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DOES BULOG STABILISE RICE PRICES IN INDONESIA? SHOULD IT TRY?

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The intuition of economists is likely to be a poor guide to the social value of food price stabilisation, because of problems in modelling the impact of stabilisation on consumer behaviour, producer behaviour, and the macro economy, including the impact on economic growth. The potential for stable food prices to contribute to economic growth is especially relevant to the poor countries of Asia, where rice is important in macroeconomic terms. Indonesia's experience since 1959 presents an opportunity to test hypotheses about the design, implementation, and impact on social welfare of food price stabilisation. The model presented here explains Bulog's activities, and confirms that its interventions stabilise rice prices. Should Bulog try to stabilise rice prices? The answer is a clear yes in the 1970s and 1980s, but is less clear in the 1990s as Bulog's costs have risen and the share of rice in the economy has fallen.

*In a narrow sense, this paper had its origins in analysis conducted for Bulog as part of its management of the severe rice shortage late in 1994 and through mid 1995. In a broader sense, it draws on more than 25 years of experience with rice price stabilisation in Indonesia, and continuing analytical efforts to understand its rationale, costs and benefits. I would like to thank David Dawe, Wally Falcon, Jonathan Morduch, Michael Reich and participants at seminars at Bulog and Harvard for useful comments. Three anonymous referees provided comments quite critical of the approach taken in the paper. I have tried to deal with their concerns while maintaining the basic thrust of the analysis. I know they will not be entirely satisfied with the result, but the paper may help to start a public dialogue on stabilisation issues. As always, my deepest gratitude is to my wife Carol for her continued willingness to help me say things as clearly as possible. Her motto is 'if you can't write clearly, you can't think clearly!' I hope the message is clear, even if controversial or wrong. Then I will have no one but myself to blame.

Most economists think that government intervention to stabilise the price of staple foods is a bad idea. Some think it is not possible for governments to stabilise food prices for extended periods of time (Salant 1983; Ravallion 1987; Williams and Wright 1991). Some think the social benefits from stabilising prices are very small or negative (Newbery and Stiglitz 1981; Behrman 1987; Bigman, Newbery and Zilberman 1988; Newbery 1989; Braverman *et al.* 1993). And some think that institutional costs incurred in stabilising prices, including corruption and a strong tendency for stabilisation policy to be captured by vested interests that favour higher or lower prices rather than stability *per se*, are much higher than even potentially large benefits from price stability (Anderson and Hayami 1986; Knudsen and Nash 1990; Schiff and Valdes 1992; World Bank 1994). The mainstream academic literature has judged schemes to stabilise food prices as extremely difficult to implement, not worth the costs, and highly likely to be captured by special interests.

Until the mid 1980s and the onset of donor-induced structural adjustment programs, most countries simply ignored this literature. Especially in Asia, where the average consumer is still poor in relation to the rest of the world and where rice is the dominant staple food, countries have devoted considerable policy attention and budgetary resources to stabilising rice prices. Nearly all have managed to keep their domestic rice prices more stable than rice prices in the world market, and the countries most successful at price stabilisation have also been among the fastest growing economies in the world (Timmer 1992). Where food prices have not been stabilised successfully and food security remains questionable, political stability and economic growth have been threatened (Pinckney 1993). There is a real chance that economists' intuition and micro-based models designed to explain the impact of stable food prices have missed key dimensions of the contribution of stability to social welfare.

There are three basic reasons for this failure of economists to understand the widespread desire for stable food prices (Timmer 1989a; 1991): problems in modelling consumer behaviour, producer behaviour, and the macroeconomic impact of unstable food prices (Kanbur 1984). First, consumers have a preference for price stability because they do not like to incur the transactions costs of constantly changing their optimal basket of goods. Lower food prices relax the budget constraint and relieve, even if only temporarily, pressures to optimise budget allocations. Higher food prices increase that pressure, in direct proportion to the sharpness of the price increase (and the more painfully the larger the share of food in the budget). Thus consumers respond to

the prospect of changes in food prices in a highly asymmetric fashion that is poorly captured by traditional models of risk aversion. Only utility functions that explicitly recognise habit formation, decision-making costs and reference points in consumer behaviour can help model the magnitude of this effect (Kahneman and Tversky 1979).

Second, farmers should be treated as investors rather than as static optimisers of input allocations in the face of uncertain weather and prices. The formation of price expectations then becomes critical to the efficient allocation of resources over time, including investments in human capital. Highly unstable prices reduce the reliability of these expectations in signalling efficient directions for investment. The dynamic consequences of inappropriate investments, or lowered levels of investment in the face of substantial price uncertainty, can be very large, especially if growth in agricultural productivity is important to the overall growth process in poor countries (Timmer 1992; Chai 1995).

Again, traditional models of risk aversion in the choice of static resource allocations cannot capture the long-term productivity losses that occur from misallocation of investments. Indeed, most models of the impact of price instability on farmer welfare focus on short-run income stabilisation as the objective function (Newbery and Stiglitz 1981; Jones 1995). In such models, price movements negatively correlated with yield variations tend to stabilise within-year incomes, and such price instability is preferred by farmers (although farmers never prefer drops in prices).

It is important to understand, however, that price risks and yield risks are quite different, and farmers have quite different attitudes about them. Very different skills are required to cope with each. Most farmers' accumulated human capital is directed at coping with challenges generated by Mother Nature. Especially in poor countries, farmers must become skilled at such coping in order to survive.

By contrast, markets are human institutions, and the unstable prices generated on those markets can be mitigated by human interventions. At the household level, time and resources are scarce for investing in the human capital that accumulates the skills for coping with instability, whether from nature or markets. Because of this scarcity and the likelihood of increasing returns to learning how to cope with one or the other type of instability, most farmers concentrate on learning how to farm in the face of natural challenges. Governments have virtually no skills at managing these challenges. In contrast, sharp drops in market prices during harvest periods can ruin farmers in need of cash. Such

drops can be prevented by the government if it defends a floor price.[1] But in order to establish the rationale for government action, farmers and consumers must rely on a political process to reveal to policymakers their preference for a price stabilisation policy. The only market for price stability is political.[2]

Consumers have a strong aversion to sharp increases in food prices, especially during the 'short season' before a new harvest begins. Farmers have a strong aversion to sharp falls in food prices, especially during the peak of the harvest season. A politician or government planner should easily realise that a price stabilisation program with guaranteed floor and ceiling prices would address directly both consumer and farmer concerns. If these prices also squeezed the average margin between the seasonal low and high price, the program would be even more popular, especially if the ubiquitous 'middleman' could be stuck with much of the cost.[3] The key questions for the government will be whether such a price stabilisation scheme can be implemented successfully, at what budgetary and economic cost (including the deadweight efficiency losses caused by the taxes needed to pay the net costs of the government), and whether the resulting stable prices contribute in a positive manner to economic growth.[4]

The third reason economists have not understood why governments wish to stabilise food prices is their failure to model this potential connection between stable food prices and economic growth, a connection mediated by macroeconomic factors rather than the

[1]A well-functioning rural credit market would obviate some of the concern farmers have over unexpectedly low prices at harvest, but building such markets is an extemely lengthy process and is subject to inherent market failures because of asymmetric information, moral hazard, and high transactions costs. A floor price scheme may then be an optimal second-best approach.

