How Agricultural Research Affects Urban Poverty in Developing Countries? The Case of China

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Abstract: This paper develops a framework to measure the impact of agricultural research on urban poverty. Increased investment in agricultural R&D will lower the food prices through increased food production, and lower food prices will in turn help urban poor because they often spend more than 60% of their income on food. Using China as a case, the study empirically estimated these effects. These effects are large, and are comparable to those on rural poverty.

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Introduction

Many studies have confirmed high economic returns to agricultural research investment (Alston, *et al.*, 2000), and the impact of agricultural research on the livelihood of rural residents has also been widely documented (Fan, Hazell, and Thoart, 2000; Fan, Zhang, and Zhang, 2000). However, to our knowledge, no study has explored the link between investment in agricultural research and urban poverty reduction.

Increasing urbanization in the developing world has brought a remarkably rapid shift toward a worsening incidence of poverty in cities (Haddad, *et al*. 1999, Ravillion, 2000). Compared to their rural counterparts, urban dwellers must buy most of their food from markets and have to pay higher prices for their food. They spend a large share of their expenditures on food items, and therefore are more sensitive to changes in food prices. Investment in agricultural research may have kept food prices low, benefiting urban poor. The objective of this paper is to empirically estimate these effects to fill the gap in our knowledge on how agricultural research and development have affected urban poverty using China as an example.

We will use a three-step approach in our analysis. First, we use provincial-level data over 1970-1998 to estimate a production function for the Chinese agricultural sector. Agricultural research investment will be included in the production function as a variable to explicitly measure how agricultural research has contributed to production growth. Second, a food price equation is estimated to model price changes due to increased supply from agricultural research investment. Third, we use a comprehensive data set from the national urban household expenditure surveys from 1992 to 1998 to estimate the impact of food price changes on urban poverty. Our key hypothesis is that without agricultural research, food prices would be much higher and therefore urban households would need higher food expenditures to maintain the same level of living standard. Or alternatively, without agricultural research, many urban households would fall into poverty because they would have to spend more income on food.

The current research has very important policy implications. Many developing countries are facing increasingly budget pressure to cut government spending, particularly on agricultural research. Research administrators are often requested to provide the evidence of research impact on rural poor. However, ignoring the impact of agricultural research on urban poor would severely underestimate the overall impact of agricultural research on poverty.

The paper is organized as follows. We first review the historical trend of agricultural research investment in China, followed by a brief discussion of the change in urban poverty. Then we develop a conceptual framework for our analysis on how agricultural research affects poverty in urban China. The estimated results are discussed before we conclude the paper.

Agricultural Research Investment

Overall government spending on agricultural R&D has increased dramatically during the past four decades, but not without substantial year-to-year swings in spending (Table 1). Investment in agricultural research was quite modest during the first five-year (1953-57) plan, averaging 72 million 1990 yuan per annum. During the Great Leap Forward period (1958-60), expenditures on agricultural research increased dramatically, to 497 million yuan per year. The readjustments in the following three years reduced research expenditures to 425 million yuan per year. During the Cultural Revolution period, research expenditures increased very little to only 643 million yuan annually. Since 1977, the research expenditures have grown in a more stable and balanced pattern. However, it is worrisome to observe that total agricultural research expenditures have recently stagnated. There was virtually no increase of research expenditures in real terms after 1994.

Public agencies in China employ more agricultural scientists than any other public system in the world. There are three identifiable phases in the development of China's research personnel that have not always paralleled the pattern of development of the funds allocated to research. During the 1950s and 1960s, the number of researchers increased steadily. By 1973 there were about 10,000 scientists working in the Chinese system. From 1973 to 1990, there was a rapid increase in research personnel, from slightly over 10,000 researchers to almost 60,000; a rate of increase in excess of 10% per annum. During the third stage (since 1990), the number of the researchers has been stabilized around 60,000.

The increased number of researchers from new graduates combined with a lack of growth in expenditures caused expenditures per scientist to decline sharply from 1979 to 1982. Although research expenditures per scientist increased substantially in nominal terms after 1984, but increased only marginally in real terms.

