The Demand for Fresh and Processed Potato in Southeast Asia

Keith O. Fuglie, Rachman Suherman and Witono Adiyoga

Abstract

Consumption of potatoes and potato products is growing rapidly in Southeast Asia. A lack of locally grown potatoes suitable for processing has meant that processed potato products are mostly imported, while fresh potatoes are grown locally or regionally. Estimation of a two-equation system of demand functions for fresh potatoes and frozen French fries shows that per capita consumption of both products are significantly influenced by income, price, the rate of urbanization, and country-specific factors. Single-equation estimates of potato demand in Jakarta, Indonesia, show that potatoes are not yet an important substitute for traditional staple foods.

Key words: consumer demand, frozen French fries, Indonesia, potatoes, seemingly unrelated regression equation (SUR) method

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In the rice-based food systems of Southeast Asia, the Irish potato (*Solanum tuberosum)* was largely unknown or a novelty food amongst the indigenous populations until only a few decades ago. While per capita potato consumption is still relatively small by international standards, both fresh table potatoes and processed potato products (especially potato French fries and chips) are becoming increasingly popular in the region. Per capita consumption of fresh potatoes grew at an average annual rate of 4.5 percent between 1971 and 1998. The increase in demand was especially rapid in Thailand, Indonesia and the Philippines (Table 1). In Vietnam, a food security crisis during the late 1970s and early 1980s led to a temporary jump in local potato production and consumption as Vietnam struggled to achieve food self-sufficiency (Fuglie, et al., 2001). The long-term trend for per capita potato consumption in Vietnam, as well as Malaysia and Singapore, has also been positive. Policy makers in the region have noted the potential of the potato for diversifying the diet of consumers away from rice, despite the fact that at present potato's contribution to total caloric intake in Southeast Asia remains small, at less than 1% of total calories for the population on average.

While the demand for fresh table potatoes has been largely met locally or regionally (Indonesia supplies potatoes to Malaysia and Singapore, for example), the demand for processed potato products has so far been supplied mainly through imports.

The popularity of American-style fast food restaurants in urban centers of Southeast Asia has resulted in a rapid increase in imports of frozen French fries, especially from North America. U.S. exports of frozen potato products to Southeast Asia grew by over 12 percent per year between 1990 and 1998. After several years of steady growth, exports fell from 63,500 metric tons in 1997 to 51,000 metric tons in 1998 as a result of the Asian economic crisis (U.S. Department of Agriculture). Strict quality criteria by multinational fast-food restaurant chains have kept locally grown potatoes from supplying much of the demand for processed potatoes. This pattern of market supply differentiation between fresh and processed products has also been observed in other developing countries (see Zhang et al., 1999, for a study of frozen potato import demand in China and Taiwan).

Previous studies have, in retrospect, underestimated growth in potato demand in Southeast Asia. Konjing et al. (1989) used a cross-sectional survey of households in Bangkok to estimate a potato expenditure elasticity of 0.54 and an own-price elasticity of –0.59. They predicted that potato consumption in Bangkok would grow by 10 percent per year and by a lesser amount in the rest of the country. In fact, potato consumption in Thailand as a whole grew by more than 15 percent per year during 1981-1998. For Indonesia, Pasaribu (1989) estimated a potato expenditure elasticity of 0.69 and the own-price elasticity in the neighborhood of –0.6 to –0.8. From these estimates Pasaribu (1989) predicted per capita potato consumption would rise from 0.98 kg/person/year in 1980 to 1.37 kg/person/year by 1999. Actual per capita potato consumption in Indonesia exceeded 4 kg/person/year by the late 1990s, according to FAO food balance sheets.

In this paper we explore some of the economic and demographic factors that can help explain the changes in fresh and processed potato consumption in Southeast Asia. First, we use annual data from 1988 to 1999 from five Southeast Asian countries to examine how income, potato prices, urbanization, and country-specific factors affect per capita consumption of imported frozen potatoes and locally grown fresh potatoes. In particular, we are interested in examining the hypothesis of consumer *demand* segmentation between fresh and processed products, i.e., whether consumers view fresh and processed potato products as close substitutes or distant goods. Second, using data from Jakarta, Indonesia, we explore possible food substitution effects among potatoes and more traditional foods such as rice, root crop staples and other vegetables. Fuglie (1994) found evidence that potatoes had become a substitute food for cereal staples in Tunisia, and Bouis and Scott (1996) found a similar result for Bangladesh and Pakistan. These are also areas where the Irish potato is a relatively recent addition to the local food system.

