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**THE SENSITIVITY OF CALORIE-INCOME DEMAND
ELASTICITY TO PRICE CHANGES:
EVIDENCE FROM INDONESIA**

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ABSTRACT

The calorie-income demand elasticity is an important parameter in the development literature and in the policy arena. Yet, there is very little evidence on the extent to which it can be considered as an unchanging parameter or a time-shifting parameter that, for example, changes with the economic conditions faced by households.

In this paper I use data from the 1996 and 1999 National Socio-Economic Surveys (SUSENAS) in Indonesia to examine whether the relationship between income changes and caloric availability has changed and if so, how. Using the same questionnaire, the SUSENAS surveys collect detailed information on more than 200 different food items consumed over the last seven days by 60,000 households at the same point in each survey year. I use nonparametric as well as regression methods to examine two important relationships: (1) between income and total calories, and (2) between income and calories from cereals and other foods (excluding cereals and root crops).

The empirical analysis finds that the income elasticity of the demand for total calories is slightly higher in February 1999 (the crisis year with dramatically different relative prices) compared to its level in February 1996. Also, the calorie-income elasticity for cereals as a group increases while the calorie-income elasticity for other food items decreases. The latter finding is interpreted as consistent with the presence of a binding subsistence constraint.

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1. Introduction

Since the onset of the financial crisis in 1997 and its intensification in 1998, rural and urban households in Indonesia experienced large increases in the prices of rice and other food and nonfood products. Such price increases have two major consequences. First, they result in a decrease in the household purchasing power, especially among poorer households that spend a larger share of their income on food. Second, they result in a relative price effect, which induces households to seek substitutes for more expensive foods. Concern about the impact of the crisis on the quantity and quality of food available in poor households has given rise to a number of “social safety net” programs aimed at protecting caloric availability within households. These programs have worked by means of cash or in-kind transfers of staple foods such as rice, the sale of rice at subsidized prices, and the creation of temporary employment for poorer households (Suryahadi, Suharso, and Sumarto 1999).

Such programs, along with other related cash transfer programs, spring from the underlying assumption that there is a positive relationship between caloric availability and income. Much research in development economics and food policy has focused attention on the size of this calorie-income elasticity (e.g., Strauss and Thomas 1995) while placing less emphasis on the sensitivity of this parameter to the price environment. When no restrictions are imposed on consumer preferences, basic economic theory predicts that the sensitivity of demand for any food item to changes in price or real income will vary depending on the level of relative prices and the level of household

income. Most of the empirical evidence to date, however, has addressed the question of whether the price sensitivity of demand varies with the level of income. A number of studies, for example, have confirmed empirically that the compensated price responsiveness of consumers varies substantially across different income strata (Timmer and Alderman 1979; Timmer 1981; Pitt 1983). Along similar lines, Behrman and Deolalikar (1987), Ravallion (1990), Strauss and Thomas (1995), and Subramanian and Deaton (1996) examined whether the income elasticity of calories accessed through the consumption of all food items as a group varies with the level of income.

However, there is no empirical evidence on whether the income response of demand for calories in general or commodities in particular varies with the level of relative prices faced by households (e.g., Alderman 1986). All things being equal, when prices for food relative to nonfood are high, households may spend most of their additional income on nonfood items. Changes in the relative prices of the staple food items may plausibly give rise to rather unexpected responses to how caloric availability may respond to a cash transfer. For example, if the relative price of rice increases during a crisis, households receiving a cash transfer may choose to spend more of their additional income on rice—as long as rice continues to be the cheapest source of calories and energy starting from a situation where the level of total caloric availability is already low. In such a situation, the effectiveness of a cash transfer program may be considerably

better at maintaining caloric availability at the household level during the period of crisis compared to a period of normal relative prices.¹

Part of the explanation for the paucity of evidence rests on the fact that economic theory provides no guidance on how the income elasticity of any given commodity may change as a result of changes in prices. Unless one makes arbitrary assumptions about the separability of preferences between and within specific food groups, there are no refutable propositions that can be derived on this subject. This does not, however, justify the treatment of income elasticity estimates of demand for food as time invariant or insensitive to the economic environment. To my knowledge, there is no empirical evidence that validates this assumption. A complementary explanation for the absence of any relevant evidence is that most of the studies on the calorie-income relationship have relied on cross-sectional data. (For a survey of this literature, see Strauss and Thomas 1995.) A typical cross-sectional household survey collects data within a short time interval. As a consequence, most of the variation in the price of any given commodity faced by households arises from differences in the quality of the commodity consumed, transportation costs, market segmentation, or other transaction costs that may prohibit the equalization of consumer prices across space.² To the extent that households in different regions are surveyed in different quarters in the calendar year, then the survey may also

¹ It is important to clarify that I make no statement regarding the effectiveness of a cash transfer relative to other alternatives for increasing caloric availability. Alternatives may include in-kind food transfers and employment creation programs.

² This may explain why some of the literature has focused on the differences in the quality of food consumed by richer and poorer households as a potential for explaining the concavity in the observed relation between calories and income.

capture seasonal price variability. But even if this were possible, it is still doubtful whether seasonal price variations adequately represent the relative price changes that consumers face during major economic crises. Household panel data provide an opportunity to relax some of these shortcomings. Behrman and Deolalikar (1987), for example, analyze the calorie-income relationship using data from the village-level survey of ICRISAT. But even these data shed little light on this question, since the set of villages followed was characterized by a relatively stable economic environment during the period of the study.

During the recent financial crisis in Indonesia, the value of the rupiah depreciated dramatically. The rupiah fell from around 2,400 per US\$ in June 1997 to just under Rp15,000 per US\$ in June 1998, finally settling down to Rp8,000–9,000 per US\$ by December 1998. These fluctuations led to large increases in the price of tradable commodities in domestic markets, and contributed to an annual inflation rate of 80 percent during 1998. In addition, during 1998 the subsidies were removed on a number of major consumer goods, including rice, oil, and fuel. It is thus questionable whether estimates of the income elasticity of calories obtained from a sample of households observed before the crisis can provide guidance on how caloric availability may respond to additional income (*ceteris paribus*) during a period with a different set of relative prices. From a policy perspective, the sensitivity of calorie-income elasticity to the relative prices in the economy implies that policies aimed at increasing household income, such as employment and cash transfer programs, may be more (or less) effective

at different periods, depending on the economic conditions prevailing at the time of their implementation.