Agricultural research expenditures as a percentage of total government expenditures were comparatively low in the 1950s, averaging 0.10% during 1953-57 and 0.38% for 1958-60. Since then the ratios have been relatively stable hovering around 0.50% to 0.55% except during the Cultural Revolution when the share was substantially lower. Agricultural research spending as a share of total national R&D expenditures has also been quite stable. China earmarked about 10% to 13% of total R&D expenditures for agriculture during the past four decades. In contrast, agricultural research expenditures as a percentage of government spending on agriculture increased steadily, from just 1.5% during the first five-year plan period to over 6% in the last decade.

As a percentage of agricultural gross domestic product (AgGDP), agricultural research investment was relatively low during the first five-year plan period, at 0.12%. But it increased dramatically during the Great Leap Forward period. The percentage has gradually declined from 0.56% during the mid-1960s to below 0.4% in recent years. This indicates that government investment in agricultural research has increased substantially in absolute amount for the last several decades, but has declined in relative to the size of the agricultural sector.

Urban Poverty

Compared to rural poverty, urban poverty is minimal in China. Using the poverty line of $1 per day per capita measured in 1985 purchasing power parity (or 1985 PPP dollar), the incidence of rural poverty is 11.5% in 1998, and the number of rural poor is 103 million (World Bank, 2000). The incidence in urban area is only 1.68% and the number of urban poor is 5.06 million (Table 2). Using this poverty line, the urban poor accounts for about 5% of the national total poor. In terms of per capita income, annual growth in the urban area is slightly higher than rural area, at 5.8% and 5.0% between 1990 and 1998, respectively. Therefore the income gap between urban and rural residents has increased from 2 to 2.5.

However, there are many reasons to believe that a higher poverty line should be used in urban areas. One of the prominent reasons is the much higher cost of living of urban residents than their rural cohorts. Therefore, in this study, in addition to $1 per day per capita of consumption expenditure, we also use $1.5 and $2.0 per day per capita as poverty lines to measure the incidence and the number of urban poor. Using the poverty line of $1.5 per day per capita, China would have 40.6 million urban poor in 1992 and 30.9 million in 1998, or a decline of 4.4% per annum. The poverty incidence would be 16.3% in 1992, and 10.1% in 1998.

The Asian Development Bank even used $2 per day and $3 per day per capita as poverty lines in measuring the urban poverty in China (ADB 2001). When $2 per day per capita is used, the number of urban poor would increase to 103 million in 1992 and 74.7 million in 1998, and the incidence of poverty would be 41.3% in 1992 and 24.4% in 1998.

One significant feature of the urban poor in China is their higher shares of food expenditures in their total consumption. If the $2 per day per capita poverty line is used, the urban poor spent more than 60% of their total expenditures on food, and the percentage declined only marginally to 58% in 1998. For average urban population, this share has declined from 56% to 50%. In 1992 the poor spent 4% more on food than the average urban residents in 1992, but 8% more in 1998. This strongly indicates that the urban poor would suffer more from higher food prices.

Econometric Model

The study develops a simultaneous equation system in which the agricultural production function, price determination function, and urban poverty equation are simultaneously determined. This is because many poverty determinants such as income and its distribution, production or productivity growth, and prices are generated from the same economic process as poverty. In other words, these variables are also endogenous variables, and ignoring this characteristic leads to biased estimates of the poverty effects. Second, agricultural research investment affects poverty through changes in food prices. It is difficult to capture this effect using a single equation approach.

(1) $$Y = h(LAND, LABOR, FERT, MACH, R_1, R_2, \ldots, R_l, IRRI, SCHY, ELEC, ROADS, RTR, RAIN, X)$$

(2) $$FP = g(Y, GDP, POP, S)$$

(3) $$UP = f(FP, M, Z)$$

Equation (1) models the agricultural production function. The dependent variable (*Y*) is agricultural output measured in constant prices. Arable land (*LAND*), labor (*LABOR*), machinery (*MACH*), and fertilizer (*FERT*) are included as conventional inputs. We also include the following variables in the equation to capture the impact of technology, infrastructure and education on agricultural production: current and lagged government spending on agricultural research (RDE, RDE_{-1},…, RD_{-i}); percentage of irrigated cropped area in total cropped area (*IRRI*); average years of schooling of rural population (*SCHY*); road density (*ROADS*), agricultural electricity consumption (*ELECT*), and number of rural telephone sets (*RTR*). Annul rainfall (*RAIN*) is included to capture the impact of agroclimatic conditions on agricultural production.

