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China's Rural Enterprises: Effects of Agriculture, Surplus Labor, and Human Capital

by

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ABSTRACT

Rural industry is the most dynamic sector in China. I argue that rural industrialization is funded by agricultural accumulation, driven by surplus labor, and sustained by human capital. Rural reforms since 1978 have allowed Chinese peasants to retain a larger share of agricultural surplus to be transferred into rural industries. Rural surplus labor and shortage of farmland drive rural industrialization by the dynamic of extensive growth. Education is crucial for rural industrialization because market competition raises returns to human capital and industries need schooling more than does agriculture. 1991 data of 1,903 counties show that the top 10% of the counties produced over half of the total output by rural enterprises whereas the bottom 50% contributed little. Regression analyses confirm the above argument and find that education is the strongest predictor of rural industrial development.

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Rural industry is the most dynamic sector in China today. Official statistics show that the gross output value of rural enterprises increased from 171 billion yuan in 1984 to 1,162 billion yuan in 199 1, and 3,154 billion in 1993 (State Statistical Bureau 1994, p.363). After adjusting for inflation, from 1984 to 1993 the average annual growth rate was about 27%. Comparatively, the annual GDP growth rate was 9.5% in the same period. Rural enterprises contributed 13% in 1984, 27% in 199 1, and 32% in 1992 to the gross output value of the society; 33.7% in 1984, 59% in 1991, and 66% in 1992 to the gross output value of the rural society (Agricultural Bank of China 1993, p.338) The Ministry of Agriculture projected that by the year 2000, rural enterprises will produce one half of the total national output, replacing urban state sector as the leading sector in the national economy (Renmin *Ribao* Sept. 22,1993). Thus, rural industry has been acclaimed as China's new center of growth and profit (Li 1995; Zweig 1990).

The development of rural enterprises is market-driven (Nee 1989, 1991), although village (cun) and township *(xiang)* governments often play an organizing role (Byrd 1990; Huang 1990, p.220; Oi 1990; Wang *et el* 1995). Industrialization is the process of transforming agricultural surplus into industrial and transforming agricultural labor force into wage workers. The transference of agricultural surplus and labor into rural enterprises is motivated by a simple principle: increasing capital returns and labor earnings. Rural industrialization is thus different from the state industrialization process that siphoned agricultural surplus through bureaucratic central planning. The growth of rural enterprises since the 1980s has shown dynamics and efficiency that are unforeseen in the urban state sector.

The market-driven rural industrialization was made possible, albeit unintended, by Deng Xiaoping's rural reform programs. The implementation of various forms of

production responsibility system in 1978-83 shifted the basic unit of accounting and production from the production team to the household through contracts of farmland (Putternam 1993; Sicular 1992). The decollectivization of agriculture had two significant effects. First, it established partial property rights to farmland. Peasant households have the right to manage their contracted land and the right to dispose its residual income, although they can not alienate the land because the village formally owns it. The change in property relations boosted agricultural production (Nee 1986; Webb and Tuan 1992), even though is may just be a "one-shot" boost (Fleisher, Liu, and Li 1994). In addition, the state purchasing prices of major agricultural products increased sharply between 1978-80 and 1987-89 (State Statistical Bureau 1994, p. 231). The increase in state purchasing prices did not.change the low profitability of farming in the long run but did enable the peasants to retain a larger portion of agricultural surplus which provided the startup capital for rural industries and created home markets for consumer products and services. Peasants can now choose to set up a village or household enterprise with their retained agricultural surplus.

Second, the decollectivization of agriculture exposed and freed a huge rural surplus labor which had been bound to the limited amount of arable land under collective farming and the "gram first" policy (Huang 1990; Chang 1993; Lu 1995). Even though the existing household registration system restricts rural-urban migration, an increasing number of peasants are swarming into cities seeking temporary jobs (Cheng and Selden 1994; Wu 1994). The inefficient and stagnant urban state-run industrial sector is simply unable to absorb the rural surplus labor. Thus, rural industrialization becomes the only feasible alternative. It was the Chinese peasants rather than the central planners who, taking the opportunity of economic liberalization and marketization, opted this alternative

and then compelled the state planners to endorse it.[3] It turned out to be much more than just a solution for surplus labor. Huang (1990, pp.244-6) pointed out that the diversion of rural labor from farming to rural industries and sideline production reversed centuries-long pattern of growth in agricultural output without development in labor productivity and peasant income; and brought about for the first time a genuine possibility for transformative development.