In this study, I use household consumption and calorie data from the 1996 and 1999 consumption module of the National Socio-Economic Surveys (SUSENAS) in Indonesia to examine these issues in detail. The paper is structured as follows. In Section 2, I discuss the data used for the analysis and present some background information on the changes in calorie prices and caloric availability between 1996 and 1999 in Indonesia. In Section 3, I use nonparametric methods to examine the relationship between the calorie-income elasticity in 1996 and in 1999 and the level of household income in each survey round. I also provide estimates of the calorie-income elasticity, using regression methods that allow me to control for the role of observed household characteristics as well as differences in the level of relative prices across villages (or clusters). In Section 4, I summarize the findings and conclude with some policy considerations.

2. Data

My analysis is based on the detailed consumption module of SUSENAS collected every three years by the Central Statistical Agency (BPS) of the Government of Indonesia. The consumption module is nationally representative of urban and rural areas within each of the country's 27 provinces.³ The 1996 round surveyed 60,678 households

³ The core SUSENAS survey containing observations for approximately 205,000 households is representative at the district (*kabupaten*) level.

and the 1999 round, 62,217 households. Besides the detailed nature of the survey, some of the main advantages obtained by the comparison of the income elasticity of calories in these two years include the opportunity to examine economic behavior in the context of dramatically different relative price regimes. In February 1999, the month in which the SUSENAS was conducted, inflation in Indonesia had reached its peak since the start of the financial crisis in late 1997 and its intensification in mid 1998. Another advantage was that the same questionnaire was applied at the same point in time in each survey year. In this manner the possible influence of seasonal factors in the caloric income relationship as emphasized by Behrman, Foster, and Rosenzweig (1997) can be controlled for.⁴

The consumption module includes 216 food items in 1996 and 214 food items in 1999.⁵ The survey makes a very good effort at getting to the total value of the food consumed by households, not just the value of household food expenditures. In each of these years, households were asked to recall the quantity and value of each of these food items purchased from the market, given to them as gifts, or consumed out of own production during the last week.⁶ The latter quantities are valued by local interviewers, using the prevailing market prices in the villages where households reside.

⁴ The fasting month and the Idul Fitri-Lebaran holiday following it is a moving holiday, and in 1999 it fell in late January. We were informed by BPS officials that the survey was conducted two weeks after the Lebaran holiday, and as a result, the value of household food consumption has little chance of appearing unusually high due to the feasting holiday.

⁵ The difference of two items arises from the fact that high quality and imported rice were treated as separate food items in the cereals category in 1996, but not in 1999.

⁶ Van de Walle (1988) provides a guide to the SUSENAS consumption module that is still useful in spite of some changes in the questionnaire.

The caloric content of each food item is estimated by the BPS using established conversion factors and provided as part of the data set. Household weekly caloric availability is derived by summing weekly kilocalories (kcal) from food items purchased and “auto-consumed” or received as a gift during the week previous to the survey date.⁷ It is then transformed into household daily caloric availability by dividing by 7. Household daily per capita caloric availability is derived based on the formula $CAL(t) = TCAL(t)/N(t)$, where $TCAL(t)$ denotes household kcal available per day in the household in survey period t and $N(t)$ denotes total family size in survey period t .

The value of food consumption is the sum of expenditures on grains, meat, fish, eggs and milk, vegetables, pulses, fruits, seasonings, fats and oils, soft drinks, prepared food and other food items, and alcohol.⁸ The reference period for consumption of these items is the week preceding the day of the interview. Weekly consumption was transformed into monthly consumption by multiplying by (30/7).

For nonfood expenditures, the survey collects two measures, each for a different reference period: last month and last 12 months. To avoid exclusion errors, I utilized the average expenditures per month calculated from the reported expenditures based on the reference period of the last 12 months. Expenditures on nonfood items include those on tobacco, housing, clothing, health and personal care, education and recreation, transportation and communication, taxes and insurance, and ceremonial expenses. Expenditures on durables such as household furniture, electric appliances, and

⁷ The term “calories” is used here in place of the scientific term “kilocalories” (kcal).

⁸ In contrast to BPS, I do not include tobacco expenditures in the food consumption total.

audiovisual equipment are excluded for the aggregate of household consumption. The income of a household, measured by the value of per capita consumption, is denoted by $CON(t)$. This figure is constructed by dividing the value of total food and nonfood consumption in survey period t by the size of the household in each period.⁹

To make any meaningful comparisons across two cross-sectional surveys that are three years apart, it is essential to express the nominal income of households in 1999 in terms of 1996 rupiah. A critical point for the construction of “real” income in 1999 is the fact that changes in food prices affect households differently, depending on the share of their budget they spend on food. Typically, poorer households spend a much higher fraction of the income on food (closer to 60 percent for poor rural households in Indonesia), while this share diminishes to 40 percent for households at the top of the expenditure scale in urban areas.

The availability of value and quantity for each of the food items in the SUSENAS consumption modules allows calculation of unit values down to the household level. Given the data available, I have constructed a deflator combining the unit values calculated from the consumption module and the province-specific prices reported for nonfood items by the BPS.¹⁰ First, given that for nonfood items only expenditures are collected, I constructed a deflator for nonfood items using the mean shares of major

⁹ Thus, it is implicitly assumed that there are no economies of scale at the household level. For the present purpose of comparing income elasticity over time, this assumption is not overly limiting. In any case, the regression analysis below controls for the gender and age composition of families in each survey year.