Institutional changes and policy reforms have contributed to a large share of rapid growth in agricultural and nonagricultural production and poverty reduction in rural areas. The objective of this study is not to quantify these effects as the previous studies have done so (Fan 1991, Lin 1992, and Fan and Pardey 1997). However, in order to reduce the estimation bias from omitting these effects in our model estimation, we add year and provincial dummies (*X*) to capture the year-specific institutional and policy changes and remaining agroclimatic factors on growth in agricultural production. This specification is more flexible than Fan (1991) and Fan and Pardey (1997) in which they used time-period dummies to capture the effects of institutional change on production growth.

Equation (2) models the determination of food prices (*FP*). Growth in agricultural production (*Y*) increases the supply of agricultural products, and therefore reduces food prices. The per capita GDP variable (*GDP*) and population variable (*POP*) are used to capture the demand side effect on food prices. The variable *S* measures the effects of the factors other rather growth in agricultural production, per capita income, and population on the changes in food prices. Similar to the poverty equation, we use both provincial and year dummies (two-way fixed effects) to capture the fixed effects.

Equation (3) models the determinants of urban poverty (*UP*).[1] The *FP* variable measures the impact of changes in food prices relative to nonfood prices on urban poverty. The variable *M* is per capita income of urban residents, which measures how mean income affects urban poverty.

[1] All variables without subscripts indicate observations in year t at the provincial level. For presentation purposes, we omit the subscript. The variables with subscript "-1,...-j" indicate observations in year *t-1*,...*t-j*.

The variable GINI measure how income distribution affects urban poverty. The variable *Z* measures the effects of factors other than food prices, mean income, and income distribution. We use both year and provincial dummies to capture these effects on urban poverty.

Data and Model Estimation

Data

Both urban poverty and income variables are constructed from the urban household survey. The urban household survey is conducted annually by the National Statistical Bureau to monitor the changes in urban household expenditures and consumption. The total number of households surveyed is 40,000 to 50,000 annually over 1992-1998. We have access of 10% of the sample with one representative city from each province.

For poverty measures, we first convert the poverty line in dollars measured in 1985 purchasing power parity (for example, $1, $2, and $3) into local current currency using the following procedure: We first convert the poverty line from 1985 PPP dollars into Chinese currency based on 1985 PPP exchange rate. Then we use the Chinese consumer price index to calculate the annual national poverty line at the current price. Finally, the provincial poverty lines are calculated by adjusting the difference in the cost of living. The provincial cost of living is calculated by assuming all provinces have the same cost of living in 1982 and multiplying by their respective growth in the price index after 1982.

For the urban poverty variable, we use the percentage of urban population who has less than $1.5 per day per capita measured in 1985 purchasing power parity. To test the sensitivity, we also use $2 per day per capita as the poverty line. The results are not sensitive to this change. However, when we use $1.0 and $3.0 per day per capita, the results show a significant difference. We prefer $1.5 per day per capita mainly because this urban poverty line is more comparable to the rural poverty line of $1.0 per day per capita.

The urban mean per capita income is calculated from the urban household expenditure survey, and the urban consumer price index is used as the deflator. The food price variable is measured as food procurement price index relative to urban consumer price index. The GDP variable is gross domestic product measured in constant prices. The population variable is total population of both urban and rural areas.

The land variable is measured as arable land. The labor variable is a person-year equivalent measure of workers engaged in agricultural production; fertilizer inputs are a pure-nutrient equivalent estimate of the chemical and manurial fertilizers used in agriculture; the power variable is an aggregation of total machinery horsepower plus draft animals measured in "horsepower equivalents"; while the irrigation variable is the percentage of irrigated area in total arable land. For the education variable, we use the percentage of population with different education levels to calculate the average years of schooling as our education variable, assuming 0 year for a person who is illiterate and semi-illiterate, 5 years with primary school education, 8 years with junior high school education, 12 years with high school education, 13 years with professional school education, and 16 years with college and above education. The road variable is defined as road density measured as length of roads in kilometers per thousand square kilometers of geographic areas.