[2]The failure of the private insurance market to provide a cost-effective floor price to individual farmers is one of the topics discussed in the exchange between David Dawe and Chris Jones in this issue.

[3]See Timmer, Falcon, and Pearson (1983), ch. 4, for an analysis of the widespread desire to squeeze the middleman. The unexpected costs to the government of conducting such a squeeze are modelled in Timmer (1986b).

[4]There is a substantial literature on the failures of parastatals in agricultural marketing The special issue of *Food Policy* edited by Kay Muir-Leresche and Alberto Valdes (vol. 18, no. 4, August 1993) on 'Regional Market Integration and Trade in Southern Africa: The Effects of Agricultural Liberalisation and Market Reform' is an excellent introduction to this literature.

microeconomic factors analysed in producer and consumer decision making. The potential for stable food prices to contribute to economic growth is especially relevant in Asia, where rice is important in macroeconomic terms, at least in poor countries. At the beginning of the modern growth process in Indonesia in the mid 1960s, rice accounted for one-quarter of GDP and one-third of employment. Instability in rice prices caused macroeconomic instability, and there is little quarrel that a causal connection exists between such instability and lower economic growth (Barro and Sala-i-Martin 1994).[5] Obviously, rich countries have such diversified economies that no single commodity can have much macroeconomic impact (although petroleum prices can still send noticeable ripples through even the United States economy). But poor countries remain heavily dependent on their staple food for caloric intake, jobs and general economic activity. It seems likely that stabilising the price of this staple food should contribute to economic growth if the stabilisation program is effective and efficient.

Indonesia is one of the best cases for testing hypotheses about the design, implementation, and impact on social welfare of food price stabilisation. After more than 20 years of economic and political instability under President Sukarno, an entirely new approach to the economy was introduced in the late 1960s by the 'New Order' regime of President Soeharto. A key element of this approach was heavy investment in the rural economy, especially to increase rice production, and sustained efforts to stabilise rice prices (Mears and Afiff 1969; Timmer 1975). From 1969 to 1990 these efforts were highly successful. Rice production rose 4.6% per year, significantly faster than the 2.1% growth in population over the same period. And domestic rice prices were considerably more stable than prices on the world market (figure 1).[6] Most Indonesians believe this successful performance of the rice economy was a significant contributor to the country's rapid economic growth since the late 1960s.

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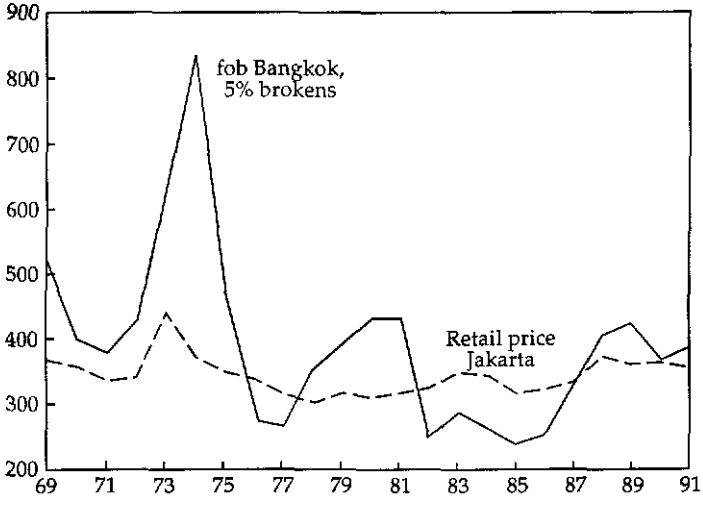
[5]Dawe (1993; forthcoming) demonstrates that price instability for commodities with macro significance, such as export commodities that form a significant share of GDP, causes lower economic growth.

[6]Figure 1 shows price data only through 1991. After that time, Thai 5% brokens no longer served as the standard quality reference, and a sharp divergence appeared between the published price quotations shown in figure 1 and actual export prices. See figure 2 for price data from 1991 to 1995 based on actual export prices.

FIGURE 1 *Indonesian Domestic Rice Prices and International Prices (constant 1985 Rp/kg)*



Source: Dawe (1993).

It is surprising, then, that the only published quantitative assessment of Indonesia's effort to stabilise rice prices asserts that it raised risks for farmers (and taxpayers) and would have had a negative impact on farm welfare if average prices had not also been increased through the buffer stock scheme operated by Bulog, the National Food Logistics Agency (Jones 1995).[7] Although Jones's assessment acknowledges that Indonesia's rice prices were more stable than the prices of comparable qualities of rice in world markets, there is little doubt that he sees the benefits from this stability as small or even negative. Whenever domestic prices fail to follow border prices, there will always be short-run efficiency losses of the sort identified in the border price paradigm

[7]A price stabilisation scheme that is implemented by squeezing the full seasonal price rise between a floor price and a ceiling price will raise the average price received by farmers at the same time the scheme lowers the average price paid by consumers. Indonesia's scheme for stabilising rice prices works in such a manner (Timmer 1986b).

(Timmer 1986b). These losses are the main reason most economists doubt the efficacy of price stabilisation schemes in the first place.

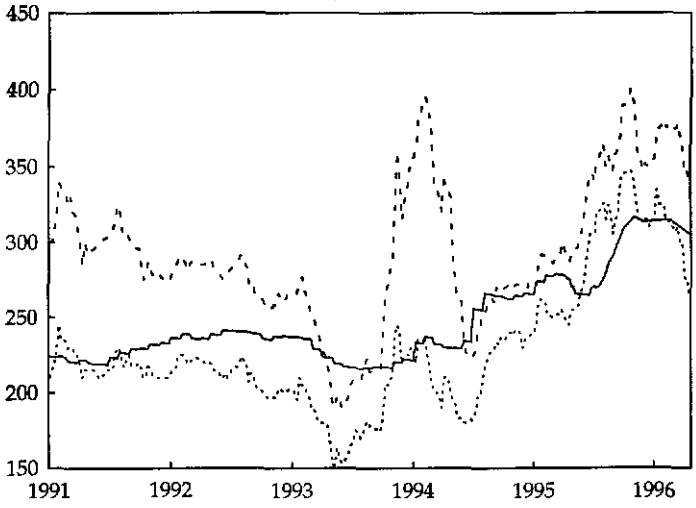
Not surprisingly, the benefits and costs of Bulog's efforts to stabilise rice prices have been the subject of considerable domestic debate, both within the Indonesian government and among local analysts, including the press. Events in the Indonesian rice economy in the first half of the 1990s—and parallel events in the world rice market—stimulated this debate and forced Bulog to reassess its role in the Indonesian economy. In particular, the rice surpluses in 1992 and 1993 that were managed by subsidising exports raised serious questions about Bulog's cost structure and its long-run role in the rice economy (Timmer 1994). The drought during the dry season in 1994, and the resumption of large-scale imports late in 1994 and throughout 1995, raised questions about Bulog's ability to stabilise rice prices even in the short run (Timmer 1995a).

