The Relationship between Development Level and Supply and Demand of Main Agricultural Products

Burhan Ozkan and Figen Ceylan

The recent trends in primary food prices have been evaluated as a signifier of the potential threats to the world in terms of food shortages and hunger. The prices of primary agricultural products like wheat and rice have risen significantly in the essential producer countries. The recent price changes were partially attributed to production shortages, which, if true, are expected to constitute a critical problem for both the suppliers and demanders. The rising prices, in accordance with the food shortages, are expected to influence the developing countries and the poverty lines that are mostly determined by the food intake. Accordingly, a relationship between poverty and real food prices is suspected mainly for developing and the least-developed countries. With this in mind, this study investigates the relationship between development level, including the indication of income distribution, and the producer prices of rice and wheat. We analyze the degree of relationship between the Gini coefficient, indicating the level of income distribution, and various production indicators such as producer prices and yields of rice and wheat.

Analysis of the data reveals that it is not possible to infer a significant relationship between yield of rice or wheat and the level of national income distribution. When the rich and poor countries are discriminated according to the level of income distribution, it is understood that rising producer prices reduce the income inequality by less than one percent. We conclude that the relationship should be reviewed with respect to contemporary changes in prices and level of income distribution and aggregates of income distribution in order to make proper inferences.

Since the beginning of 2007, the price effects of the Green Revolution and the high pace of agricultural growth, especially in ancient agrarian countries, have been reversed. Many countries started to experience inflationary pressures on consumer prices of primary staples such as rice, wheat, maize, and their derivatives. Rising agricultural productivity initially affected economic growth and poverty in producer countries in two ways. Abundance of staples led to a decline in food prices, which benefitted the poor populations, who must devote much of their budgets to food, and poverty lines are determined according to food intake. The increasing food intake of the poor led to creation of labor-intensive industries, where real wages could be stabilized due to lower food prices, leading to economic growth and a decline in poverty (Timmer 2003). Therefore during Green Revolution growth in agricultural productivity was assumed to be the easiest way to end poverty in highly populated countries.

However, the decline in the staples prices was unsustainable. According to a European Commission Fact Sheet Report from June 2008, between 2007 and 2008 wheat prices in the European Union increased 96 percent and prices of dairy products increased by 30 percent. A U.S. Congressional Research Report from April 2008 indicated an average rise of four percent in food-commodity prices in the U.S. during 2007 and an expected rise of 3.5–4.5 percent for 2008; this report was issued prior to the price booms of mid-2008.

The reasons for this price-trend reversal can easily be enumerated. First, the growing global population and high-speed development of overpopulated countries such as China, India, and Brazil led to rising consumer demand accompanied by changing consumption patterns of the poorer populations of these countries. One of the indicators of this expansion was an overall contraction in the global supply of cereals as these countries started to impose export restrictions in order to meet local demand. Second, climatic conditions resulting from global warming led to poor harvests in Australia, Canada, and many European countries, which if they persist may result in harsher supply reductions. Third, due to the declining stock of fossil fuels the demand for bio-fuels started to rise. This rise resulted in devotion of many agricultural lands, mainly maize and soybean lands, to energy-crop production. This conversion contributed to the reduction in primary staples supplies at a time of rising global demand. Finally, the consistent rise in energy prices led to a rise in farm-input prices for machinery and fertiliz-

Ozkan is professor and head of the Department of Agricultural Economics and Ceylan is a doctoral student, Akdeniz University, Antalya, Turkey.

ers. The rise in input prices carried over to farm-gate prices, which, along with financial speculation in declining food-commodity stocks, resulted in rising consumer prices.

An essential consideration lies in whether the rise in producer prices leads to welfare improvements among agriculture and agricultural workers, who primarily tend to be poor. We investigate global prices of rice and wheat in 2004 and their effect on poverty as a preliminary study into whether food prices affect income discrepancies. We use the Gini coefficient, an inequality index, to measure the effects of prices on development, which can be linked to a decline in inequality.