Demand for Potatoes in Southeast Asia

A two-equation system was estimated using the Seemingly Unrelated Regression (SUR) procedure to examine the demand for fresh and processed potatoes in Southeast Asia. The specification of the model is

(eq 1)

$$Q_{fresh} = a_1 * Income^{h_f} * P_f^{e_f} * P_p^{e_{fp}} * Urban^{a_2} * \prod_{i=3}^{6} \exp(D_i^{a_i}) * \exp(u_1)$$

$$Q_{proc} = b_1 * Income^{h_p} * P_p^{e_p} * P_f^{e_{pf}} * Urban^{b_2} * \prod_{i=3}^{6} \exp(D_i^{b_i}) * \exp(u_2)$$

where $\boldsymbol{Q_{fresh}}$ and $\boldsymbol{Q_{proc}}$ are grams/capita/year of fresh and processed potatoes consumed, respectively; ***Income*** is per capita annual income expressed in international dollars using Purchasing Power Parity (PPP) exchange rates; $\boldsymbol{P_f}$ and $\boldsymbol{P_p}$ are the price of fresh and processed potatoes, respectively, expressed in U.S. dollars; ***Urban*** is the share of total population residing in urban areas; the $\boldsymbol{D_i}$'s are dummy variables for individual countries to capture country-specific differences in culture and lifestyle that may affect potato consumption, and $\mathbf{u_1}$ and $\mathbf{u_2}$ are error terms. Parameters to be estimated are the income elasticities of demand η_f and η_p , the own-price elasticities of demand, ε_f and ε_p ; the cross-price elasticities of demand ε_{fp} and ε_{pf}.; and other coefficients $a_1..a_6$ and $b_1..b_6$

To make equation 1 linear, the regression variables are expressed as natural logs. Thus, the coefficients of log(income) and log(price) provide direct measures of demand elasticities. At least two restrictions on the values of the elasticities can be imposed on the model from utility maximization. Since the expenditure shares of the foods in the model are small, the Slutsky symmetry condition can be approximated as

(eq 2) $$e_{ij} = \frac{p_j q_j}{p_i q_i} e_{ji} \quad for\ i, j = p, f\ .$$

If equation 1 is correctly specified, homogeneity implies that the income, own- and cross-price elasticities sum to zero. However, the separability assumptions necessary for equation 1 to represent the potato demand system are admittedly restrictive. It is possible,

for example, to consider potato French fries as part of a "fast food" bundle of foods including hamburgers and other products. Omitting some substitute or complement goods from the estimation might imply that the homogeneity restriction does not strictly hold for the elasticities in equation 1. However, so long as the values of omitted variables are not correlated with the variables in model, their omission should not lead to biased estimates of the elasticities in equation 1. But omitting relevant variables is likely to bias upward the estimates of the standard errors of the coefficients, implying that the normal levels of statistical significance may be conservative (Greene, 1993). In the results section, we report estimates of equation 1 with and without the homogeneity restriction.

The per capita quantity of fresh potatoes consumed is taken from FAO food balance sheets (which do not include consumption of processed potato products).[1] For processed potatoes, per capita quantity is estimated by dividing total imports of frozen potato products by population. This is possible because most processed potato products in these countries are supplied through imports. While there is some local manufacture of potato chips and some restaurants use locally grown potatoes to prepare French fries, imported frozen potatoes dominate this market. Locally grown varieties are generally not suitable for processing because of excessive moisture or sugar content. Potato prices are border prices or urban wholesale prices: For processed potatoes, the price is the unit

[1] FAO food balance sheets don't directly measure food consumption but rather food availability, after accounting for production, stock changes, net trade, non-food use, and wastage. Estimates of per capita potato consumption from household expenditure surveys in Indonesia indicate consumption levels below those implied by FAO food balances (BPS,1997). But this could also be due to underreporting of potato consumption in the households in the survey since potatoes are often eaten infreqently and may be consumed away from home. In a household consumption survey conducted in Java that focused specifically on potatoes, Woolfe (1987) found both urban and rural potato consumption to be significantly higher than the estimates reported in national consumption surveys, and even slightly above the rates indicated by the FAO food balance sheets. Thus, we consider the FAO estimates to be approximately correct in the case of potatoes, especially for measuring consumption changes over time.