BULOG'S ROLE IN STABILISING RICE PRICES

Since the mid 1980s, Indonesia's rice economy has been subject to repeated cycles of surpluses and deficits. The large deficit in rice in 1994 raised serious doubts that self-sufficiency on trend could be maintained. As the domestic rice economy has become more unstable, the international rice market has also been subject to substantial fluctuations. Some of the price variations were caused by Japan's sudden emergence as a large importer in 1993. Some were caused by Indonesia's unexpected exports in 1993 and imports in 1994 (figure 2). The doubling of prices for high-quality rice in late 1993 was driven by the severe drought in Japan in 1993 and that country's decision to import more than two million tons of rice. When the drought in Indonesia in 1994 led to more than a million tons of imports, mostly of low-quality rice, the relative price of high-quality to low-quality rice dropped from its peak of 1.75 in early 1994 to less than 1.2 by late in the year. Both the level of prices in world markets and their structure have been very unstable during the first half of the 1990s.

In the face of all this instability, both domestic and international, Bulog's task of stabilising the price of rice in domestic markets has become more challenging. This is especially so because relatively little is known about the long-run functional relationships that mediate the quantitative impact on domestic rice prices of Bulog's activities in the rice market, such as market operations (i.e. sales) or domestic

FIGURE 2 *Rice Prices in Bangkok and Indonesia, Weekly, from January 1991 to April 1996*[a]
($ per metric ton)



Average retail price in Indonesia, minus $60 per ton (to convert from retail domestic price to fob Bangkok equivalent)

- - - - Thai 100Bs (high quality)

····· Thai 35% broken (low quality)

[a]Thai prices are based on actual export contracts.

Source: Bulog.

procurement. Without this knowledge, it is very difficult to plan Bulog's logistical activities more than a month or two in advance. A short planning horizon creates serious problems for Bulog in carrying out its stabilisation functions effectively and efficiently.

These problems arise from the substantial time that elapses between the determination of the need for rice imports, the granting of permission for Bulog to execute contracts to import, and the rice becoming available for market operations or distribution to the Budget Groups. In the face of the time required for each of these logistical steps and the instability

being experienced in the world rice market, the need for a longer planning horizon for Bulog's activities is clear.

A SIMPLE MODEL OF BULOG OPERATIONS

The simple model presented here has two functions. First, it begins to generate the quantitative relationships needed to understand Bulog's impact on the rice market, and thus to improve its planning ability. Second, the model assumes that Bulog's physical interventions in the rice market are motivated by its charge to stabilise rice prices at levels determined exogenously by the government (in fact, by the President personally); thus, if it is successful in explaining Bulog's activities, the model will be a reasonably powerful test of whether the agency's interventions do stabilise rice prices. Such a test is an important link between the clear statistical evidence that domestic rice prices are more stable than equivalent prices in the world market, and the level of Bulog interventions in the domestic market. Only a model of these interventions can plausibly claim to establish causality between Bulog's actions and stability in rice prices.

The model is also designed to quantify the relationship between the level of trade in rice and the interventions Bulog must carry out in order to stabilise rice prices. Thus it does not assume, for the long run, a closed rice economy based on self-sufficiency, nor does it assume that rice prices are held completely constant in the short run (prices can obviously move seasonally within the price band). In fact, rice prices are included directly in various components of the model so that it is possible to examine the tradeoff between restrictions on imports and increases in the real price of rice. In the extreme, the model can be used to examine the question 'what price self-sufficiency?' The answer to this question also helps answer another: 'should Bulog try to stabilise rice prices?'

There are two major sources of instability in the Indonesian rice economy: fluctuations of rice production around its trend; and fluctuations in the world price of rice that would be passed into the Indonesian economy if free trade were permitted. Because Indonesia has had a longstanding policy of following the long-run trend in the world price of rice, domestic rice prices are not supposed to deviate from world prices for extended periods of time. Although Bulog is charged to stabilise domestic rice prices, the price targets must be set with enough flexibility to ensure that large differences between domestic and world prices do not persist for years. Any model of Bulog interventions in the

domestic rice economy must recognise this need for some flexibility in rice prices, and thus incorporate the real level of rice prices in the model as well as the quantities of rice that Bulog handles.

The structure of the model is straightforward, and it is estimated on the basis of annual time series data that are readily available in public sources.[8] It has three basic components:

- an equation used to generate a measure of instability in domestic production, especially in relation to the expectations of private sector traders. This instability measure is based on a price-corrected time trend of production (PROD). This trend equation, corrected for autocorrelation, is used to generate residuals from the 'predicted' level of production. These residuals serve as a physical measure of instability that is incorporated in subsequent equations. The inclusion of the real price of rice (DRICEP) in this equation allows these residuals to be net of expected supply response to changes in price in the short run;
- an equation for domestic procurement (PROC) by Bulog that is based on current levels of production (PROD), deviations from the expected level of production (PRRPAR1), deviations in the previous year (PRRPAR1(–1)), and the adequacy of Bulog's stocks at the beginning of the procurement season (RELSTK2); and
- an equation for market operations (MO12APR) by Bulog, which is based on supply, demand, and price relationships in the domestic market.[9]

The logic behind the use of these three equations as the basis for modelling Bulog's efforts to stabilise rice prices is straightforward. In a

[8]The appendix contains the time series used to estimate the equations reported in this paper. Most readers of this journal will be aware of the significant difficulties with many Indonesian statistical series. The production data are the most questionable of the series used here, as the Bulog-reported operational data are quite reliable.

[9]The production and procurement equations are based on calendar year data; the market operations equation is based on data from April to March of year t to $t + 1$ (hence the name MO12APR). The difference in timing of domestic procurement and market operations is an important reason why a single 'net procurement' equation cannot be used to understand Bulog's impact on the rice economy.

market economy, prices can only be stabilised by interventions that add to market demand when prices would otherwise be 'too low', and that add to market supply when prices would otherwise be 'too high'. Deciding the level of this price band, and its width, requires a blend of technical analysis and political judgment, and many countries have failed badly in getting this blend right. 'Getting prices right' is complicated (Timmer 1986a, 1986b). Indonesia, however, has managed this part of the stabilisation process quite successfully (Timmer 1989b, 1991).[10]

The logistical tasks of price stabilisation must then be carried out within the policy mandate dictated by the announced price band and level. Because Bulog has monopoly control over rice trade (at least when domestic prices do not deviate too far from world prices and thus when smuggling is not a problem), determination of domestic prices in the short run is influenced almost entirely by the level of domestic supply in relation to domestic demand. That is, in the short run, Indonesia's rice economy is closed.[11] Any deviation in monthly demand from monthly harvests must be met by building up or drawing down stocks, in the hands of either the private sector or Bulog. Building up stocks through domestic procurement from rural markets (PROC) or drawing them down through urban market operations that supply rice to markets (MO12APR) are the only two means that Bulog has to influence the domestic price of rice. If these activities are carried out in a manner consistent with smoothing the instability in the 'real' rice economy, the model argues, Bulog is successfully stabilising rice prices.

Instability in Rice Production

Rice production is estimated as a supply function using the current real price of rice (DRICEP), plus a time trend and a one-period

[10]All three external reviewers of this paper challenged the notion that other countries might be expected to be successful at these difficult tasks. Certainly the historical record is littered with failures and abuses. That several Asian countries have been successful in stabilising food prices is no reason to expect that the skills are transferable to Africa, Latin America (or even the Philippines, which has also failed badly at this task). On the other hand, the failures of other countries are not a reason to prevent Indonesia from stabilising its own food prices if it can do so in a cost-effective manner.