In order to look deep inside the prices, we reviewed FAO data of wheat and rice prices in 2004 and 2005. The average real rise in producer prices for rice in 82 countries from 2004 to 2005 was found to be around five percent, but the primary rice producers experienced price increases between 20 percent and 30 percent in that period. Average real prices for wheat were almost stable between 2004 and 2005 among the 100 countries analyzed, but middle-income countries such as Brazil and Argentina experienced price increases of more than 30 percent. These countries are on the development path and have an increasing demand for agricultural products. Overpopulated countries such as China and India experienced price increases for wheat. These trends in rice and wheat process indicate two outcomes. First, producers face large demand from developing countries, and overpopulated producer countries such as India and China intervened in exports of products due to pressure from domestic markets and domestic prices. Second, developing countries are beginning to face higher producer prices due to rising per-capita income and food demand.

Gini Coefficient and Poverty Considerations

By examining the pattern demonstrated by Lorenz curves since 1910s, inferences can be made about the national and global distribution of income and consumption. The Lorenz curve is a graphical representation of the cumulative share of household income (or consumption level) to the cumulative number of households. The level of perfect equality is indicated where every household has an identical level of income, and the level of perfect inequality is indicated where only one household owns all income generated. Accordingly, a corresponding distribution and its geometrical demonstration by Lorenz Curve provide an interpretation of the distributive income equality of a single nation or of a group of countries or the world as a whole.

In order to simplfy the calculations, the geometrical demonstration is converted into a single number, the Gini coefficient. The Gini coefficient is twice the area between the line of equality and the Lorenz curve, and it takes a value between 0.0 and 1.0 (Barrett, Crosley, and Worsick 1999). The Gini coefficient functions as an indicator of income inequality as the value rises from 0.0 to 1.0. In another sense, the Gini coefficient is calculated as the mean difference in consumption or income levels between households relative to the household size (Jha, Gaiha, and Sharma 2006). Therefore the Gini inequality indicator can be calculated for both distribution of income and distribution of consumption. Generally the Gini coefficient for consumption is lower than the Gini coefficient for income, yet the overall pattern reflects the same situation, specifically when the baseline income tax system features a marginal tax rate of 0.30 (Benjamin, Brandt, and Giles 2004; Kopczuk, Slemrod, and Yitzhaki 2002). Therefore it is possible to infer the same outcomes about welfare inequality from both income and consumption indicators for most of the cases.

The applicability of the Gini coefficient to poverty analysis also makes it useful for assessment of poverty changes resulting from changes in primary agricultural prices. The incorporation of inequality and distribution is linked to market considerations for agricultural products. As the market starts to overstate the pricing mechanisms due to various factors, the market outcome may result in a degree of inequality that is highly unacceptable to the public (Ellis 1996). While an economic expansion affecting all parties improves the income situation of the parties, the reversal is also possible, and when coupled with price increases for primary staples it will be unsustainable (Ellis 1996). Farm output prices prove three main outcomes incorporating allocation of farm resources, distribution of incomes and changing capital formation in agriculture (Ellis 1996; Mellor 1968). In a study of 35 countries it was found that a one-percent growth in agricultural GDP per capita led to a 1.61-percent increase in the poorest parts of the population in these countries

(Timmer 1997; Norton 2004). So changes in prices can change the distribution of income, leading to a change in the situation both of the poor and of the rich.

There is a need to assess the relationship between agricultural price changes and changes in the distribution of income. This has gained importance, as indicated earlier, due to the recent extreme rises in prices of primary staples such as wheat and rice. Because the price booms are such a recent occurrence, full data for global prices and income distribution are not yet available. However, since the prices of primary staples have been rising in recent years, analysis of the relationship incorporating prior prices will be beneficial for future macro- and micro-level studies.

Data and Methodology

We determined the Gini coefficient for income level of producer countries using 2004 income data from the United Nations Development Program and 2004 producer prices from Food and Agriculture Organization of the United Nations. The analysis encompassed the prices of wheat and rice per ton and the Gini coefficient for 86 wheat-producer countries and 71 rice-producer countries.