value of imported frozen potatoes; for fresh potatoes, the price is the unit value of imported fresh potatoes in the case of Malaysia and Singapore and the unit value of exported fresh potatoes in the case of Indonesia. Thailand and the Philippines do not export significant quantities of potatoes and most of their fresh potato imports are seed potatoes. For the Philippines, we use the wholesale price of fresh potatoes in Manila (Philippine Department of Agriculture). For Thailand, the FAO producer price is increased by 30 percent to reflect marketing costs and converted to US$.[2] Complete data for all countries over the 1988-1999 time period are not available.[3] Population, GDP measured in purchasing power parity (PPP) US$, and exchange rates are from Easterly and Yu (2000).

Table 2 shows the results of the estimation of demand system of equation 1. For both demand equations the R-squares are high (0.96 for fresh potatoes and 0.93 for frozen potatoes). This implies that the variables included in the model provide a fairly complete picture of potato demand in Southeast Asia. Also, it would seem to imply that omitted variable bias is not likely to be large.

With homogeneity and Slutsky restrictions imposed on the model, the estimate of the income elasticity of demand for fresh potatoes is 0.20 and for imported frozen potatoes 2.66. With only the Slutsky restriction, the income elasticity for fresh potatoes is 0.53 and for frozen potatoes 3.89. Demand for both fresh and processed potatoes is strongly influenced by the share of the population residing in urban areas. Imported

[2] Konjing et al. (1989) found that the marketing margin between potato producers in northern Thailand and the Bangkok wholesale market averaged 28.7 percent between 1980-1987.
[3] A total of 43 observations are available for estimating equation 1, including data for Malaysia (1988-1999), Indonesia (1989-1999), Singapore (1995-1999), Philippines (1991-1999), and Thailand (1989-1998).

frozen potatoes, in particular, are a luxury good demanded primarily by the growing urban middle and upper income classes. The growth in income and urbanization has been the most important factors explaining the rapid growth in potato demand in Southeast Asia. Country-specific factors not captured in the other variables are also significant (the coefficients are relative to the left-out country, Indonesia). Ceteris paribus, Thailand and Indonesia appear to have stronger preferences for potato compared with other countries in the model.

Prices also significantly influence potato demand.. The own-price elasticity of imported frozen potatoes is estimated to be –3.02 or –2.66 and for fresh potatoes, –0.22 or –0.17, for the models with and without exact homogeneity, respectively. Evidence for close product substitution between fresh and processed potatoes is weak, however. While the cross-price elasticity from the model with only the Slutsky condition is positive and significant at the 10% level, the elasticity is not significant in the model with both the homogeneity and Slutsky condition. It is possible that consumers differentiate between consumption of these products such that the "distance" between these goods is relatively large. One factor may be the principal venues for consumption. While fresh potatoes are purchased mainly at local markets and prepared into a variety of dishes at home, imported frozen potatoes are largely consumed at restaurants, especially fast food chains.

The segmentation of the potato market into fresh and processed products on both the supply and demand side has implications for policy. One is that trade policies on processed potato products, such as tariffs on imported French fries, are unlikely to offer much support to local potato producers. A second implication concerns potato research

and development. As demand for potato processed products is likely to rise much faster than demand for fresh table potatoes, potato researchers may want to shift some of their efforts from table potatoes to potatoes for processing. Breeders may first want to focus on developing varieties suitable for the chipping industry as the technical requirements of chippers are generally less severe compared to those for French fries.

Role of Potatoes in Urban Indonesia

In order to explore further consumer's behavior toward potato in Southeast Asia, we use data from Jakarta, Indonesia, to examine whether the Irish potato is a significant food substitute for traditional staples and other vegetables. We collected information on quantities of potatoes delivered to the main vegetable wholesale market serving Jakarta (Kramat Jati) each month from January, 1996 to August, 1999. This was a period of sharp movements in real wages and food prices in Jakarta due to the onset of the economic crisis in late 1997 (Figure 1).[4] The price of the main staple rice was stable until the onset of the economic crisis in late 1997. The removal of retail price and trade controls on rice led to a significant price increase of this commodity. Even after adjusting for inflation of about 100 percent in 1998, real wholesale price of the main staples of rice and cassava rose by around 10 percent during 1998 before falling back in 1999. Potato prices also rose, but show some seasonality with relatively low prices earlier in the year in 1997 and 1998. Wages in the service industry (which makes up

[4] Monthly Jakarta wholesale prices for potatoes, rice, and other crops are recorded in Directorate General of Food Crops and Horticulture (1999). A monthly index of vegetable prices is from BPS (various issues). To capture income effects, we use the monthly index of wages for service industries (BPS, 1999). Wages and prices are deflated by the monthly consumer price index for Jakarta (BPS, various issues) and expressed in constant 1997 Rupiah.

about 70 percent of employment in Jakarta), fell by about 10 percent in real terms in 1998. This was a period of significant changes in food prices, relative to each other, to other goods and to wages.