QUESTIONS

Rural industrialization in China is uneven. Even though some rural areas such as Southern Jiangsu are fully industrialized (Zou 1995), most rural regions in inner China has little industry and remains backward. This is an often noted phenomenon that lacks systematic examination. Quantitative analyses of the regional variation of rural industry are very limited and based primarily on provincial level data (for example, Sengupta and Lin 1990; Islam 199 1; Fleisher, Liu, and Li 1994). Knight and Song (1993) argued that the county should be an appropriate unit of analysis because every county behaves like a little kingdom. Using 1987 county-level data, they examined geographic (primarily provincial) inequality in agricultural and nonagricultural income. Quantitative analysis of the factors that correlate with the regional inequality in rural industrialization is wanting.

The objective of this article is to examine the inter-county variation in levels of rural industrialization and explore its correlating factors. Using 1991 county-level data, I ask: (I) *How big are the regional variations in rural industrial development? (2)* ***What*** *explains the county level variations in rural industrial development?* I contend that rural industrialization is funded by agricultural accumulation, driven by surplus labor, and sustained by human capital. Consequently, I argue, regional variations in these resources

cause the regional inequality in rural industrialization. In the following I will first state my hypotheses regarding these factors and then explain why they should matter.

HYPOTHESES

1. Agricultural output is positively correlated with rural industrial output. Counties with a higher level of agricultural output have more capital for setting up rural enterprises. Although rural industrialization is induced by the declining agricultural productivity, it is supported, at least initially, by agricultural surplus.
2. Rural surplus labor has a positive impact on rural industrialization. A county with a large pool of "underlanded" peasants has a stronger drive for industrialization than a county with abundance of farmland for its peasants.
3. Human capital stock has a strong effect on the growth of rural industries. Rural enterprises operate under hard-budget constraints. They have to struggle for survival in fierce competition. Education provides an edge in competition. Other things being equal, a county with a better educated population have an advantage in developing rural industries over a county with a less educated population.
4. All the above hypotheses still hold after adjusting for provincial variation in rural industrial development.

Agricultural Accumulation

Agricultural accumulation supports rural industrialization by creating a consumer market and providing initial capital for setting up rural enterprises. Before 1978, most Chinese peasants lived under poverty. They were equally poor, barely able to make a subsistence. The rural reform has raised the living standard of a large section of the Chinese peasantry

above the level of subsistence. A representative sample survey of households done longitudinally by the State Statistical Bureau (1992, p.9, 13) shows that the per capita net annual income of rural households in 1978 was 133.57 yuan (in cash and kind), 76% of which was used for food, clothing, and fuel. The figure increased to 397.6 yuan in 1985, 58% of which was spent on food, clothing, and fuel; to 708.55 yuan by 1991, 60% of which was spent on food, clothing, and fuel *(ibid). The* proportion of nonagricultural income was merely 7% in 1978 and increased to 25% in 1991. Therefore, since mid-80s, peasants began to have some extra cash which they can use for building new houses or buying consumer products such as bicycles, sewing machines, wrist watches, and television sets, etc. Nationwide, the minimum purchasing power of each individual peasant implies a very large market.

Due to the lack of state investment and restrictions on factor mobility, agricultural surplus is the primary source of startup capital for rural enterprises (Knight and Song 1993, pp.200-1; Byrd and Gelb 1990, p. 364; Wang 1990, pp. 222-3). Although in 1983 the Communist Party officially ratified rural enterprises in industry, construction, transportation, commerce and catering, not a penny from the state budget was committed. Therefore, the startup capital for rural enterprises had to be generated locally. Although in advanced regions nonagricultural accumulation outweighs agricultural accumulation, the latter is crucial at the initial stage.

Declining agricultural productivity is the key behind the movement of agricultural surplus into non-agricultural activities. Agricultural reforms in the late 70s and early 80s led to a one-shot increase in the productivity. Since the mid-80s, drastic increases in the prices of agricultural input (fertilizers, pesticides, plastic films and etc.) made farming unprofitable (Webb and Tuan 1992; Zhu 1995). Agriculture compares miserably with

rural industry in terms of marginal labor productivity (Sengupta and Lin 1993) and rates of return to capital investment (Fleisher, Liu, and Li 1994, pp. 102-3). Agricultural productivity will remain low without some kind of land consolidation, a necessary condition of which is, however, sufficient industrialization absorbing rural surplus labor. The popular saying among Chinese peasants is: wealth comes only from industry.

Agricultural surplus can be transformed into capital for rural enterprises primarily through two channels: personal savings and local financial institutions. New private enterprises tend to raise funds through personal savings because they are discriminated against in obtaining bank loans. Village-and-township-run enterprises could sell stocks to villagers (Jizi) and sometimes do so as a condition for new workers (Wong 1988, p.25). Local bank deposits constitute the basic source of credit available for developing rural enterprises (Wang 1990; Byrd 1990). Initially, agricultural surplus is the primary source of local bank deposit. Even though per capital residual income from agriculture may be meager, its accumulation provides the crucial capital for starting industrial accumulation.