[11]The rice economy is also 'closed' in the sense used by trade economists, in that changes in the world price do not 'pass through' to have an impact on the domestic price. Thus estimating an import demand equation makes little economic sense.

autoregressive term to compensate for the strong autocorrelation in the residuals (these are estimated in TSP by using an AR(1) variable). The residuals from this equation (called PRRPAR1) are then used in the equation that predicts the level of domestic procurement by Bulog. The statistical results for this production equation are shown as equation 1 of table 1. Because the model presented in this paper attempts to explain only Bulog operations, not the entire Indonesian rice economy, the supply function itself is of little direct interest.

However, the annual residuals from the production equation (shown in the data appendix) are important explanatory variables in the model of procurement. A price-adjusted time trend is plausibly a simple mechanism by which private traders form expectations about likely levels of production, and deviations from this trend should capture the unexpected volume of production for which Bulog might be called upon to provide compensatory stock adjustments in order to keep prices stable.

Domestic Procurement

The procurement model has four components plus an autoregressive term, as shown in equation 2 of table 1. First, production is expected to influence procurement in the same year. On average, according to the estimates, about 8.2% of each year's rice production is purchased by Bulog as part of its effort to defend the floor price for rice (holding other elements of the model constant).

The second factor influencing procurement is the extent to which rice production in the same year deviates from its 'expected' level—that is, the size of the production residual. Large positive deviations should lead to larger Bulog procurement; large negative deviations should cause procurement to fall if Bulog is serving to defend a floor price rather than operating under quantitative procurement targets. There is scope for using other trends to identify this residual. However, the goal should be to find a production trend that captures the expectations of market participants in such a way that the residuals will be successful in explaining Bulog procurement. The model reported here meets this test extremely well.

Equation 2 (table 1) implies that on average 45.7% of the residuals (denoted 'PRRPAR1')—both positive and negative—from our estimated production equation (i.e. equation 1 in table 1) are procured by Bulog in the current year. Note that current-year deviations are five times as important in explaining variations in Bulog procurement as the production level itself. The statistical significance of the coefficient is

TABLE 1 *Estimates for Components of the Bulog Model*[a]

Independent Variable	Equation Number, Estimation Technique and Dependent Variable			
	(1) OLS PROD	(2) OLS PROC	(3) OLS MO12APR	(4)[b] TSLS MO12APR
CONSTANT	−47,189	−452.0	−8,681.8	−9,268.1
	(4.13)	(3.68)	(2.08)	(1.97)
TIME	796.3		264.8	271.8
	(5.98)		(4.11)	(3.91)
DRICEP	5 775		−3.345	−2.943
	(1.75)		(2.27)	(1.40)
DRICEP(−1)			−4.119	−4.212
			(3.14)	(3.10)
PROD		0.082	−0.351	−0.361
		(14.8)	(4.11)	(3.88)
PROC			0.405	0.420
			(2.10)	(2.09)
PRRPAR1		0.457		
		(8.30)		
PRRPAR1(−1)		0.240		
		(2.87)		
RELSTK2		−306.3		
		(1.96)		
AR(1)	0.794	−0.478		
	(4.57)	(2.24)		
Adjusted R^2	0.983	0.911	0.740	0.739
Durbin–Watson statistic	1.60	2.18	2.56	2.59
Number of observations	25	24	25	25

[a][t]-statistics are in parentheses.

[b]Instruments for DRICEP in equation 4 are RELSTK2 and CPI, as well as the other exogenous variables in equation 4.

high. Bulog's procurement activities are clearly acting to stabilise supplies of rice in rural markets. It buys when production is in 'surplus'; it refrains from buying when production is in 'deficit'.

The third element of the procurement model is the size of the production deviation in the previous year. This variable is included to reflect the need to build up (or run down) stocks held by farmers and traders. In 1994, for example, drought depressed the harvest, and the production residual was –2.05 million metric tons (mmt) in the price-based supply model shown in table 1. Such a sharp drop in production below the expected trend was likely to have depleted the private stocks of farmers and traders. Bulog would then have had to compete with the private demand to replenish these stocks in 1995. The impact of this demand for private stocks is captured by including the estimated production equation residual from the previous year in the procurement model for the current year. Put differently, two good (or bad) years in a row affect procurement in a significant manner.

The production deviation in year $t-1$ is quite important quantitatively and is statistically significant. On average, 24% of the production deviation in the previous year in the production model is procured by Bulog, a figure only somewhat smaller than that for the deviation in the current year. The significance of the lagged production residual in the procurement model reflects the large role of the private sector in rice marketing in Indonesia and the crucial part that changes in private stocks play in stabilising prices.

The fourth element of the procurement model is the volume of stocks in Bulog's warehouses at the start of the fiscal year, April 1, when domestic procurement begins to intensify on Java. If warehouses are full, or supplies are large in relation to expected needs for the coming 12 months, Bulog procurement activities might be less aggressive, and quality standards could be raised to permit Bulog's local buying agents to reject a larger share of supplies offered for sale at the floor price. In contrast, when warehouses are empty, special campaigns can be mounted to procure additional supplies. Quality standards are lowered, additional transportation allowances are paid, and rice millers are pressured to sell supplies to Bulog. The variable used to measure this effect, RELSTK2, is the ratio of stocks on April 1 to total supplies needed for distribution to the Budget Groups in the coming 12 months plus the level of market operations in the previous 12 months.

The coefficient on RELSTK2 is expected to be negative if Bulog reacts to varying levels of stocks in the manner suggested. Such behaviour is not, of course, consistent with operations needed to

stabilise rice prices. Instead, a significant negative coefficient would indicate that Bulog still operates to some extent as a supply agency dedicated to provisioning civil servants and the military, tasks that dominated the early years of its existence (Timmer 1975). The coefficient on RELSTK2 in the PROC model in equation 2 is negative and nearly significant, suggesting that Bulog has not completed the transition from a logistics agency driven by quantity targets to a pure price stabilisation agency. However, the impact of this behaviour has not been large in relation to normal levels of procurement. A change of one standard deviation in RELSTK2, for example, would change expected procurement by less than 100,000 tons.

The procurement model does not have a term that captures the margin between the floor price that Bulog is charged to support and market prices in urban locations that the private sector supplies. There is no question that when the floor price has been set 'too low', Bulog is unable to buy very much rice because the private sector finds it profitable to purchase everything offered in the market. But over the 26-year history incorporated in the model, policymakers have been quite successful in keeping the floor price at a level that reflected long-run parity with the world market. Accordingly, there has been little opportunity for the margin between the floor price and urban retail prices to be an important determinant of Bulog procurement, and hence its effect does not show clearly in the statistical record.

In addition, production residuals are derived from a price-based supply model, and this price effect might contribute to the margin term's being insignificant. Much of the price effect has already been captured in the short-run supply response incorporated in the production model. When the price term is omitted from the production model, a margin term then becomes significant in the procurement model. Research is still under way to find a better-defined margin variable, which should be more successful even when price response is built into the production model. More attention to regional variations and monthly patterns may be needed for this approach to work.

Market Operations

The third component of the model is market operations. These have the highest variance of all the elements of Bulog's activities, and market operations are the hardest to predict. The model shown in equation 3 of table 1 has five elements, all of which are highly significant. Still, the overall equation explains less than 75% of the variance observed in market operations between 1969 and 1994.