The estimated model for fresh table potato demand in Jakarta is

$$\text{(eq 3)} \qquad Q_{fresh} = c_1 * Wage^{h_f} * P_f^{e_f} * P_{vegetables}^{e_{fv}} * P_{rice}^{e_{fr}} * P_{cassava}^{e_{fc}} * \exp(u_3)$$

where $\boldsymbol{Q_{fresh}}$ is the quantity of potatoes delivered monthly to the Kramat Jati wholesale market in Jakarta. The coefficient η_f on the ***Wage*** variable only provides an approximation for the income elasticity of potato demand, since this variable does not take into account changes in hours worked, unemployment, and other factors that affect household income and expenditures.[5] The population of Jakarta is assumed to be relatively stable over this period.[6] The main cross-price elasticities of interest are the potential substitution between fresh potatoes and other vegetables (ε_{fv}), the main staple rice (ε_{fr}), and cassava (ε_{fc}), a traditional root crop. If these coefficients are significant and positive, it implies that an increase in the relative price of these commodities leads to more potato consumption as consumers substitute potatoes for these foods.

Due to the presence of significant serial correlation in the data, the first-order autoregression (AR1) method was used to estimate equation 2 after taking log transformations of the variables. If the residual OLS error terms show serial correlation,

[5] The economic crisis in Indonesia since late 1997 caused unemployment to increase. A rise in labor force participation, however, enabled wage levels and household earnings to remain closely correlated during this period (Manning, 2000).

[6] Jakarta's population is recorded as 8.26 million in the 1990 Census and 8.39 in the 2000 Census (BPS, 2001).

then OLS will provide inefficient estimates of the regression coefficients and biased estimates of the standard errors (Greene, 1993).

Estimates of equation 2 are given in Table 3. As with in the previous section, we have included elasticity estimates with and without the homogeneity condition imposed on the data. The wage and own-price elasticities estimated for fresh potatoes in Jakarta are considerably higher than the income elasticities estimated for Southeast Asia as a whole. For the AR1 models, the wage elasticity is estimated in the range of 0.8 to 1.0 and the own-price elasticity at about –0.5 to –0.6. The cross-price elasticity with rice is borderline statistically significant (t-statistic is –1.654) and negative, indicating that potatoes and rice and complements. Rather than serving as a substitute for the main staple, fresh table potatoes appear to be primarily consumed in side dishes that are eaten together with rice. Other cross-price effects are not statistically significant. When the insignificant variables are omitted from the regression, the statistical significance of the cross-price elasticity with rice improves (t statistic is above -2). The results confirm the importance of consumer income and potato price on the quantity of potatoes demanded found in the previous section. But it does not appear that the Irish potato has yet made a significant inroad to substitute traditional food staples.

Summary and Conclusions

The rising demand for fresh and processed potatoes in Southeast Asia appears to be strongly influenced by consumer income, potato prices, and urbanization. Given that

the long-term prospects for economic growth in the region are good (despite the current downturn), the growth in potato consumption is likely to continue.

The income elasticities reported in this study for processed potato products are in the range of 2.7 to 3.9, which is exceptionally high for a food product. Further, each percent increase in the rate of urbanization increases per capita consumption of processed potato products by 5-8 percent, on average. With resumption of moderate economic growth and a continued trend toward urbanization, it is easy to derive forecasts of 10 to 20 percent annual growth in demand for processed potato products. Much of this demand growth is likely to be met through imports from temperate countries.

Per capita consumption of fresh table potatoes is currently much higher than processed potatoes and is also likely to show strong growth in the future. Income elasticities measured for Southeast Asia ranged from 0.20 to 0.53, and for urban Jakarta, the elasticity with respect to real wage is between 0.8 and 1.0. While potatoes have not yet reached the stage where they are a frequent item in the household menu, they should no longer be considered a "luxury good" (defined as goods having an income elasticity greater than 1). Demand for fresh table potatoes in Southeast Asia appears to be relatively inelastic, with an own-price elasticity of around –0.17 to –0.22 (and –0.5 in Jakarta).