¹⁰ Suryahadi et al. (2000) and Levinsohn, Berry, and Friedman (1999) adopt a similar approach in constructing household-specific price indices for Indonesia.

groups of nonfood items in the February 1999 survey as weights and the province-specific price indices for these groups.¹¹ Second, I constructed a household-specific food deflator from a weighted average of the 52 food items used in the calculation of the poverty line in Indonesia. Specifically, the household-specific food deflator is calculated using the formula

$$P_F^h(99) = \left(\sum_{i=1}^{52} \left(S_i^h(99) \left(\frac{P_i(R,96)}{P_i(R,99)} \right) \right) \right)^{-1}, \quad (1)$$

which is the standard formula for calculating a Paasche price index (see Deaton and Zaidi 1999). The letter S denotes the share of food item i of the total amount expended on the 52 food items, and the superscript h indicates that this share varies from household to household. The second term is the ratio of the median unit value of food item i in region R in 1996 to the corresponding unit value in 1999. Household-specific unit values of food items are replaced by median unit values within each of the 53 regions so as to minimize the influence of measurement errors and differences in the quality of food consumed by wealthier households (Deaton 1988). Having a price deflator for food and nonfood, the price deflator for household h in 1999, $P^h(99)$, can be expressed as

$$P^h(99) = \hat{W}_F^h(99)P_F^h(99) + (1 - \hat{W}_F^h(99))P_{NF}(R,99). \quad (2)$$

Note that the weights applied to food and nonfood are allowed to vary once more across households. The weight for each household was calculated from the predicted value of

¹¹ The province-specific price indices for food and nonfood groups reported by BPS are based solely on urban prices, for 27 cities in 1996 and 44 cities in 1999.

the regression of household food share in 1999, $\hat{W}_F^h(99)$, on the logarithm of per capita consumption, $\ln(C(99))$, and the logarithm of household size (i.e., a log-linear Engels curve for food). In this manner the influence of household-specific unobserved components or tastes on the share of food is eliminated.

At this point, it is also appropriate to outline some caveats. First, this study is primarily concerned with the relationship between income and the demand for energy from calories. There is now a consensus that total caloric availability provides only limited insight into how the availability of micronutrients within households responds to changes in income. Indeed, when household income drops, caloric availability within the household may be maintained more or less constant through substitutions within and between food groups, while the consumption of essential micronutrients may decrease dramatically as households consume less meat, vegetables, eggs, and milk (Behrman 1995). In an attempt to obtain some insight into these issues, I also investigate the relationship between income and calories from two food groups: cereals and all other food sources excluding cereals (and root crops such as cassava and sweet potato).

Second, the analysis is based on a seven-day recall food consumption and expenditure survey rather than a 24-hour recall consumption survey. Food expenditure surveys, it has been argued, lead to upwardly biased estimates of the calorie-income elasticity (Bouis and Haddad 1992; Bouis 1994). Correlated measurement errors in the total food consumption, and thus caloric availability, are one potential source of an upward bias in estimates of the level of calorie-income elasticities. A related source of

upward bias is attributed to the under-coding of food transfers from richer to poorer households. For example, a food expenditure survey may overstate the caloric availability within wealthier households, since it is common for these households to provide meals to employees and domestic servants. In contrast, a food expenditure survey may understate the caloric consumption of poorer households if food is consumed outside the household, e.g., at the place of employment. Although generally valid, these issues do not diminish the credibility of this study of whether there have been changes in the level of the calorie-income elasticity. The same questionnaire was applied at the same time in each survey year, and there are no reasons to believe that there are changes in the sources of these biases across the two years. Nevertheless, it is worthwhile to point out that the SUSENAS survey—for the purpose of getting at the total caloric availability within households—asks whether household members received food from sources other than own production and market purchases. Although no explicit questions are asked about food given to others, it should be noted that domestic servants are counted as household members, which to some extent are upwardly biased estimates of caloric availability within wealthier households. This bias may be reduced by using per capita calories and consumption figures.

To provide more concrete evidence about the relative price regimes prevailing in the two survey years, Table 1 presents the mean prices per kcal paid by households in 1996 and in 1999 in rural and urban areas in the islands of Java and Bali, which are by far

the most densely populated islands of Indonesia.¹² The prices per kcal are calculated by dividing the nominal value of household consumption for each food group by the total quantity of kcal provided by all the food items in the group divided by 1,000.¹³ Columns 1 and 2 contain the means of these prices for the full sample of households in 1996 and in 1999.¹⁴ Poorer households may consume food items of lower quality, and, as a consequence, the prices of kcal paid by these households may be lower than those paid by richer households. To investigate for this possibility, prices per kcal are also calculated separately for households at the bottom and at the top quartile of the distribution of total consumption per capita in each year (see columns 3–4, and 5–6, respectively). In 1999, the percentiles of total consumption per capita are estimated after dividing consumption by the deflator discussed earlier. Columns 7-8, 10–11, and 13-14 express these prices relative to the price of cereals in each region in each year. Lastly, columns 9, 12, and 15 present the changes in these relative prices between 1996 and 1999.

Table 1 confirms that the relative prices faced by households changed considerably between 1996 and 1999.¹⁵ The price of calories from tubers or root crops

¹² Java and Bali include province codes 31 to 51. Other regions as well as the regions of East rural Java are examined further below.

¹³ It is important to keep in mind that the calorie prices reported are derived by dividing expenditures by total calories in the food group in each year. As such, the price of calories in 1999 may be biased downward depending on the extent to which households manage to find substitutes for more expensive food items within and between groups.

¹⁴ Means were obtained by weighting individual household observations by the inverse probability of selecting the household into the sample times the number of family members in the household.

¹⁵ For a related analysis of the impact of the Indonesian crisis on budget shares with repeated observations on sampled households, see Thomas et al.(1999).

such as cassava and sweet potatoes, which are also rich in calories and typically serve as a substitute for rice, decreased substantially, especially for households at the bottom end of the distribution of per capita expenditure (a decrease of 34 percent). In contrast, the changes in the relative prices of micronutrient-rich foods such as fish, meat, eggs and milk, and vegetables vary by income and geographic location. For example, for poorer households in rural areas of Java and Bali, the price of calories from fish, meat, eggs and milk, and vegetables is higher, whereas for households at the top of the distribution, these relative prices (excepting eggs and milk) are lower or unchanged. More or less the same pattern is also observed for households in urban areas. However, there seems to be greater variation in how relative prices changed in rural areas than in urban areas. For example, the relative price of other foods (foods excluding cereals and tubers) decreased by 3 percent in rural areas and by 11 percent in urban Java and Bali.