Public investment in agricultural R&D is accounted for in the total national science and technology budget. The sources of agricultural R&D investment are from different government agencies. Science and technology commissions at different levels of government allocate funds to national, provincial, and prefectural institutes primarily as core support. These funds are primarily used by institutes to cover researchers' salaries, benefits, and administrative expenses. Project funds come mainly from other sources including departments of agriculture, research foundations, and international donors. Recently, revenues generated from commercial activities (development income) have become a particularly important source of revenue for the research institutes. The research expenditures reported in this study include only those expenses used to directly support agricultural research. The data reported here were taken from Fan and Pardey (1992) and various publications from Government Science and Technology Commission and Government Statistical Bureau. Research expenditures and personnel numbers include those from research institutions at national, provincial, and prefectural levels, as well as agricultural universities (only research part).

Input and output data are taken from various statistical yearbooks of State Statistical Bureau and Ministry of Agriculture. Road density and education levels are from various issues of *China's Transportation Yearbook*, *China Population Yearbook*, and *China's Education Yearbook*.

Functional Form and Estimation Technique

We use double-log functional forms for all equations in the system. More flexible functional forms such as translog or quadratic impose fewer restrictions on estimated parameters, but many coefficients are not statistically significant due to multicollinearity problems among many interaction variables. For the system estimation, we use the full information maximum likelihood technique.

Since our provincial urban poverty data are only available for six years—1992, 1994-1998, a two-step procedure was used in estimating the full equations system. The first step involves estimating production and price functions from 1970 to 1998. Then the values of *AP* at the provincial level are predicted using the estimated parameters. The second step involves estimation of the poverty equation using the predicted values of the *FP* variable at the provincial level using the available poverty data in 1992, and 1994-98. The advantage of this procedure is to fully use information available for all non-poverty equations, therefore increase the reliability of estimates and avoid the endogeneity problem of many variables in the poverty equation.

Lags and Distributions of R&D Investments

Government investments in R&D can have long lead times in affecting agricultural production, as well as long-term effects once they kick in. One of the thornier problems to resolve when including the agricultural research investment variable in a production function concerns the choice of appropriate lag structure. Most past studies use stock variables which are usually weighted averages of current and past government expenditures on R&D. But what weights and how many years lag should be used in the aggregation are currently under hot debate.[2] Since the shape and length of these investments are largely unknown, we use a free

[2]Alston *et al*. (1999) argue that research lag may be much longer than previously thought or even infinite. But for many developing countries where the national agricultural research

form lag structure in our analysis, i.e., we include current and past government expenditures on R&D in the production function. Then we use statistical tools to test and determine the appropriate length of lag for R&D expenditure.

Various procedures have been suggested for determining the appropriate lag length. The adjusted R^2 and Akaike's Information Criteria (*AIC*) are often used by many economists (Greene 1993). In this report, we simply use the adjusted R^2. Since R^2 estimated from the simultaneous system does not provide the correct information on the fitness of the estimation, we use the adjusted R^2 estimated from the single equation. The optimal length is determined when adjusted R^2 reaches maximum. The *ACI* is similar in sprit of adjusted R^2 in that it rewards good fit but penalizes the loss of degrees of freedom. The lag determined by the adjusted R^2 approach is 17 years.

Another problem related to the estimation of lag distribution is that independent variables (RDE, RDE_{-1}, RDE_{-2}, ... and RDE_{-i}) are often highly correlated, making the estimated coefficients statistically insignificant. Many ways of tackling this problem have been proposed. The most popular approach is to use what are called *polynomial distributed lags*, or *PDLs.* In a polynomial distributed lag, the coefficients are all required to lie on a polynomial of some degree *d*. In this report, we use *PDLs* with degree 2. In this case, we only need to estimate three instead of $i+1$ parameters for the lag distribution. For more detailed information on this subject, refer to

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systems are much younger than those in developing countries (often 30 to 50 years old), and their research are more applied types. Therefore, it is certain that research lags in developing countries are much shorter than those in developing countries.

Davidson and MacKinnon (1993). Once the lengths of lags are determined, we estimate the simultaneous equation system with the *PDLs* and appropriate lag length for each investment.

Estimation Results

The results of the systems equation estimation are presented in Table 3. For the poverty determination equation, we estimate the equation using the poverty lines of both $1.5 and $2 per day per capita. Most of the coefficients in the estimated system are statistically significant at the 5 percent confidence level (one-tail test). Since we used the double-log functional form, the estimated coefficients are elasticities in their respective equations.

The estimated agricultural production function (equation (1)) shows that agricultural research, improved roads, irrigation, access to electricity, and education have contributed significantly to agricultural production. The coefficient reported here for agricultural research and extension is the sum of the past 17 years coefficients from the *PDLs* distribution. The significance test is the joint *t* test of the three parameters of the *PDL*s.