Evidence that fresh table potatoes are a significant substitute for processed potato products (and vice versa) is weak. This would be consistent with the view that consumers think of French fried potatoes consumed in fast-food restaurants as a different food product from home-prepared potatoes purchased in local vegetable markets. Market

segmentation between fresh and processed potatoes also occurs on the production side: while most fresh potatoes consumed in Southeast Asia are also grown there, most processed potato products are imported from outside the region. In Indonesia, the econometric evidence suggests that potatoes are a complement, rather than a substitute, to the main staple rice. Potatoes do not appear to be a close substitute for other vegetables and are yet too expensive a source of carbohydrates to have a role as a substitute for staple foods.

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Table 1. Potato Consumption in Southeast Asia

Country	Population in 1998	1971	1981	1991	1998	Average annual growth in per capita potato consumption 1971-1998
	millions	Kg of potato/capita/year				
Indonesia	203.8	0.9	1.2	2.1	4.1	5.6%
Malaysia	22.2	2.0	2.7	3.5	4.1	2.7%
Philippines	75.2	0.5	0.6	1.1	1.8	4.7%
Thailand	61.1	0.2	0.3	1.1	2.8	9.8%
Vietnam	77.6	2.4	9.1	3.6	4.2	2.1%

Source: Population from Easterly and Yu (2000); Annual availability of fresh potatoes from FAO (2000).

Table 2. SUR estimates of potato demand functions for Southeast Asia

	Fresh Potatoes		Processed (frozen) Potatoes	
Variables	*Slutsky condition & Homogeneity*	*Slutsky condition*	*Slutsky condition & Homogeneity*	*Slutsky condition*
Per capita income	0.204	0.531	2.661	3.893
	(2.270)	(4.248)	(4.792)	(6.073)
Price-fresh potatoes	-0.222	-0.169	0.3686	0.672
	(-2.780)	(-2.078)	(0.976)	(1.750)
Price-frozen potatoes	0.0184	0.0336	-3.029	-2.659
	(0.976)	(1.750)	(-7.914)	(-6.401)
Urban (%)	3.072	3.634	4.757	8.249
	(10.460)	(11.102)	(2.806)	(4.101)
Intercept	-3.340	-8.262	-15.857	-41.596
	(-3.210)	(-5.064)	(-2.788)	(-4.405)
Malaysia	-1.270	-1.867	-1.724	-4.590
	(-9.079)	(-8.899)	(-2.566)	(-4.342)
Philippines	-2.035	-2.439	-3.436	-5.469
	(0.1540)	(-13.044)	(-4.654)	(-5.928)
Singapore	-2.652	-4.033	-5.860	-12.634
	(-8.390)	(-8.396)	(-3.821)	(-5.130)
Thailand	0.979	0.985	0.736	1.355
	(5.713	(5.741)	(0.667)	(1.189)
R-squared	0.957	0.966	0.915	0.933
Adjusted R-squared	0.948	0.959	0.897	0.919
Standard dev. of residuals	0.1307	0.1151	0.616	0.547
F-statistic	104.89	136.82	51.11	66.03
Significance of F	0.000	0.000	0.000	0.000