To complete the picture, Table 2 presents the mean total kcal per capita available within households through the same food groups.¹⁶ Average (total) daily kcal per capita are generally lower in 1999 than in 1996. For example, among poor households in rural Java and Bali, average daily kcal per capita decrease from 1,651 in 1996 to 1,493 in 1999. Irrespective of whether the minimal daily caloric requirement of 2,100 kcal is an appropriate measure, the lower mean daily kcal per capita in 1999 relative to 1996

¹⁶ These means are derived using weights as in footnote 10.

Table 2—1999 versus 1996 calories per capita (Java and Bali)

	Calories per capita												Calories as percent of total											
	All				Bottom 25%				Top 25%				All				Bottom 25%				Top 25%			
	1996	1999	2	3	1996	1999	4	5	1996	1999	6	7	1996	1999	8	9	1996	1999	10	11	1996	1999	12	
Rural areas																								
Cereals	1,181	1,113	1,114	1,114	1,002	1,002	1,229	1,215	59.4	60.5	67.5	67.1	67.5	67.1	50.6	52.5								
Tubers	54	61	63	63	60	60	47	62	2.7	3.3	3.8	4.0	3.8	4.0	1.9	2.7								
Fish	29	24	21	21	16	16	41	36	1.5	1.3	1.3	1.1	1.3	1.1	1.7	1.6								
Meat	27	13	6	6	2	2	67	38	1.4	0.7	0.4	0.2	0.4	0.2	2.7	1.7								
Eggs and milk	24	15	9	9	5	5	50	35	1.2	0.8	0.6	0.4	0.6	0.4	2.1	1.5								
Vegetables	38	34	31	31	27	27	45	43	1.9	1.8	1.9	1.8	1.9	1.9	1.9	1.9								
Pulses	70	62	46	46	44	44	100	91	3.5	3.4	2.8	2.9	2.8	2.9	4.1	3.9								
Fruits	38	31	22	22	16	16	65	56	1.9	1.7	1.3	1.1	1.3	1.1	2.7	2.4								
Oils and fats	196	184	146	146	130	130	262	260	9.9	10.0	8.8	8.7	8.8	8.7	10.8	11.2								
Beverages (nonalcoholic)	97	89	70	70	65	65	135	128	4.9	4.9	4.2	4.4	4.2	4.4	5.6	5.5								
Spices	17	18	11	11	12	12	25	25	0.9	1.0	0.7	0.8	0.7	0.8	1.0	1.1								
Miscellaneous food	29	23	14	14	11	11	55	47	1.4	1.2	0.8	0.7	0.8	0.7	2.3	2.0								
Prepared food	187	174	98	98	103	103	304	278	9.4	9.5	5.9	6.9	5.9	6.9	12.5	12.0								
Alcohol	0	0	0	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0								
Total	1,988	1,840	1,651	1,651	1,493	1,493	2,426	2,314	59.4	60.5	67.5	67.1	67.5	67.1	50.6	52.5								
Total cereal	1,181	1,113	1,114	1,114	1,002	1,002	1,229	1,215	40.6	39.5	32.5	32.9	32.5	32.9	49.4	47.5								
Total noncereal	807	727	537	537	491	491	1,197	1,099	37.9	36.2	28.7	28.9	28.7	28.9	47.4	44.8								
Total other	753	666	474	474	431	431	1,150	1,036																
Urban areas																								
Cereals	1,003	920	1,040	1,040	923	923	976	879	51.6	52.2	62.6	62.5	62.6	62.5	42.4	41.3								
Tubers	26	31	28	28	32	32	30	32	1.4	1.8	1.7	2.2	1.7	2.2	1.3	1.5								
Fish	30	24	19	19	15	15	45	34	1.5	1.3	1.1	1.0	1.1	1.0	1.9	1.6								
Meat	58	28	18	18	7	7	111	69	3.0	1.6	1.1	0.4	1.1	0.4	4.8	3.2								
Eggs and milk	50	34	20	20	11	11	93	73	2.6	1.9	1.2	0.7	1.2	0.7	4.0	3.4								
Vegetables	32	28	27	27	23	23	38	34	1.7	1.6	1.6	1.5	1.6	1.5	1.7	1.6								
Pulses	74	70	56	56	53	53	93	87	3.8	4.0	3.4	3.6	3.4	3.6	4.0	4.1								
Fruits	36	28	21	21	14	14	56	49	1.9	1.6	1.3	1.0	1.3	1.0	2.4	2.3								
Oils and fats	222	201	162	162	143	143	299	274	11.4	11.4	9.7	9.7	9.7	9.7	13.0	12.9								
Beverages (nonalcoholic)	112	97	80	80	67	67	149	133	5.8	5.5	4.8	4.6	4.8	4.6	6.5	6.3								
Spices	19	18	13	13	12	12	25	24	1.0	1.0	0.8	0.8	0.8	0.8	1.1	1.1								
Miscellaneous food	50	40	22	22	16	16	86	74	2.6	2.3	1.3	1.1	1.3	1.1	3.7	3.5								
Prepared food	230	243	155	155	160	160	299	363	11.9	13.8	9.3	10.8	9.3	10.8	13.0	17.1								
Alcohol	0	0	0	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0								
Total	1,942	1,762	1,661	1,661	1,476	1,476	2,301	2,126	51.6	52.2	62.6	62.5	62.6	62.5	42.4	41.3								
Total cereal	1,003	920	1,040	1,040	923	923	976	879	48.4	47.8	37.4	37.5	37.4	37.5	57.6	58.7								
Total noncereal	939	842	621	621	553	553	1,325	1,247	47.0	46.0	35.7	35.3	35.7	35.3	56.3	57.1								
Total other	913	811	594	594	522	522	1,295	1,215																