The estimated food price equation (equation (2)) indicates that the increase in agricultural output does exert strong downward pressure on food prices with an elasticity of 0.439. However, the per capita GDP and population variables have little and statistically insignificant impact on agricultural prices.

The estimated poverty equation (equations (3a) and (3b)) shows that growth in per capita income has contributed most significantly to the rapid reduction in urban poverty. When the poverty line of $1.5 per day per capita is used, poverty elasticity to per capita income growth is -3.54. When the poverty line of $2 per day per capita is used, the absolute elasticity declines to -

2.13. This implies that poverty elasticity to growth in income is larger when a lower poverty line is used. On the other hand, worsened income distribution has increased urban poverty in both cases. Lower food prices have helped reducing urban poverty. For every one percent decline (increase) in food prices, 1.01% of urban poverty will be reduced (increased) when the poverty line of $1.5 per day per capita is used. The poverty elasticity to food price increases to 1.16 when the poverty line of $2 per day per capita is used.

Elasticities and Contribution of Agricultural Research to Urban Poverty

By totally differentiating equations (1)-(3), the impact of government investment in agricultural research and development in year *t-i* on poverty at year *t* can be derived as:

$$(4) \qquad dUP/dRDE_{-i} = (\partial UP/\partial FP)(\partial FP/\partial Y)(\partial Y/\partial RDE_{-i}).$$

By aggregating the total effects of all past government expenditures over the lag period, the sum of marginal effects is obtained for any particular year. When the poverty line of $1.5 per day per capita is used, the estimated elasticity of urban poverty to agricultural research is –0.064, i.e., for every one percent increase in agricultural research investment, 0.064 percent of urban poor will be reduced. But with the poverty line of $2 per day per capita, the elasticity declines to -0.053. Using these elasticities, we can further calculate the number of poor reduced for an additional 10,000 yuan invested in agricultural research. Similarly, we can also calculate total number of urban poor reduced annually attributed to agricultural research investment.

In Table 4, we also presented the effects of agricultural research on urban poverty using an alternative approach. Instead of estimating the elasticity of poverty to food price changes econometrically, we simulate the effects on the changes in urban poverty of changes in food prices. We calculate the average elasticities from 10 simulations by assuming a 1%, 2%, …, and 10% change in food price. These elasticities are much larger than those from econometric estimation (Figure 1). For example, when the poverty line of $1.5 per day per capita is used, it ranges from 1.83 to 3.10, higher than 1.69 from econometric estimation. When the poverty line of $2 per day per capita is used, the elasticity ranges from 1.51 to 1.84, again higher than 1.41 from econometric estimation.

As we have expected, in addition to its significant contribution to rural poverty reduction, agricultural research has played a large role in urban poverty reduction through lowered food prices. We first discuss the results estimated from econometric models. For every 10,000 yuan more investment in agricultural research, more 6.08 of urban poor would be reduced in 1992, and 3.96 of urban poor would be eliminated in 1998 when the $1.5 per day per capita poverty line is used. The poverty reduction effects are much larger when the $2 per day per capita is used as the poverty line. For every 10,000 yuan investment, 12.7 in 1992 and 7.9 urban poor in 1998 would be reduced, or more than 13.2 million in 1992 and 5.9 million urban poor have been eliminated because of increased research investments.

The poverty effect of agricultural research is declining as number of urban poor continues to decline over time. This indicates that agricultural research must have played even larger role prior to 1990. Unfortunately, due to the lack of urban poverty data in earlier years, we are not able to capture this large impact. Nevertheless, the impact is till large even today.

Household simulation reveals even larger poverty reduction effects of agricultural research investment. With $1.5 per day per capita as the poverty line, every additional investment of 10,000 yuan would eliminate 10.3 urban poor in 1992, and more than 5.1 in 1998.

Or almost 10.6 million urban poor in 1992 and 3.8 million in 1998 was eliminated due to increased investment in agricultural research. With the $2 per day per capita as the poverty line, every 10,000 yuan investment would eliminate 13.9 urban poor in 1992 and 8.9 in 1998.