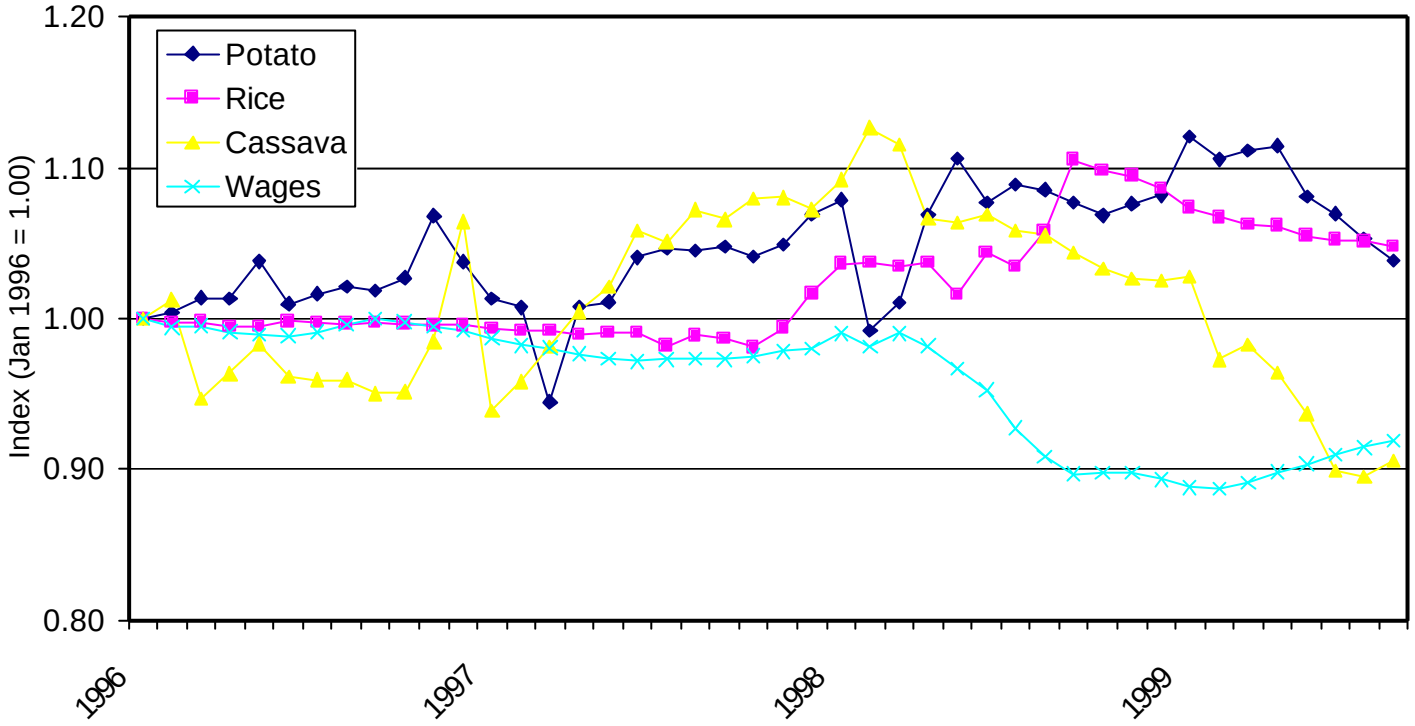
Data are annual estimates for Indonesia, Malaysia, Thailand, Philippines, and Singapore during 1988-1999 (for some countries fewer years of data are available). Quantity, income, price, and urban variables in log form, so coefficients are (uncompensated) elasticities. t-statistics are in parentheses.

Table 3. Fresh potato demand functions for Jakarta, Indonesia

Variables	AR1 *unrestricted*	AR1 *with homogeneity*	AR1 *with homogeneity*
Wage	1.025	0.915	0.842
	(1.875)	(2.625)	(8.011)
Price-potato	-0.544	-0.560	-0.570
	(-4.025)	(-4.629)	(-4.843)
Price-rice	-0.204	-0.265	-0.272
	(-0.758)	(-1.654)	(-2.032)
Price-vegetable	-0.00852	-0.0189	..
	(-0.033)	(-0.074)	
Price-cassava	-0.0755	-0.0715	..
	(-0.765)	(-0.733)	
Intercept	9.730	10.696	10.594
	(2.578)	(14.782)	(31.096)
ρ	0.499	0.499	0.500
	(3.776)	(3.776)	(3.781)
R-squared	0.830	0.830	0.828
Adjusted R-squared	0.812	0.812	0.820
Standard dev. of residuals	0.138	0.138	0.135
F-statistic	47.44	47.44	98.85
Significance of F	0.000	0.000	0.000
Durban-Watson statistic	1.221	2.188	2.188

Data are monthly between January, 1996 and August, 1999. Quantity, income, price, and urban variables in log form, so coefficients are (uncompensated) elasticities. t-statistics are in parentheses. The serial correlation coefficient ρ is from the AR1 model: $u_3(t) = \rho\ u_3(t-1) + e(t)$, where e(t) is the final residuals of the AR1 model.

Figure 1. Movements in Real Wholesale Food Prices in Jakarta, 1996-1999



Source: Wholesale prices from Directorate General of Food Crops and Horticulture (1999); CPI from BPS (various issues); wages from BPS (1999).