The 2004 producer price ($/ton), yield (Hg/Ha), and Gini coefficient for the commodities are shown in Table 1. The data indicate that the most equal wheat-producer country was Denmark, while the most unequal country was Namibia. The minimum per-ton wheat price of 2004 was the Bangladeshi price, which was 1.7-percent of the price in Japan; it declined to 1.6 percent in 2005. The 2004 yield of Venezuela was 3.7-percent that of Belgium.

The data indicate that the most equal rice-producer country was Japan, while the most unequal country was Bolivia. The minimum per-ton rice price of 2004 was in Ethiopia, at 4.5-percent of price in Japan; in 2005 the minimum price was in Russia, 5.9 percent of Japanese price. The 2004 yield of Nigeria was 9.7 percent that of Egypt (Table 2).

The real producer prices of wheat and rice, being the explanatory variables, are regressed to the respective Gini coefficients, which are multiplied by 100 for ease of interpretation. A similar analysis was undertaken for the yield level of corresponding countries in 2004. The *a priori* data relationships and correlations were checked, and the relationship between the yield level and corresponding coefficients is found to be null. Therefore the analysis is completed for prices and the Gini coefficients where causal relationships can be inferred by correlations and Granger causality results.

The historical inequality of the countries is thought to be determinative in the relationship. The literature indicates that a Gini coefficient higher than 0.4 refers to high level of inequality (Yemtsov 2001). There are 30 wheat-producer and 42 rice-producer countries with a Gini higher than 0.4 (Figures 1 and 2)

Dummy variables differentiating high and moderate-low inequality levels are created. The highly unequal countries having Gini coefficient higher than 0.4 are indicated by a dummy variable of 1. In order to disaggregate the effect of already being poor, the Gini coefficient is multiplied by the dummy variable and this adjusted dummy variable is inserted in the regressions as an explanatory variable.

Findings

We used the E-Views 5.0 statistical package to estimate the equations.

According to the estimation outputs, it can be inferred that the coefficients are jointly significant with an absolutely high F-statistic ($p(F) = 0.00$) and the explanatory power of the variables in explaining the variation in Gini coefficient is 78 percent. Looking at the significant price coefficient, it can be inferred that a one-percent rise in real producer price in 2004 leads to a less than one-percent decline in the magnitude of Gini coefficient for that country on significant grounds. Having a Gini coefficient higher than 0.4 contributes to the Gini coefficient by 36 percent (Table 3).

According to the estimation of price and Gini coefficient for 2004, it is also possible to infer that the parameters are jointly have explanatory power ($p(F) = 0.00$) and the goodness of fit of the regression is 79 percent. The decline in the mean level of the Gini coefficient resulting from a rise in the producer price is less than one percent and the coefficient itself is affected by the inequality of the country by 31 percent (Table 4).

The findings in general indicate that higher producer prices led to a decline in the mean of Gini coefficients, resulting in a closure of the inequality

Table 1. Data Summary: Wheat.

Country	Gini Coefficient		Wheat Price 2004		Wheat Price 2005		Wheat Yield 2004	
	Maximum	Minimum	Maximum	Minimum	Maximum	Minimum	Maximum	Minimum
	Namibia	Denmark	Japan	Bangladesh	Japan	Bangladesh	Belgium	Venezuela
Level	0,743	0,247	1.368,14	22,69	1.351,51	21,77	89.805,76	3.333,33

Table 2. Data Summary: Rice.