Source: Author's calculation based on the 1996 and 1999 SUSENAS Consumption modules, Indonesia.

suggest that households in Indonesia experienced a serious reduction in the per capita level of energy available.¹⁷

Table 2 also reveals a remarkable stability in the average share of calories obtained from cereals between 1996 and 1999. Although cereals are relatively more expensive in 1999, poor households in rural areas appear to either maintain or increase slightly the share of their calories from cereals. In addition, in 1999 a higher share of calories is obtained from root crops, which provide a rich source of calories and whose price relative to cereals decreased significantly. Among poorer households in rural areas, the shares of calories obtained from fish, meat, eggs and milk products, and fruits and vegetables decreased in 1999. The share of calories from meat, in particular, decreased by 50 percent in 1999 from the already low level of 1996. In contrast, the share of calories from cereals and root crops such as cassava and sweet potatoes increased. Considering that fish, meat, eggs and milk products, and fruits and vegetables are important sources of necessary micronutrients or dense calories such as vitamins A and C, calcium, iron, niacin, thiamin, and riboflavin, Table 2 suggests that poorer households in 1999 experienced a significant reduction in their dietary intake as well as in total calories. Whether these adjustments to crisis have adverse consequences on the nutritional status of children, pregnant and lactating women, or other adult members as well as permanent impacts on their health and human capital is a critical policy question that cannot be

¹⁷ In Tables 1 and 2, the mean level of per capita expenditures in 1999 has also decreased considerably. Thus a comparison of kcal per capita in the bottom 25th percentile of the distribution in 1996 and in 1999 is not necessarily at the same level of income or expenditures. In the regression analysis below, I also ensure that differences in total real expenditures and the age and gender composition of households are accounted for.

addressed using SUSENAS data.¹⁸ What is clear, however, is that the changes in the relative prices of cereals and noncereals or other foods do not appear to be associated with any major change in the way poorer households acquire calories. Put differently, holding income constant, the changes in relative calories between 1996 and 1999 do not appear to induce a poor household to substitute away from cereals or change significantly the way in which it acquires calories. This finding is generally consistent with the earlier finding of Timmer (1981), who provided evidence that the poorest segment of the Indonesian population exhibited no compensated price reaction at all to calorie prices aside from the income effect resulting from the changed prices. To the extent that the preceding insights are valid, the income elasticity of total calories is less likely to be affected by relative price changes, no matter how large these changes are. Whether this is indeed the case is examined empirically in Sections 3 and 4.

3. Empirical Analysis and Results

The available evidence to date on the calorie-income relationship in Indonesia suggests that it is nonlinear, with poorer households having a higher elasticity than richer households (e.g., Timmer and Alderman 1979; also see Timmer, Falcon, and Pearson 1983; Ravallion 1990). To get a better sense about how the income elasticity of calories varies with the level of income in each of the two years of the SUSENAS surveys, I use

¹⁸ See Block et al. (2002) for a confirmation of the negative impact of the financial crisis in Indonesia on the nutritional status of children.

nonparametric methods. Using y to denote the logarithm of per capita calorie availability, and x the logarithm of per capita total household expenditure, the regression function can be written as

$$m(x) = E(y|x) . \quad (3)$$

Following Subramanian and Deaton (1996) and Deaton (1997), I estimate $m(x)$ using a smooth local regression technique proposed by Fan (1993).¹⁹ At any given point x , I run a weighted linear regression of the logarithm of kcal per capita on the logarithm of per capita consumption. The weights are chosen to be largest for sample points close to x and to diminish with distance from x . Instead of estimating a regression for each point x in the sample, I divided the distribution of log per capita into 100 evenly spaced grids and estimated local regressions for each grid. For the local regression at x , observation i gets the (quartic kernel) weight

$$w_i(x) = \frac{15}{16} \left[1 - \left(\frac{x - x_i}{h} \right)^2 \right]^2 , \quad (4)$$

if $-h \leq x - x_i \leq h$ and zero otherwise. The quantity h is a bandwidth that is set so as to trade off bias and variance, and that tends to zero with the sample size. I have set the bandwidth to the value of 0.8.²⁰

¹⁹ Fan (1993) has demonstrated the superiority of the smooth local regression technique over kernel and other methods.

²⁰ As pointed out by Deaton (1995), graphs of the slope of the regression function $m'(x)$ may necessitate higher bandwidths than graphs of the regression function itself.

A useful feature of the smooth local regression technique is that it allows estimation, not only of the regression function at each point, but of its derivative as well. Given that both y and x are expressed in log form, the derivative of the regression function, denoted by $m'(x)$, is an estimate of the elasticity of calories with respect to income. Then a graph of the calorie-income elasticity estimate against the level of (log) income allows one to determine easily the extent to which the elasticity varies with income. Given the focus of the paper on the elasticity of calories with respect to income, I will limit my presentation and discussion to estimates of the slope of the regression function.

The topography of Indonesia also requires consideration of the differences in the cost of living across space within any survey year. For this reason my nonparametric analysis of the calorie-income relationship will be limited within a specific region: rural areas of the province of East Java. The reason for choosing this region is based on three factors: (1) rural East Java is very densely populated and has a high concentration of poor people; (2) there is a sufficiently large number of households sampled in this region, thus facilitating the application of the nonparametric regression method; and (3) a number of other studies have analyzed the calorie-income relationship in the same area (e.g., Ravallion 1990). In the latter part of the paper, I use regression methods that allow me to control for differences in the price level of food items, not only at the province level, but even at the village (or cluster) level. Figure 1 below graphs the estimated income elasticity of calories against the level of income for rural East Java in 1996 and 1999. The elasticity for 1999 was constructed using the per capita consumption that has been

deflated by the household-specific price index discussed above. The vertical line in the graph denotes the 25th percentile on the log of 1996 per capita expenditures in each region so as to make it easier to identify the poorest quartile.