When compared to rural poverty reduction, agricultural research has had comparable effects on urban poverty reduction. For every 10,000 yuan invested, 7.8 rural poor has been eliminated in 1997 (Fan, Zhang, and Zhang 2000). The large impact on rural poverty comes from not only increased agricultural productivity, but also improved nonfarm employment through agricultural and nonfarm sector linkages.

Conclusions

This study is designed to estimate the impact of agricultural research investment on urban poverty using the case of China. A system equation econometric model is constructed and estimated. The key feature of the model is to capture the impact of agricultural research on urban poor through changes in food prices. In addition to econometric estimation of poverty elasticity to food price, we have also simulated this elasticity using the household level data. The study combines the urban poverty data from the urban household survey with the published secondary level data on agricultural production, prices, and government investment in agricultural research.

The results show that agricultural research has played an important role in urban poverty reduction in the 1990s. Without increased investment in agricultural research, urban poverty in China would be much higher. The marginal returns to urban poverty reduction are comparable to the returns to rural poverty reduction. The urban poverty effects must have been even higher prior to the reforms in China, because agricultural research was used by the government to produce adequate food for urban and industrial development during most of the pre-reform period.

The large impact of agricultural research on urban poverty confirmed by this study implies that agricultural research may play an equally important (if not larger) role on urban poor. As the urbanization process continues in many developing countries, more attention has to be paid to how agriculture, particularly agricultural research, can contribute to the welfare of increased number of urban poor. Ignoring this effect, the overall returns of agricultural research investment to poverty reduction would be severely underestimated.

Table 1 : Public Investment in Chinese Agricultural Research

	Agricultural Research Expenditures	Number of Scientists	Expenditures Per Scientist	As a Percentage of Total Government Spending	As a Percentage of Total R&D Expenditures	As a Percentage of Total Government Spending in Agriculture	As a Percentage of Total AgGDP
	Constant 1990 Million Yuan		*Constant 1990 Yuan*	*%*	*%*	*%*	*%*
1953-57	72	n.a	n.a	0.11	11.04	1.49	0.12
1958-60	497	2,122	n.a	0.38	10.17	3.25	0.54
1961-65	425	7,469	56,829	0.56	10.24	3.90	0.57
1966-76	643	11,621	55,883	0.45	9.93	4.53	0.43
1977-85	1,348	30,257	45,669	0.56	10.34	5.24	0.44
1986-90	1,725	53,598	32,480	0.51	11.90	6.16	0.39
1991-94	2,099	61,876	33,886	0.54	14.29	6.14	0.39
1995-97	2,203	64,352	35,211	0.53	12.06	8.42	0.32

Sources: Fan and Pardey (1992), Fan and Pardey (1995), and State Statistical Bureau and State Science and Technology Commission (various years).

Table 2: Poverty and Income in Urban China

	Per Capita	Incidence of Poverty (%)			Number of Poor (million)			Engle Coefficient	
	Income (yuan)	($1.0/day)	($1.5/day)	($2/day)	($1.0/day)	($1.5/day)	($2/day)	All Sample	Poor
1992	2191	2.96	16.27	41.33	7.39	40.64	103.23	56.48	60.80
1994	2686	3.15	13.83	31.31	5.22	37.78	85.53	55.10	62.85
1995	2828	1.91	10.63	27.36	4.98	30.25	77.86	55.01	62.03
1996	2879	1.75	9.51	26.78	7.05	27.71	78.03	52.91	60.37
1997	3001	2.42	11.27	26.56	4.93	33.69	79.39	51.49	59.27
1998	3078	1.65	10.10	24.35	5.06	30.97	74.66	49.87	58.01
Annual growth rate									
1992-98	5.83	-9.28	-7.64	-8.44	-6.13	-4.43	-5.26	-2.05	-0.78

Note: Per capita income is measured in 1992 prices. Total consumption expenditures are used for poverty measures. The Engle coefficient is calculated as the share of food expenditure in total expenditures for the households who have per capita consumption expenditure of less than $2 per day.