The components of the model of market operations are simple. First, time is included to capture the impact of growing incomes and population. Second, production in the current year is included on the assumption that higher production in a year leads to lower market operations, as the private sector has access to domestic supplies to meet a greater proportion of consumers' needs.

Third, procurement in the same year is included to reflect the stabilisation role that Bulog plays in seasonal price formation. If Bulog is successful in narrowing the margin between the floor price and the price at *paceklik* (the pre-harvest period of highest prices), some of the rice procured in defending the floor price has to be injected into markets to keep urban retail prices from rising too high. The equation implies that, for given levels of real prices and production, higher procurement leads to increased market sales by Bulog.

Fourth, the real rice price for the current year is included to capture the impact on Bulog of changes in retail rice prices, when other variables in the equation are held constant.[12] In addition, higher market prices for rice should lower demand, as consumers substitute cheaper commodities in their consumption bundle. With lower market demand (caused by higher market prices), market operations by Bulog can be less extensive, but stability can still be maintained at the new, higher price level.

This consumption effect is also likely to be felt with some lag, as consumers are not immediately responsive in a flexible fashion to changes in rice prices, especially at higher levels of per capita income. The specification shown in table 3 includes the price lagged one period. Both price terms are highly significant and similar in magnitude: the coefficient on DRICEP is -3.3 and on DRICEP(-1) is -4.1.

[12]If the annual rice prices that Bulog is ordered to defend are determined by policy, they are statistically exogenous, and equation 3 is correctly specified. An alternative interpretation of policy would have prices and the level of market operations determined simultaneously. Then the market operations equation should be estimated with a technique such as two stage least squares (TSLS). As equation 4 in table 1 indicates, the results of doing so, using the consumer price index (CPI) and Bulog's opening stock position (RELSTK2) as instruments, leave all non-price coefficients (and their interpretation) little changed. Even the price coefficients are similar in magnitude, although the significance of DRICEP is reduced below normal levels of confidence.

WHAT DOES THE MODEL TELL US?

This relatively simple model of Bulog's role in the Indonesian rice economy has surprisingly robust estimated coefficients in equations based on the hypothesis that Bulog's interventions are designed to stabilise rice prices.[13] In total, these results are strong confirmation that Bulog has acted as a price stabilisation agency since 1970. There are, of course, years when Bulog's interventions were not entirely successful: 1973 and 1988, for example, when prices increased too much; and 1985 when prices fell too far. But, on average over the entire time period, the statistical model presented here is strong evidence that Bulog carried out its price stabilisation role successfully.[14]

The model is not entirely appropriate for planning purposes, however. An annual time horizon is too long for all but the roughest of strategic planning, and a monthly or quarterly model would be much more useful. The data exist to build such a model, but the difficulty of specifying the formation of prices seasonally as well as inter-annually is a roadblock to developing such a model.[15] In addition, the clear importance of current and lagged production residuals in determining the level of domestic procurement emphasises the need to understand the factors that influence private stockholding, especially among farmers and traders (Ellis 1993). It should be possible, with some ingenuity, to fashion a time-series index of private stocks from the information contained in the role of the lagged production residual in determining domestic procurement, and this index could be the basis for further research on stockholding behaviour.

The variables that determine Bulog's success or failure in price stabilisation are included in the model. Thus its strength, even as it stands, is that by clarifying the role of these variables the model can help Bulog to focus its planning efforts on price stabilisation and continue to move away from being a quantity-oriented logistics agency.

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[13]The coefficients in both the procurement and market operations equations change little if the sample is restricted to the 1969–92 period.

[14]Lest the argument be misinterpreted, the evidence presented here is not a defence of all the myriad Bulog interventions in the Indonesian food economy. Indeed, the author is well known within Bulog for longstanding concern that the agency act only to stabilise rice prices. This debate has surfaced occasionally in public discussion (for example, Timmer 1987).

[15]Timmer (1995b) constructed a monthly model of Bulog's market operations, which utilises accumulated experience month-by-month to improve progressively the forecast of total market operations for the fiscal year.

It is more difficult to make progress in understanding the contribution of price stability to social welfare, and none of the econometric results presented so far speaks to this important issue. As was noted in the introduction, this is a topic of longstanding analytical interest to economists. Indonesia is likely to be a proving ground for examining the hypothesis that society places a large premium on stability of food prices for reasons that are not clearly apparent in economists' models of the impact of price stabilisation policies. If both producers and consumers demand price stability, there should be a way of including this desire in the specification of their welfare functions, and of testing empirically which models and specifications best explain actual behaviour with respect to changes in prices. This approach involves macro dynamics and political economy, not just narrow microeconomics.

THE BENEFITS FROM STABILISATION OF THE RICE ECONOMY

Rice price stabilisation confers several benefits. It reduces the risk rice farmers face in making productive investments. This encourages them to make larger investments in innovations and new technologies that increase the productivity of rice farms. A significant component of these investments goes to rural human capital, which is important in the overall process of economic growth (Chai 1995).

Consumers also benefit from stable rice prices because they do not have to incur the transactions costs of reallocating their budgets frequently, nor face the risk of sudden and sharp deterioration in their real income. This benefit accrues disproportionately to the poor because they spend a larger share of their budgets on rice and because they react more sensitively to price changes than do the rich (Timmer 1981). Benefits to consumers from rice price stabilisation thus have a significant equity dimension, and stabilisation plays an important role in alleviating poverty.

The Macroeconomic Impact of Stabilising Rice Prices

An important class of benefits is macroeconomic in nature. Rice price stabilisation affects investment and growth throughout the entire economy, not just in the rice sector. These effects have been significant in the past because rice constituted such a large share of the Indonesian economy and because world rice markets were so unstable.

If Bulog did not stabilise rice prices effectively, one effect of the instability would be to increase the level of precautionary savings in the economy (Deaton 1992). Consumers would save to protect themselves against the effects of a possible increase in the rice price, while farmers would save to insure against a sudden drop in the rice price. These precautionary savings would need to be kept in liquid form so that they could be called upon in the event of a sudden change in rice prices. If these extra savings were deposited with financial intermediaries and channelled to productive investments, instability would have the potential to be beneficial, not harmful, to growth.[16] If the savings were held as gold, cash, or other highly liquid instruments, growth would stagnate. Because of the need for precautionary savings, therefore, instability would increase aggregate savings and at least some forms of investment (depending on the efficiency of financial intermediaries). The right kinds of investment could stimulate economic growth if price shocks were localised.

The quantity of investment is not, however, the only determinant of growth. The efficiency, or quality, of that investment is equally important. Rice price instability can affect the quality of investment in at least two distinct ways. When rice prices increase (owing to a poor harvest or an increase in world prices), consumer expenditures on rice also increase, because demand is price inelastic—that is, the pecentage price increase is greater than the percentage decline in the quantity consumed. The increase in expenditures on rice causes expenditures on other commodities to fall, which lowers demand for all other commodities in the economy. The opposite occurs in the event of a good harvest, when consumer expenditures on rice decrease. This reduction causes demand for other commodities to increase temporarily, putting upward pressure on prices in other sectors. Over time, if rice is an important commodity in macroeconomic terms and the rice market is geographically integrated, instability in rice prices causes instability in all other prices in the economy.