Country	Gini Coefficient		Rice Price 2004		Rice Price 2005		Rice Yield 2004	
	Maximum	Minimum	Maximum	Minimum	Maximum	Minimum	Maximum	Minimum
	Bolivia	Japan	Japan	Ethiopia	Japan	Russia	Egypt	Nigeria
Level	0,601	0,249	2.292,05	103,81	2.015,14	117,97	98.384,16	9.562,64

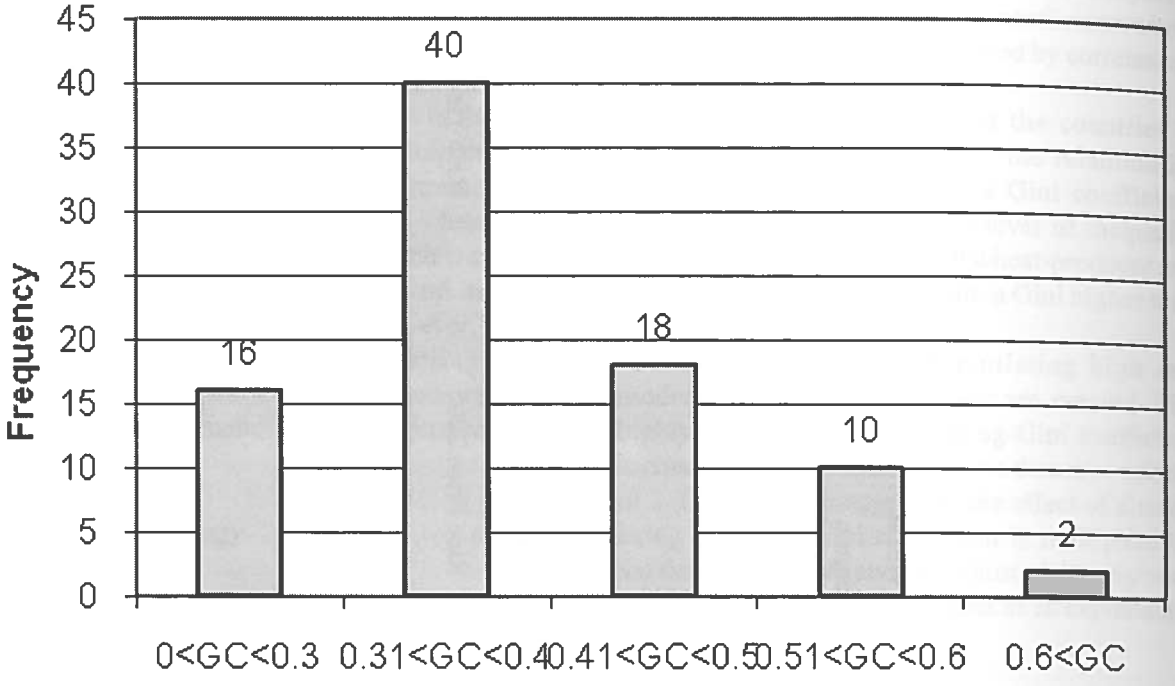

Figure 1. Gini Level Frequency for Wheat.

