_t - \hat{a}_4 Y_t] \\ &\quad - (\mathbf{a}_1 + \mathbf{b}_1)^{-1} \sum_{i=1}^4 (\mathbf{a}_2 + \mathbf{b}_2)^i (\mathbf{a}_1 + \mathbf{b}_1)^{-i} [\mathbf{a}_3 E_t r_{t+i} - \mathbf{a}_4 Y_{t+i}] \\ &\quad + (\mathbf{a}_1 + \mathbf{b}_1)^{-1} [u_t - v_t] + (\mathbf{a}_1 + \mathbf{b}_1)(\mathbf{a}_2 + \mathbf{b}_2)^{-1} D_{t-1}. \end{aligned} \quad (15)$$

The last term is the bubble component, while the rest is defined as the fundamental component of the solution. A deviation in a period may grow over time, feeding on expectations until the fundamentals cease to provide an anchor for the market price. Consequently, a bubble component may generate a hyperinflation in the host market.

More generally, the literature on bubbles has shown that in rational expectations models we can derive an equation such as (11) by solutions to the following stochastic difference equation (Diba and Grossman (1984)):

$$D_{t+1} - b^{-1} D_t = Z_{t+1}, \quad (16)$$

where Z_t (as defined by Blanchard (1979), Blanchard and Watson (1982), and Diba and

Grossman (1984) is a random variable denoting new information which becomes available at time i to the participants. Z_i therefore satisfies the following requirement:

$$\begin{aligned} E_t Z_i &= Z_i \quad \text{for } i < t \\ &= 0 \quad \text{for } i > t \end{aligned} \quad (17)$$

The above specification suggests that new information is normally unexpected. Such shocks are called “news”, as they represent information unavailable in the previous period.

The solution to (16) can be obtained through an iterative process:

$$D_t = [b^{-1}]^t D_0 + \sum_{i=0}^t [b^{-1}]_i^{t-i} Z_i \quad (18)$$

The first term--the same as in (13)--is the *deterministic bubble component (DBC)*, while the second term involving Z is called the *stochastic bubble component (SBC)*. This term also diverges with t , but it is different from DBC in that its origin and existence each period involves uncertainty.

To summarize, in the absence of speculative bubbles, the market price equals its fundamental component. However, destabilizing speculation as represented by a price bubble is possible in storable food markets.

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