The banking system in China is highly regionalized (Wang 1990; Wang et el 1995). Local protectionism limits the cross-regional financial exchanges. Decollectivization of agriculture deprived local governments of the agricultural management function. But bureaucratic redistribution does not necessarily wither. In some advanced regions township and village governments take an active interest in rural industrialization and resume their redistributive functions for rural industries and sideline production (Byrd 1990; Huang 1990, p.220; Oi 1990; Nee 1992). In the early 90s about two-thirds of the total rural industrial output were produced by township-and-village-owned enterprises whereas the remaining one-third was produced by group-owned and privately-owned enterprises (State Statistical Bureau 1994, p.363). Protective of their

collective coffers, community governments build up barriers restricting the flow of local resources out of the community boundary. The mentality is that "fertile water must not run into other people's fields" (Wang et el1995).

Village credit cooperatives played an important role in transferring agricultural surplus into nonagricultural investment (Wang 1990 pp. 222-3; Zweig 1992, p.428). The initial governmental ratification of village credit cooperatives in the.early 1980s was intended to encourage peasants' investment in agriculture and to make up for the cut in state investment in agriculture. These credit coops turned out to be an effective agency for channeling agricultural surplus into rural industries. In 199 1, rural credit coops throughout the country received a total deposit of 27 1 billion yuan, 85% of which were from private households, and loaned 100.7 billion yuan to rural enterprises (State Statistical Bureau 1993, p.667).

It may be argued that rural enterprises, once taking off the ground, in turn promote agriculture (Bao 1991; Knight and Song 1993). Theoretically, the reciprocal causality between industrialization and agriculture may be obvious. But in the particular case of China's rural industrialization, it is far from being obvious. On the one hand, a small fraction of the profits from rural enterprises was invested in agriculture: 7.78 billion yuan (about 13% of the total profits) in 1990, 8.65 billion (12.6%) in 1991, and 10.5 billion (10%) in 1992 went back to agriculture nationwide (Agricultural Bank of China, 1993, p.336). Rural industrialization may also benefit agriculture through income redistribution of farming and nonfarming work. In some villages in Southern Jiangsu, for example, where the collective economy remains strong, farming and nonfarming jobs are paid about the same wage, a hidden form of subsidizing agriculture (Wang et el l995, p.50). On the other hand, the development of rural enterprises has adverse effects on agriculture. First,

the construction of rural enterprises uses and abuses farmland. China has been losing her limited arable land at an alarming speed in the last decade due to the development of market towns, setting-up of rural enterprises, and construction of private housing (Orleans 1992; Lu 1995). Second, rural enterprises provide an alternative to the back-breaking and not very rewarding agricultural activities. Fertile farmland is left uncultivated in relatively developed regions because peasants turn to nonfarming jobs (Lu 1995). In 1994 I visited a suburban village near Luoyang which is virtually a village corporation with a dozen factories. All the village farmland was left uncultivated except those used as factory sites. Given the earnings differentials between farming and nonfarming work, peasants will escape from farming whenever they can. Therefore, the net effect on agriculture from rural industrialization may even be negative.

The association between rural industrialization and agriculture observed in cross-sectional data is the end result of prior complicated processes. Doubtful of my ability to solve the reciprocal causality with cross-sectional data, I refrain from specifying simultaneous effects.4 I will interpret the association as the effects of agricultural accumulation on rural industrialization while admitting the possibility of confounding elements.

Rural Surplus Labor

Decollectivization of agriculture turned rural surplus labor force into potential wage laborers. Under collective farming, the production team was the basic unit of accounting. Peasants got work-points for their work on the collective farm and would be paid partly in kind (grain, cotton, and etc.) and partly in cash for their accumulated work points at the end of a harvest season. Individual peasants got their work assignments each day and

were not free to engaged in nonagricultural activities on their own. A craftsman had to have permission from team leaders to work his trade. He had to remit his earnings to his team for redistribution and got work points in return. The household responsibility system broke down the collective "big rice-pot." Freed from collective farms, peasants now become independent commodity producers. They can choose what to do and keep for themselves what they earn from agricultural and nonagricultural activities (Huang 1990; Luo 1990; and Lu 1995). They are free to become industrial wage laborers.