These 'spillover' effects from the rice economy into other sectors have two separate consequences. First, risk is increased in all sectors, because non-rice prices fluctuate more than if rice prices were stable. Second, the price changes that occur throughout the economy contain

[16]Such potential could be realised only if price shocks were localised and not a feature of the macro economy. With relatively well-integrated rice markets, most price shocks will be economy-wide rather than local. Even good financial intermediation could not mediate such economy-wide shocks.

relatively little information about long-run investment opportunities—a classic example of a 'signal extraction' problem (Lucas 1973).

The fundamental role of relative prices in a market economy is to serve as signals for allocating both consumption and investment resources. If demand curves shift because of sustained growth in incomes or a change in consumer preferences, or supply curves shift because of changes in technology, then relative prices should change accordingly. These price changes convey information to investors about fundamental shifts in expected returns on investment opportunities, shifts that should lead to a reallocation of investment. If prices are changing frequently in various sectors throughout the economy because of temporary fluctuations in the rice harvest, however, price changes will convey less information about attractive opportunities for long-run investment than they would if rice prices were stable. Investors will become confused about the information contained in prices, and their investments will not flow to the sectors with the highest returns. In short, the rate of return on investment will decline, and economic growth will suffer.

The quality of investment might decline for another reason. If spillovers from the rice sector increase risk throughout the economy, investment is biased toward more speculative activities and away from fundamentally productive activities, such as investment in machinery and equipment, or away from investments in the long-term development of human capital. Both the latter types of investment are closely associated with higher rates of economic growth (De Long and Summers 1991).

Consequently, instability in the rice sector can have three important macro-level effects. It can *increase* precautionary savings and thus the quantity of investment. It can *decrease* the quality of investment (rate of return) because prices contain less information that is relevant for long-run investment. Finally, because of spillovers creating additional risk throughout the economy, instability can induce a bias toward speculative rather than productive investment activities and thereby reduce economic growth.

Empirical Evidence Relating Price Instability and Economic Growth

Historical data offer empirical evidence about these effects. Dawe (1993; forthcoming) analyses these data with respect to instability of export earnings as a share of GDP from 1970 to 1985 for 85 countries (table 2). The results support the theoretical arguments presented above. Higher export instability (caused mainly by variations in export prices)

TABLE 2 *Regression Results for Investment and Growth*[a]

Independent Variables	Dependent Variable	
	INV	Growth, 1970–85
CONSTANT	0.152	0.0259
	(0 027)	(0.0091)
PRINVCON	–0.0536	
	(0.0125)	
INV		0.113
		(0.026)
GDP70		–1.261
		(0.237)
PRIM60	0.0848	
	(0.0193)	
SEC60	0.0927	
	(0.0394)	
EXIN	1.280	–0.375
	(0.327)	(0 119)
STDINF		–0.0209
		(0.0055)
GOVCON		–0.133
		(0.038)
Adjusted R^2	0.708	0 386
RMSE	0.041	0.015
Number of Observations	85	85

[a]Definitions (for sources and definitions of the first 4 variables below, see Summers and Heston 1991)·

INV = Average investment share of GDP from 1970 to 1985;
Growth, 1970–85 = Annualised growth rate of GDP per worker in international prices, 1970–1985;
GDP70 = Level of GDP per worker in 1970 (in thousands of 1985 international dollars);
PRINVCON = Relative price of domestic investment to domestic consumption (US = 1);
PRIM60 = Primary school enrolment ratio in 1960;
SEC60 = Secondary school enrolment ratio in 1960;
EXIN = Export instability from 1968 to 1982 (deviations from a five-year moving average normalised by GDP);
STDINF = Standard deviation of rate of inflation from 1968 to 1982;
GOVCON = Barro's index of market distortions.
White-corrected standard errors are shown in parentheses.

Source: Dawe (1993).

is associated with increased investment. After controlling for the quantity of investment, export instability *decreases* the efficiency of investment. Both effects are statistically significant and robust to changes in the specification of the regressions (in the Levine-Renelt sense of robustness in growth equations). The net sum of these two effects is negative—that is, on balance, instability in export prices, when exports are measured as a share of the total economy, leads to a slower rate of growth.[17]

It is interesting, if somewhat controversial, to apply the parameters estimated in these regressions to rice in Indonesia. The logic for doing so is as follows: when the rice economy as a share of GDP is unstable because of unstable prices, the relative impact on the macro economy will be similar to the shocks to the economy from unstable export prices, for the same share of exports in GDP. In fact, the impact of unstable rice prices should be greater than a similar instability in export prices because rice prices also have a large weight in the consumer price index. As the growth equation in table 2 indicates, instability in inflation has an independent and negative impact on the rate of economic growth. Thus using only the net coefficient (after allowing for the larger investment induced by price instability) of the impact of export price instability on growth should yield a lower bound for the impact of unstable rice prices on growth.

Using this net coefficient, one can generate rough measures of the quantitative impact of Bulog's rice price stabilisation activities on the historical rate of economic growth in Indonesia (table 3). These numbers reveal two important facts: Bulog made large contributions to the growth process over the last 25 years by stabilising rice prices; and Bulog's role in the growth process has declined in importance over time.

The contribution of Bulog's rice price stabilisation activities in the early years of the New Order regime was very large. During Repelita I, from 1969 to 1974, the rice price stabilisation program alone generated nearly one percentage point of economic growth each year, which was

[17]One reviewer of the present paper suggested that the negative effect of export instability on GDP growth estimated by Dawe might have resulted from econometric biases. However, nearly all modern growth accounting has found a positive relationship between growth in exports and growth in GDP, rather than the negative relationship posited by the reviewer. Accordingly, the negative relationship between economic growth and export instability established empirically by Dawe is all the more significant.

TABLE 3 *Contribution of Bulog's Rice Operations to Economic Growth in Indonesia*

Period	Growth of Indonesian per Capita GDP	Growth of per Capita GDP Due to Bulog (% per year)	Share of Growth Due to Bulog
1969–74	5.96	0.98	16.4
1974–79	4.51	0.61	13.5
1979–84	4.17	0.28	6.7
1984–89	3.42	0.27	7.9
1989–91	5.01	0.19	3.8

Source: Calculations using data from Bulog; table 2.

more than one-sixth of the total increase in output during that period. In the second Five-Year Plan, from 1974 to 1979, the contribution was 0.61% per year, or 13.5% of the total growth in per capita income. In absolute terms, rice price stabilisation contributed more than $300 million (in 1991 dollars) per year to increased output in the first Five-Year Plan and more than $270 million in the second. These estimates are lower bounds, because they do not credit the rice price stabilisation program with any benefits from enhanced political stability and the resulting confidence felt by investors. Also, as noted, these estimates do not include the direct contribution of rice price stabilisation to reduced variance in the rate of inflation (which enters separately in the regressions shown in table 2).

The second important fact, however, is that the benefits from stabilising rice prices have fallen markedly over time. By the middle of the fifth Five-Year Plan, in 1991, stabilisation activities contributed only 0.19 percentage points a year to economic growth, just 3.8% of the total increase in per capita income during that period. Because the Indonesian economy was much larger, the absolute contribution to increased output did not fall nearly so fast, and this contribution still averaged more than $180 million per year between 1989 and 1991.