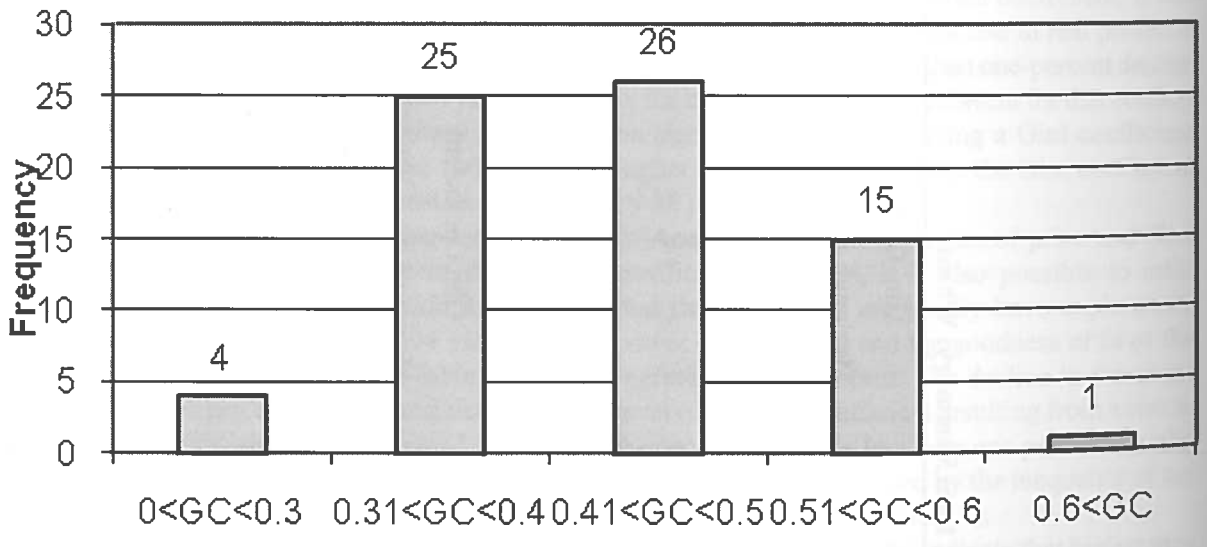

Figure 2. Gini Level Frequency for Rice.

Table 3. Wheat Price and Gini Coefficient Relationship.

Variable	Coefficient	t-statistic (p-value)
Constant	33.10	46.92 (0.00)
Adjusted dummy= dummy*Gini coef.	0.36	14.12 (0.00)
Price_2004	−0.0043	−2.48 (0.00)
Adj. R^2	0.78	
F (Probability F)	151.96 (0.00)	
Mean dependent var.	38.40	

Table 4. Rice Price and Gini Coefficient Relationship.

Variable	Coefficient	t-statistic (p-value)
Constant	34.60	41.91 (0.00)
Adjusted dummy= dummy*Gini coef.	0.31	15.78 (0.00)
Price_2004	−0.0031	−3.95 (0.00)
Adj. R^2	0.79	
F (Probability F)	72.46 (0.00)	
Mean dependent var.	140.52	

gap. The dummy variables affect the mean level of the Gini coefficients, but a unitary rise in the producer price for wheat reduced the Gini coefficient by 0.43 percent and a similar rise in the producer price for rice resulted in a decline of 0.31 percent. The goodness-of-fit statistics, which are obtained from the analyses, are of considerable importance: 78 percent for wheat and 79 percent for rice.

Conclusion

The preliminary research findings indicate a unilateral causation between the price indicators and national level of inequality, while no significant relationship to the inequality coefficient can be inferred through estimation of yield per country. However, even though the findings suggest relatively small changes result from a one-percent change in the producer prices, the trends need to be interpreted for the contemporary price boom as well. The magnitude of change is low, as expected, since the coefficient is an aggregate figure measuring all extremes in the society; the effect on the inequality coefficient resulting from the change in producer prices is found to be less than one percent. Direct effects of price changes on the poorer populations in these countries need to be measured. The Gini coefficient itself, manipulated with a variable differentiating countries that are highly unequal from relatively equal ones, affects the Gini coefficient by 30–35 percent.

We propose two possibilities for future research

based on inequality and producer price variation. Using the change in prices between 2007 and 2008 will provide a better explanation for the poverty challenges observed between 2007 and 2008; this preliminary research was undertaken with 2004 databases both for the Gini coefficient and for prices due to the unavailability of current data. Incorporation of 2005 prices for 2004 Gini data is considered to be less determinative. Interpretation of micro-level income and consumption distributions and their relation to farm-level incomes can provide deep insights into the effect of primary staples-price differentials. This analysis provides room for interpretation of the effect on rural households that are more dependent on agriculture as a sector.

The effects of pricing also need to be disaggregated. The interpretation of price policy effect on income distribution for agriculture by Ellis (1996) is still important for considerations regarding poverty reduction via changing income distribution. The rise in staple prices coupled with the decline in supply is expected to affect rural population and the distribution of income in many aspects. It is essential to keep in mind that farmers are also rural households demanding agricultural products, and rising prices are mostly beneficial to farmers producing a food surplus, but reduce the income of landless workers and farmers producing a food deficit. The benefited farmers producing a food surplus are the ones who are open to the market. This indicates commercialization of farming is essential in order to gain from price increases.

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