China has an acute shortage of farmland and a huge surplus of peasants. The size of China's rural labor force (without urban registration) was about 43 1 million in 199 1 and 444 million in 1993, which accounted for over 70% of the total labor force (State Statistical Bureau 1994b, p.21). Nationwide, the average land-labor ratio is about 3 ***mu*** (one fifth of a hectare) per peasant. On the basis of the current rate of agricultural productivity in China, Lu (1993, p.263) estimated that no more than 150 million are needed for agricultural employment. Therefore, roughly two thirds of the officially-classified peasants are surplus laborers and need find nonagricultural work. China's rural enterprises employed 52 million peasant workers in 1984,96 million in 1991, and 112.8 million or about 25% of the rural labor force by 1993 (Ministry of Agriculture 1992, p.9; State Statistical Bureau 1994, p.71). 331 million people were classified as agricultural laborers in 1993 but over half of them were actually unemployed. On the basis of the current rate of expansion of rural enterprises, the projected growth of labor force size, and the amount of arable land, Lu (1993, p. 236) predicted that in the year 2000 there will still be approximately 150 million surplus laborers in the countryside.

Labor supply may affect the development of rural industries through two mechanisms: availability of cheap labor and unemployment pressure. Although there is

each year a large army of "floating laborers" roaming the country in search of jobs, the household registration system still restricts formal migration and adds friction to the geographic flow of labor. Therefore, local abundance of cheap labor itself may be an advantage for local development of rural industries. More importantly, surplus labor exerts unemployment pressure on local community. Community governments play an active role in rural industrialization. They are concerned with the social goal of increasing employment as well as the economic goal of enriching their collective coffers (Byrd 1990; Oi 1990; Wang et el l995). Even though in the few developed regions (Zhejiang, Southern Jiangsu, and Guangdong), employment goal comes secondary to profits in the priority list by local cadres, it is the foremost motivation for the industrialization drive for cadres in less developed regions (Byrd 1990).

Human Capital Stock

The importance of education for the development of rural industries in China has been suggested by comparative studies (Svejnar and Woo 1990) and analyses of provincial level data (Sengupta and Lin 1993, p.190). Nee (1989) argued that the transition to a marketlike economy in rural China increases the returns to human capital and found that education raises peasant household income. Consistent with Nee's market transition theory, I argue that market competition enhances the returns to human capital. Rural enterprises, operate under hard-budget constraints and the profit-losing ones go bankrupt. Private and village-run enterprises receive no soft-budget protection at all. The township-owned enterprises receive only limited protection because township governments themselves are under hard-budget constraints and can not engage in deficit financing (Byrd and Lin 1990).

Therefore, the survival of rural enterprises is a competition of management skills and

production technology, which are directly linked to education. Formal schooling fosters entrepreneurial spirits and managerial ability, and helps peasants acquire industrial skills and technical know-how. A county with a large pool of educated entrepreneurs, managers, and workers who can read, calculate, digest technical literature, obtain and analyze market information will do well in competition. Conversely, a county with a large pool of illiterates and semi-illiterates will lose out in the competition for rural industrialization.

Human capital theorists (Becker 1964; Schultz 1960; Denison 1967) have long documented the effects of human capital stock on economic performance; but critics (Collins 1979) argue that education merely serves the function of producing and reproducing class stratification and contributes little to economic growth. In response to the debate, Hage, Gamier, and Fuller (1988) argue that education has a stronger impact on economic growth when it is related to the needs of the economy. I contend that rural industries need education and training more than does agriculture. Agricultural production in China is scattered among millions of small family farms, with simple technology, small investment, and low risk of bankruptcy. Comparatively, the operation of rural enterprises, even small ones, is much more complicated and requires much more skills, information, and calculation than the operation of family farms. The acquisition of management skills and industrial technology comes from schooling and training, as well as from experience; the acquisition of agricultural skills comes mainly from experience. Therefore, I expect that human capital is more important for the development of rural industries than for agriculture.

There are two types of human capital: (1) high-grade scientific and technological research and (2) general education and skill training. In the development of high technology industries, top scientists play the key role (Zucker, Darby, and Brewer 1994).

In low technology industries, mass education is important (Gamier and Hage 1990; Hage, Maurice and Fuller 1988). In general, China's rural industries are at a very low level of technological development. Rural enterprises commonly recycle old equipment from the urban state firms and only the exceptionally successful ones import state-of-the-art foreign equipment. Therefore, general human capital in the form of mass education and skill-training are most needed in China's rural industry. There are in fact very few college graduates, in the countryside. When rural enterprises do upgrade their technology, they tend to attract skilled workers and technicians from the urban state sector and universities and research institutes. Peng (1992) and Gelb (1990) found that among the employees in China's rural enterprises junior high-school education brings the highest return in wages.