The decline in benefits from stabilising rice prices has occurred mainly because the share of rice in the economy has fallen over time, and this decline has reduced the importance of spillovers from rice into other sectors of the economy. In other words, the impact of rice price stabilisation on investment and economic growth declines as per capita income increases. Still, when instability in both the domestic and world rice economies is as great as in the mid 1990s, unstable rice prices are capable of slowing the rate of economic growth significantly.

To illustrate how these calculations were carried out, the relevant coefficients in the equations in table 2 add up to a net reduction of 0.23% per year in the growth rate of GDP for every percentage point increase in export instability as a share of GDP.[18] If the instability in world rice prices seen from 1993 to mid 1995 (figure 2) had been transmitted to the Indonesian economy, the increase in price instability would have been dramatic—a doubling of the coefficient of variation of domestic rice prices from 9.1% to 18.6%, or an increase of 9.5 percentage points. Even with the small share of rice in the Indonesian economy in the early 1990s, which comprises only 7.2% of the consumer price index, the impact on economic growth of a doubling in rice price instability would not have been trivial.

Using Dawe's coefficient, Bulog's contribution to economic growth through stabilisation of rice prices during the 1993–95 period was $200–300 million per year, a magnitude similar in absolute value to that of its contribution in the early years of the New Order regime in the late 1960s. As a share of the economy, the contribution is less than 0.2% of GDP instead of almost 1%, but rice has a diminished share of an economy that has grown to be very large.

Between 1969 and 1995, Bulog's stabilisation of rice prices contributed on average approximately 0.5% per year to Indonesia's economic growth, leaving total GDP more than 11% higher at the end of the period than it would have been without the stabilisation program. Of course, this contribution is now built into the Indonesian economy, and those historic benefits continue to be reaped by the current population. But the contribution each year is clearly on a declining trend, and the important question for current policy is whether this contribution is still worth the cost.

[18]The impact of instability on investment is 1.28 times the impact of investment on growth of 0.113, which equals 0 145. Added to the negative direct impact of price instability on growth of –0.375, the net impact is –0.23.

Disentangling the costs of price stabilisation from the costs of Bulog's other myriad activities is no easy task, and at least one reviewer thought it was foolish to try (or to claim to have done so). Estimates of Bulog's costs for stabilising rice prices in the 1970s, when variable imports were used as the 'balance wheel' to stabilise supplies in the market, are less than $50 million per year (in 1991 dollars). After self-sufficiency was reached in the mid 1980s, however, and domestic buffer stocks played a larger role in stabilising supplies, Bulog's stabilisation costs seemed to jump to roughly $100 million per year, not including the export subsidies needed for occasional disposal of surpluses (Pearson 1993; Timmer 1994).[19]

With more effective long-range planning in the context of trend self-sufficiency for rice, and tighter management control over short-run costs, the annual cost of Bulog's efforts to stabilise rice prices could be held to $70–100 million.[20] Costs could be lowered even more. For example, Indonesia could rely on domestic rice production for only 97 or 98% of consumption levels on trend, and it could routinely use variable imports to stabilise supplies and provide 2 to 3% of average consumption. With the smaller buffer stocks such a strategy would permit, the cost of stabilisation could return to approximately $50 million per year, the level incurred in the 1970s when imports were used routinely as the balance wheel to stabilise prices (Timmer 1994).

When the world rice market is depressed and prices are stable, which was the case from 1990 to 1992, Bulog's contribution to the Indonesian economy is likely to be small. Keeping costs below $50 million per year would be essential to its remaining a cost-effective agency. When rice prices in the world market are high and unstable, however, as they were from 1993 to 1995, it is easy to justify the higher costs Bulog incurs as part of the resources devoted to maintaining full self-sufficiency on trend. Perhaps these higher costs should be regarded as insurance for when Bulog's interventions are urgently needed and will have a high return. No matter what, relatively few investments

[19]Admittedly, Bulog's costs are not open for public inspection, although they are audited annually by the Ministry of Finance. Even with open books it would be difficult to allocate the costs of the many activities Bulog carries out. Pearson (1993) is the first public discussion of Bulog's costs that is based on access to internal accounts.

[20]Obviously, this is no more than an 'informed' judgment. But it is informed by 25 years of working as a consultant to Bulog to make it a more cost-effective agency!

made by government (or the private sector) repay their costs threefold each year!

AN ASSESSMENT OF BULOG'S ROLE

Does Bulog stabilise rice prices? Yes. The evidence shows that Indonesian rice prices are substantially more stable than rice prices on the world market. But the mere evidence of more stable prices domestically does not necessarily point to Bulog's actions as the cause.

The model of Bulog's interventions into the Indonesian rice market presented in this paper addresses the issue of causality directly. According this this analysis, Bulog has stabilised the real rice economy through its procurement and market operations. These interventions are designed as a matter of policy to stabilise rice prices. And they do (most of the time). Bulog has been successful, at least historically, at keeping Indonesia's rice prices more stable than market forces alone would have done.

On the other hand, not all tasks a government agency is capable of performing successfully are worth doing. The larger question is whether Bulog should continue to stabilise rice prices. The answer to this question is largely independent of its success historically, because the rice sector is no longer the 'barometer of the economy', to use a phrase from the late 1960s. Nevertheless, experience in the world market for rice in the mid 1990s, illustrated vividly in figure 2, is unsettling. The degree of instability in the world rice market, brought on by the drought in Japan in 1993 and Indonesia's drought during the dry season of 1994, is substantial enough for Bulog's price stabilisation activities to have been enormously profitable in social terms despite the smaller share of rice in the Indonesian economy.

REFERENCES

Anderson, Kym, and Yujiro Hayami (1986), *The Political Economy of Agricultural Protection East Asia in International Perspective*, Allen and Unwin, Sydney.

Barro, Robert, and Xavier Sala-i-Martin (1994), *Economic Growth*, McGraw-Hill, New York

Behrman, Jere R (1987), 'Commodity Price Instability and Economic Goal Attainment in Developing Countries', *World Development* 15 (5), pp. 555–73.

Bigman, David, David M.G. Newbery and David Zilberman (1988), 'New Approaches in Agricultural Policy Research: Discussion', *American Journal of Agricultural Economics* 70 (2), pp. 460–1.

Braverman, Avishay, Ravi Kanbur, Antonio Salazar P. Brandao, Jeffrey Hammer, Mauro de Rezende Lopes and Alexandra Tan (1993), 'How to Analyze the Brazilian Price Band Proposals', in Karla Hoff, Avishay Braverman and Joseph E. Stiglitz (eds), *The Economics of Rural Organization: Theory, Practice, and Policy*, Oxford University Press for the World Bank, Oxford, pp. 436–52.

Chai, Chuckra P. (1995), Rural Human Capital and Economic Growth in Developing Countries, Unpublished Senior Honours thesis, Department of Economics, Harvard University, Cambridge MA.

Dawe, David (1993), The Effects of Export Instability on Investment: The Information Content of Prices and Growth, Unpublished PhD dissertation, Department of Economics, Harvard University, Cambridge MA.

—— (forthcoming), 'A New Look at the Effects of Export Instability on Investment and Growth', *World Development*.

Deaton, Angus S. (1992), *Understanding Consumption*, Clarendon Press for Oxford University Press, Oxford.

De Long, see Long.

Ellis, Frank (1993), 'Indonesian Rice Marketing Study: Aggregate Rice Market and Role of Bulog', *Indonesian Food Journal* 4 (7), pp 23–37.