Figure 1—Income elasticity of total calories in 1996 and in 1999, rural East Java, Indonesia

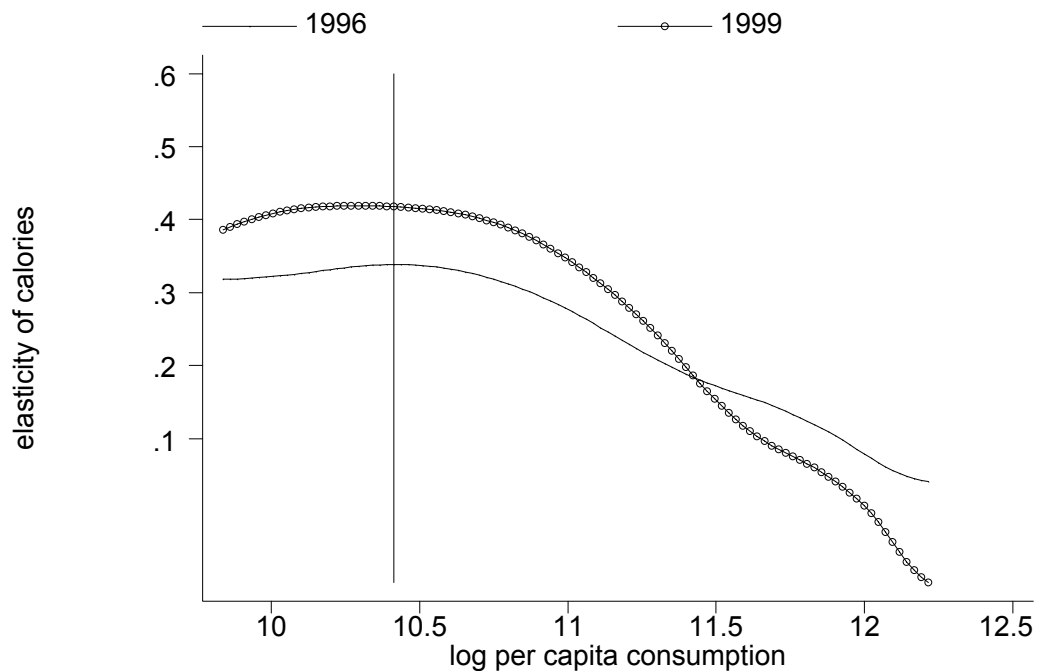


Figure 1 shows that the estimated relationship between the income elasticity of calories and income is best described as a curve rather than a straight line, as already indicated by earlier studies on the calorie-income relationship in Indonesia. At low levels of income, the elasticity in 1996, the year of normal price environment, rises slowly from 0.32 to 0.35. This estimate is very close to the 0.334 estimate reported by Ravallion

(1990) using SUSENAS data from the same province, and it is substantially lower than earlier estimates of calorie-income elasticity for Indonesia.²¹ Timmer and Alderman (1979), for example, using the 1976 round of the same SUSENAS survey, report elasticity estimates of 0.776 and 0.615 for households in the lowest and second-lowest quartiles of the income in rural areas of Indonesia. Chernichovsky and Meesook (1984), using the 1978 SUSENAS survey, report a slightly higher calorie-income elasticity estimate of 0.79 for the poorest 40 percent of households.²²

At income levels higher than the 25 percentile, the value of the elasticity begins to decrease steadily (Figure 2). The calorie-income elasticity in 1999 appears to have the same general shape, but it appears to be slightly higher among poorer households (just over 0.4), and slightly lower among richer households relative to the elasticity in 1996.

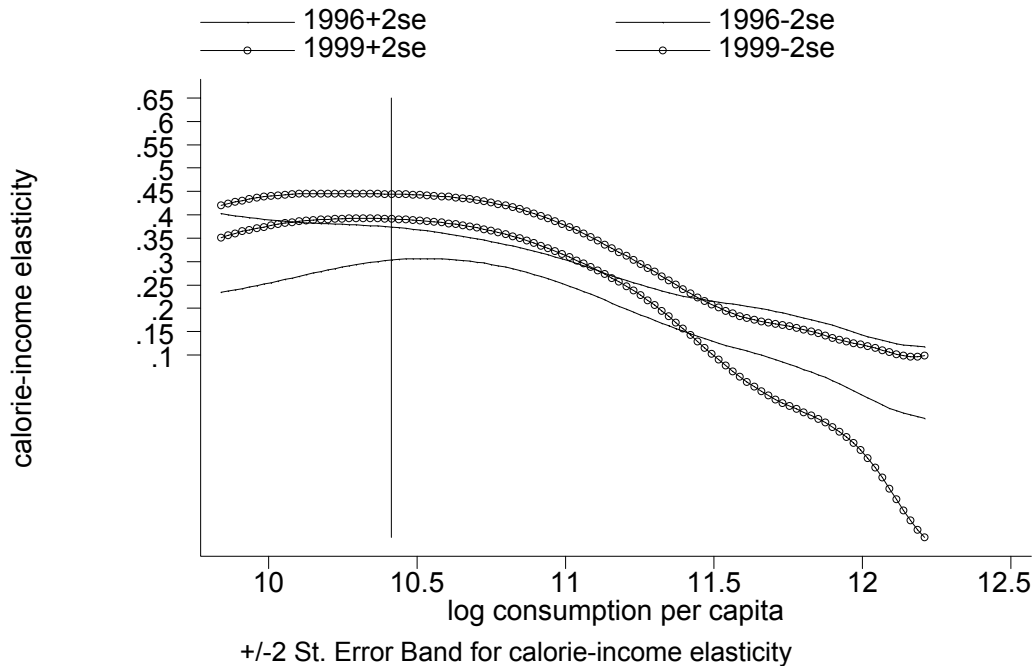
To determine whether the two elasticity values at each level of income are significantly different from each other, it is essential to have some estimates of the standard error associated with each of the elasticity values. Figure 2 graphs the standard error bands separately for the 1996 and 1999 estimates of the calorie-income elasticity. They were calculated using the formula

$$m'(x) \pm 2s.e(m'(x)).$$

²¹ Ravallion's (1990) estimate, derived from a regression model that allows nonlinear effects of income, is evaluated at one standard deviation below the mean. At the mean the elasticity is estimated to be 0.146.