Table 3: Estimates of the Simultaneous Equation System

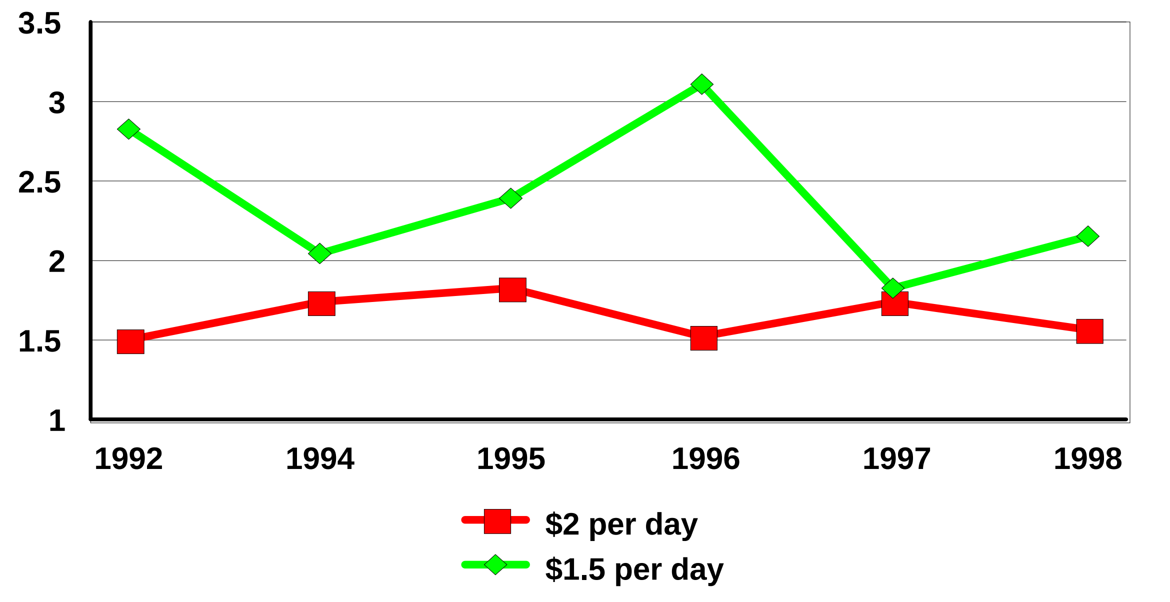
(1)	Y =	0.336 LAND (4.83)*	+ 0.229 LABOR (2.98)*	+ 0.351 FERT (6.70)*	+ 0.083 MACH (1.48)	+ 0.274 IRRI (4.57)*	+ 0.087 RDE (3.25)*	$R^2 = 0.976$
		+ 0.100 ROAD (4.22)*	+ 0.132 ELECT (6.09)*	+ 0.158 SCHY (4.93)*				
(2)	FP =	- 0.439 Y (2.86)*	- 0.026 GDP (-0.18)	+ 0.577 POP (1.50)				$R^2 = 0.795$
(3a)	P =	– 3.54 M (-16.35)*	+ 1.04 GINI (2.69)*	+ 1.69FP (4.37)*				$R^2 = 0.908$
(3b)	P =	– 2.13 M (-9.43)*	+ 0.529 GINI (1.83)*	+ 1.41FP (5.11)*				$R^2 = 0.916$

Note: Asterisk indicates significance at the 5% level. The coefficient for RDE is the sum of the coefficients for the past 17 years, and the *t-value* of the coefficient is the joint *t-value* of the coefficients for the past 17 years. The dependent variable in equation 3a is the incidence of urban poor using the $1.5 per day poverty line, while the independent variable in equation 3b is the incidence of poverty using the $2 per day poverty line.

Table 4: Impact of Agricultural Research on Urban Poverty

	Econometric Model				Household Simulation			
	Number of Poor Reduced Per 10,000 Yuan		Total Number Reduced (Million)		Number of Poor Reduced Per 10,000 Yuan		Total Number Reduced (Million)	
	$1.5/day	$2/day	$1.5/day	$2/day	$1.5/day	$2/day	$1.5/day	$2/day
1992	6.08	12.78	6.27	13.19	10.32	13.89	10.66	14.34
1994	5.27	9.88	4.51	8.45	6.43	12.41	5.50	10.61
1995	4.27	9.10	3.32	7.09	6.13	12.07	4.77	9.40
1996	3.31	7.73	2.59	6.03	6.15	8.55	4.80	6.67
1997	5.05	9.86	4.01	7.83	5.53	12.50	4.39	9.92
1998	3.96	7.91	2.96	5.91	5.14	8.93	3.84	6.67

Fig. 1 Elasticities of Poverty to Food Price



Note: These elasticities are obtained by simulating changes in urban poverty as a result of changes in food prices.

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