Jones, Chris (1995), 'Rice Price Stabilisation in Indonesia: An Economic Assessment of the Changes in Risk Bearing', *Bulletin of Indonesian Economic Studies* 31 (1), pp 109–28.

Kahneman, Daniel H., and Amos Tversky (1979), 'Prospect Theory: An Analysis of Decision under Risk', *Econometrica* 47, pp. 262–91.

Kanbur, S.M. Ravi (1984), 'How to Analyse Commodity Price Stabilization? A Review Article', *Oxford Economic Papers* 36, pp. 336–58.

Knudsen, Odin, and John Nash (1990), 'Domestic Price Stabilization Schemes in Developing Countries', *Economic Development and Cultural Change* 38, pp. 539–57.

Long, J. Bradford de, and Lawrence H. Summers (1991), 'Equipment Investment and Economic Growth', *Quarterly Journal of Economics* 106 (2), pp. 445–502.

Lucas, Robert E. (1973), 'Some International Evidence on Output-Inflation Tradeoffs', *American Economic Review* 63, pp. 326–34.

Mears, Leon A., and Saleh Afiff (1969), 'An Operational Rice Price Policy for Indonesia', *Ekonomi dan Keuangan Indonesia* [The Indonesian Economy and Finance] 3 (1).

Newbery, David M.G. (1989), 'The Theory of Food Price Stabilization', *Economic Journal* 99, pp. 1,065–82.

Newbery, David M.G., and Joseph E. Stiglitz (1981), *The Theory of Commodity Price Stabilization: A Study in the Economics of Risk*, Clarendon Press for Oxford University Press, Oxford.

Pearson, Scott R. (1993), 'Financing Rice Price Stabilization in Indonesia', *Indonesian Food Journal* 7 (4), pp. 83–96.

Pinckney, Thomas C. (1993), 'Is Market Liberalization Compatible with Food Security? Storage, Trade and Price Policies for Maize in Southern Africa', *Food Policy* 18 (4), pp. 325–33

Ravallion, Martin (1987), *Markets and Famines*, Clarendon Press for Oxford University Press, New York

Salant, Stephen (1983), 'The Vulnerability of Price Stabilization Programs to Speculative Attack', *Journal of Political Economy* 91 (1), pp 1–38.

Schiff, Maurice, and Alberto Valdes (1992), *A Synthesis of the Economics in Developing Countries*, vol 4 of Anne O. Krueger, Maurice Schiff and Alberto Valdes (eds), *The Political Economy of Agricultural Pricing Policy*, Johns Hopkins University Press for the World Bank, Baltimore.

Timmer, C. Peter (1975), 'The Political Economy of Rice in Asia: Indonesia', *Food Research Institute Studies* 14 (3), pp 197–231

—— (1981), 'Is There "Curvature" in the Slutsky Matrix?' *Review of Economics and Statistics* 62 (3), pp 395–402.

—— (1986a), 'The Role of Price Policy in Increasing Rice Production in Indonesia, 1968–1982', in Ray A Goldberg (ed), *Research in Domestic and International Agribusiness Management*, vol. 6, JAI Press, Greenwich CT, pp 55–106

—— (1986b), *Getting Prices Right: The Scope and Limits of Agricultural Price Policy*, Cornell University Press, Ithaca NY.

—— (1987), 'Corn in Indonesia's Food Policy', in C P. Timmer (ed.), *The Corn Economy of Indonesia*, Cornell University Press, Ithaca NY, pp 253–85.

—— (1989a), 'Food Price Policy: The Rationale for Government Intervention', *Food Policy* 14 (1), pp. 17–42

—— (1989b), 'Food Price Policy in Indonesia', in Terry Sicular (ed), *Food Price Policy in Asia*, Cornell University Press, Ithaca NY, pp 22–64.

—— (1991), 'Food Price Stabilization: Rationale, Design, and Implementation', in Dwight H. Perkins and Michael Roemer (eds), *Reforming Economic Systems*, Harvard Institute for International Development, Harvard University, Cambridge MA, distributed by Harvard University Press, pp 219–48 and pp. 456–9 (notes).

—— (1992), 'Agriculture and Economic Development Revisited', in Paul Teng and Frits Penning de Vries (eds), *Agricultural Systems* 40, special issue, pp. 21–58.

—— (1994), The Long-Run Role of Bulog in the Rice Economy, Harvard Institute for International Development, Cambridge MA (mimeo).

—— (1995a), An Annual Model of Bulog's Role in the Rice Economy of Indonesia, Harvard Institute for International Development, Cambridge MA (mimeo).

—— (1995b), A Monthly Model of Bulog's Market Operations and the Implications for Rice Price Stabilization, Harvard Institute for International Development, Cambridge MA (mimeo).

Timmer, C. Peter, Walter P. Falcon and Scott R. Pearson (1983), *Food Policy Analysis*, Johns Hopkins University Press for the World Bank, Baltimore.

Williams, Jeffrey C., and Brian D Wright (1991), *Storage and Commodity Markets*, Cambridge University Press, Cambridge MA.

World Bank (1994), Indonesian Agricultural Policy: Issues and Options, Draft report, 2 vols, Washington DC.

APPENDIX: TIME SERIES USED TO ESTIMATE EQUATIONS

	PROD	PROC	MO12APR	DRICEP	PRRPAR1	RELSTK2	CPI
1969	12,249	244	204.1	717.3	349	NA	9.38
1970	13,140	531	227.7	724.5	125	0.252	10.21
1971	13,724	562	202.5	685.5	96	0.452	10.46
1972	13,183	138	768 5	593.2	–719	0.480	13.17
1973	14,607	268	377.7	786.8	–571	0.119	16.76
1974	15,276	536	342.5	705.1	163	0.486	22.34
1975	15,185	539	559.5	637.6	–608	0.744	26.74
1976	15,845	410	979.3	665.3	–509	0.373	30.54
1977	15,876	404	2,006.5	614.0	–743	0.327	34.15
1978	17,525	881	1,038 1	609.8	505	0.192	36.43
1979	17,873	431	2,053.2	606.9	–622	0.381	44.37
1980	20,163	1,635	1,646.3	622.2	1,126	0.190	49.91
1981	22,286	1,952	1,034.2	633.7	1,271	0.452	55.59
1982	22,837	1,933	1,528.5	651.4	–77	0.690	60.90
1983	24,006	1,189	398.9	696.9	309	0 339	68.16
1984	25,933	2,374	87.7	684.0	1,427	0.739	75.22
1985	26,542	1,943	280.1	640.5	535	1.399	78.63
1986	27,014	1,496	188.8	644.6	136	1.305	84.33
1987	27,253	1,215	639.9	661.4	–242	0.808	91.73
1988	28,340	1,801	141.9	745.8	80	0.404	98.76
1989	29,072	2,203	57.4	742.1	194	0.372	105.05
1990	29,366	1,348	161.3	725.8	–181	0.906	113.00
1991	29,046	1,740	462.4	713.9	–905	0.530	123.54
1992	31,356	2,326	47.9	719.0	1,412	0.311	132.77
1993	31,318	1,821	414.9	641.4	–153	0.997	145.97
1994	30,059	950	1,035.8	667.0	–2,050	0.440	158.12