²² Empirical studies based on the estimated (or actual) caloric intake of individual household members, typically obtained from 24-hour recall surveys, yield calorie-income elasticity estimates that are zero (Bouis and Haddad 1992 and Bouis 1994). This implies that changes in household income per capita will have little or no effect on malnutrition.

Figure 2—Standard error bands around the income elasticity for total calories in 1996 and in 1999, rural East Java, Indonesia



The standard errors in each year are estimated by bootstrapping (Efron and Tibshirani 1993) with a modification that takes into consideration the clustered structure of the SUSENAS sampling procedure.²³ One simple way of determining whether the elasticity estimates are significantly different at different levels of outlay is to check whether the standard error bands for the 1996 estimate overlap with standard error bands for the 1999 estimate. If at some range of outlay the standard error band for the 1999 estimate is clearly above the standard error band for the 1996 estimate, it is safe to say that the elasticity estimate in 1999 is significantly higher. The confidence interval bands around

²³ For a detailed description of how to do bootstrapping within a clustered sampling design, see Subramanian and Deaton (1996).

the estimated elasticity is wider at the tails of the distribution, suggesting that the elasticity is measured with less precision at the very bottom and very top ends of the distribution of per capita consumption. Nevertheless, there appears to be a considerable range of per capita consumption to the left and right of the vertical line at the 25th percentile, where the elasticity in 1999 is statistically significantly higher than that in 1996. However, although the increase in the calorie-income elasticity is significantly higher in a statistical sense, the increase does not seem to be substantially higher in any economic sense.

Regression Analysis

The analysis so far has focused on the bivariate relationship between calories and total outlay. Next, I examine whether the elasticity estimated by the nonparametric methods for 1996 and 1999 is robust to controlling for household age and gender composition and other observable characteristics. Given that Figure 1 reveals that the relationship between the log of caloric availability and the log of income is nonlinear, I estimate, separately for each survey round, linear regressions of the form

$$\ln CAL(i, \nu) = \alpha D(\nu) + \beta \ln CON(i, \nu) + \gamma (\ln CON(i, \nu))^2 + \delta \tilde{X}(i, \nu) + \eta(i, \nu), \quad (5)$$

where $CAL(i, \nu)$ is per capita caloric availability in household i in cluster/village ν , CON is per capita outlay (deflated in 1999 using the deflator of equation 2), α , β , γ , and δ are fixed parameter vectors allowed to vary across survey rounds, $D(\nu)$ is vector of binary

variables summarizing cluster-specific fixed effects, \tilde{X} is a vector of household characteristics, and η is an error term summarizing the influence random disturbances.

The cluster-specific fixed effects (denoted by $D(v)$) are included to control for price differences across clusters and other village or cluster-specific characteristics that may have also a direct effect on caloric availability.²⁴ The elements of the vector \tilde{X} are specified to be as follows: the logarithm of household size and variables characterizing the age and gender composition of the household, all expressed as ratios of the total family size (number of children aged 0–5 years, number of children aged 6–12 years, number of males and females aged 13–19 and 20–54 years, and the number of males older than 55 years). The list of additional binary variables includes whether the household head is female and a group of dummy variables describing the educational level of the household head and spouse, such as level of schooling, sector of employment, and whether self-employed, unemployed, or a wage worker.

Table 3 contains the estimated income elasticity of calories evaluated at the same point in each of the two years: the 25th percentile of per capita outlay in 1996 in each geographic region.²⁵ Equation (5) is estimated separately for the rural and urban regions of East Java as well as for the urban and rural areas of five regions of Indonesia (Sumatra,

²⁴ Each cluster contains 16 households that are surveyed by the SUSENAS.

²⁵ The elasticity estimates reported are obtained from 84 regressions estimated separately. To conserve space, the coefficients of the individual regressors are not reported, but are available upon request from the author. In all regressions, the parameters β and γ were significantly different from zero at conventional levels of significance.

Table 3—Calorie-income elasticity estimates using regression analysis

	Rural areas			Urban areas		
	1996		1999	1996		1999
	Elasticity	Standard error	Elasticity	Standard error	Elasticity	Standard error
Total calories						
East Java	0.36	0.0108	0.38	0.0081	0.27	0.0129
Sumatra	0.44	0.0081	0.48	0.0071	0.33	0.0106
Java and Bali	0.38	0.0056	0.41	0.0045	0.29	0.0064
Nusa Tenggara	0.53	0.0138	0.53	0.0139	0.35	0.0202
Kalimantan	0.47	0.0131	0.50	0.0105	0.36	0.0153
Sulawesi (including Maluku and I. Jaya)	0.51	0.0124	0.52	0.0112	0.35	0.0125
All regions pooled	0.43	0.0039	0.45	0.0034	0.32	0.0046
Calories from cereals						
East Java	0.18	0.0156	0.17	0.0130	0.02	0.0184
Sumatra	0.23	0.0119	0.33	0.0112	0.07	0.0161
Java and Bali	0.15	0.0080	0.19	0.0072	0.04	0.0095
Nusa Tenggara	0.38	0.0195	0.39	0.0209	0.12	0.0294
Kalimantan	0.26	0.0201	0.30	0.0165	0.06	0.0236
Sulawesi (including Maluku and I. Jaya)	0.39	0.0215	0.39	0.0189	0.16	0.0194
All regions pooled	0.23	0.0059	0.27	0.0053	0.07	0.0069
Calories from other foods (excludes grains and root crops)						
East Java	0.84	0.0177	0.80	0.0125	0.62	0.0199
Sumatra	0.88	0.0117	0.85	0.0100	0.71	0.0146
Java and Bali	0.87	0.0091	0.82	0.0071	0.64	0.0099
Nusa Tenggara	1.09	0.0274	1.11	0.0268	0.86	0.0301
Kalimantan	0.97	0.0212	0.80	0.0150	0.71	0.0203
Sulawesi (including Maluku and I. Jaya)	0.89	0.0191	0.89	0.0167	0.72	0.0173
All regions pooled	0.90	0.0063	0.85	0.0052	0.69	0.0067

Notes: Elasticities are evaluated for the 25th percentile of the 1996 per capita outlay in the respective region, using the parameters estimates from equation (5) in the text. For more details on the additional explanatory variables used in the regressions, see text.

Java and Bali, Nusa Tenggara, Kalimantan, and Sulawesi [including Maluku and Irian Jaya]).²⁶

The estimates for rural East Java reveal that the elasticity estimates obtained earlier from the nonparametric bivariate graphs are robust to the inclusion of other control variables. In 1996, the elasticity of calories from cereals is low; between 0.15 and 0.39 in rural areas and between 0.04 and 0.16 in urban areas, depending on the region examined. In contrast to cereals, the income elasticity for calories from other foods is higher, between 0.84 and 1.09 in rural areas and between 0.62 and 0.86 in urban areas.

A comparison of the income elasticity estimates for total calories in 1999 against those in 1996 reveals that the pattern that was observed in rural East Java also holds in urban East Java as well as within any other geographic region (rural or urban): the income elasticity of total calories either remains the same or increases slightly in 1999.

It is possible that focusing on the total energy available in the household may be hiding opposing changes in the income elasticity of specific food groups that cancel each other out, thus leaving the elasticity for total calories unaffected. I now turn to a discussion of the separate regressions for the demand for calories from cereals and calories from foods other than grains and root crops. In all other regions, the calorie-income elasticity for cereals is higher in 1999 while the income elasticity of calories from other foods remains the same or decreases in 1999. In urban areas, in particular, where the elasticity for calories from cereals is low during 1996, the normal year, the income

²⁶ Specifically, Sumatra includes province codes 11 to 18 (inclusive); Nusa Tenggara, codes 52 to 54; Kalimantan, codes 61 to 61; and Sulawesi, codes 71 to 82.

elasticity for calories from cereals more than doubles in 1999 (e.g., compare the elasticities in 1996 and in 1999 in urban areas in Sumatra, Java and Bali, and Kalimantan). Thus during the period of higher relative prices for cereals, households allocate a larger percentage of their additional income on cereals, even though they are costly relative to other foods.²⁷

One plausible interpretation of this finding is that it is consistent with the presence of a binding minimum subsistence constraint (Behrman 1988; Behrman and Deolalikar 1989). As higher prices decrease the purchasing power of income and push households below the minimum level of calories required for subsistence, households exhibit willingness to allocate a higher proportion of a marginal increase in their income to cereals. Irrespective of whether the relative price of cereals is higher, on an absolute level cereals continue to provide more calories per rupiah than any other food group.

The increase in the income elasticity of calories from cereals also appears to be accompanied by a corresponding decrease in the income elasticity for calories from foods other than cereals and root crops (such as cassava). This finding is consistent with what is predicted by economic theory for the extreme case where there are only two food groups being consumed, such as cereals and other foods, and utility is strongly separable in the consumption of nonfood items.

²⁷ There is practically no other empirical evidence that can be related to these findings. Timmer, Falcon, and Pearson (1983), in Figure 2.8 of their classic book, display a higher income elasticity for rice of poorer households during the September to December period, when rice prices are also higher, but they provide no discussion of this finding.

4. Concluding Remarks and Policy Considerations

This paper has examined the robustness of the income elasticity of the demand for calories to changes in the relative prices and economic environment price faced by households. Using household consumption and calorie data from the 1996 and 1999 consumption module of SUSENAS in Indonesia, the analysis revealed that the calorie-income elasticity is remarkably insensitive to changes in relative prices. The income elasticity of the demand for total calories in Indonesia appears to be slightly higher in February 1999 (the crisis year) compared to its level in February 1996. Although statistically significant, this increase in elasticity is very small, which implies that from an economic perspective, at least, the income elasticity of calories may be considered as invariant to the level of relative prices. This suggests the effectiveness of either cash transfer programs or other programs aimed at protecting *caloric availability* within households at a time of crisis do not run any risk of becoming less effective due to changes in the price environment faced by households. At a broader level, this finding suggests that structural parameters estimated using cross-sectional data from a normal economic environment continue to be very useful in describing economic behavior even at times of crises and higher inflation.

In an effort to uncover the main reasons behind this finding, income elasticity estimates were also obtained for calories from cereals and from other food crops (excluding cereals and root crops). The income elasticity of the demand for calories is a weighted aggregate of the income elasticity of the demand for individual food items, each

one of which may be sensitive to changes in the relative price environment faced by the consumer. The change in the income elasticity of calories for cereals may be countered by opposing changes in the income elasticity of other foods, thus leading to the absence of any significant effect of the change in prices on the income elasticity of total calories. A closer look at the changes in the income elasticity of the demand for calories from cereals and other food items in 1999 relative to 1996 reveals that the calorie-income elasticity for cereals as a group increases while the calorie-income elasticity for other food items as a group decreases.

The opposing changes in the income elasticity for cereals and other foods are not only consistent with economic theory, but also plausible with the presence of a binding subsistence constraint. As higher prices decrease the purchasing power of income and push households below the minimum level of calories required for subsistence, households tend to allocate a higher proportion of a marginal increase in their income to cereals. Irrespective of whether the relative price of cereals is higher, on an absolute level, cereals continue to provide more calories per rupiah than any other food group. This finding also highlights a serious limitation of an income transfer program aimed at protecting the consumption of nutrients of poorer households. Cash transfers may be effective at maintaining the total calories available at the household level, but as the analysis in this paper demonstrates, most of these calories are likely to be derived from cereals rather than the foods such as meat, fish, and fruits and vegetables that provide essential micronutrients. Any effort to maintain the consumption of micronutrients of

poorer households during a lengthy economic crisis must involve something different than or complementary to an income transfer.

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