The relationship between economic growth and human capital is also depicted as reciprocal (Rubinson and Browne 1994; Meyer and Hannan 1979; Inkeles and Smith 1974). I interpret the association between human capital stock and rural industrial output in my cross-section data solely as the effects of education on economic growth. The rural industrial development in China is too recent to contribute much to human capital stock. According to national statistics, in 1990,1991, and 1992, township and village enterprises invested only 1.47, 1.8 1, and 3.29 billion yuan, or 2.5%, 2.6%, and 2.7% of their total profits respectively, in the expansion of schools (Agricultural Bank of China 1993, p. 336). These investments seem too little to have any significant effects on the overall trend: school dropout rates in the countryside are actually on the rise (Wang et el 1995). Historical evidences from the United States, England, and France also suggest that early industrialization impedes rather than spurs educational expansion, because the opportunity cost of staying in school is too high (Fuller 1983; Gamier, Hage, and Fuller 1989; Smelser 199 1). Although industrialization may spur school expansion in the long run by

increasing the pay-off to human capital, we can safely assume that the educational data in 1991 mainly reflect the results of decades of campaign to reduce illiteracy and provide basic education for peasants prior to the burgeoning of rural industries in 1980s.

Provinces

Provinces differ widely in their levels of rural industrialization. Provinces differ in terms of natural endowments, historical heritage, provincial government policies, access to overseas investment, levels of urbanization and etc., as well as in agriculture, labor, and human capital. Therefore, different provinces have different starting points and different paces for rural industrialization. Controlling for provincial variations adjusts for the factors that produce the provincial variations.

DATA

My unit of analysis is the county. The State Statistical Bureau (1992) listed some 2,300 rural and suburban counties in 1991 in China. The data used in this study were collected in 1992 by the State Statistical Bureau and the Chinese Academy of Social Sciences for the purpose of evaluating affluent (Xaokang) counties in 1991. The study surveyed all the counties in 24 provinces (missing Liaoning, Hainan, and Tibet) and the three metropolitans (Beijing, Shanghai, and Tianjin). The whole data set covered 2,044 counties. I abandoned two provinces (Inner Mongolia and Qinghai, 123 counties) because of poor data quality; and deleted another 18 counties because they are either outliners or contain missing or inconsistent information. 1,903 counties are used in the following analysis.

DEFINITIONS

In this paper I define rural industries broadly to include all nonagricuitural enterprises that are owned by township (xiang), village (cun), group (zu), and single or multiple peasant households. Major variables in this paper are defined in the following.

1. **Rural Industrial Output** refers to the gross annual output value by all rural enterprises in industry, construction, transportation, commerce and catering in a county.
2. **Rural Population** is the year-end total number of people who are registered as rural residents in the specified county (excluding those with urban registration).
3. **Rural Industrial Output Per Capita** is the gross output value of rural enterprises averaged by the rural population.
4. **Gross Agricultural Output Value** is the total annual output of agriculture, forestry, animal husbandry, sideline production, and fishery
5. **Agricultural Output Per Capita** is the gross agricultural output value divided by the rural population.
6. **Land-labor Ratio** is the total amount of farmland divided by the total rural labor force. Rural labor force includes those who are registered as rural residents in the specified county but work and probably live outside of the county, and excludes those who work inside the county but are not registered as local residents. This is an inverse measure of rural surplus labor.
7. **Human Capital Stock** is measured as the proportion of people with at least junior high school or equivalent education in the whole population of the county.

METHOD

First I use univariate statistics to describe the cross-county variation in the levels of rural industrialization and then use regression analysis to explain the variation in terms of the agricultural output, land-labor ratio, education, and provincial differences. For comparison, I also estimate regressions of agricultural output on land-labor ratio and education.

Because rural industrial output, agricultural output, land-labor ratio, and the rural population size follow a lognormal distribution, I took their natural logarithms.
After exploring the data with a spline smoothing technique in generalized additive models (Breiman and Friedman 1985; Hastie and Tibshirani 1989) (see Appendices A and B), I decide to estimate the following equations:

For rural industries,

$$ln(I) = \beta_0 + \beta_1 ln(A) + \beta_2 ln(R) + \beta_3(E) + \beta_4(E^2) + \beta_5 ln(P) \quad (1)$$

$$ln(I) = \beta_0 + \sum_i \gamma_i PRV_i \quad (2)$$

$$ln(I) = P_O + \beta_1 ln(A) + \beta_2 ln(R) + \beta_3(E) + \beta_4(E^2) + \beta_5 ln(P) + \sum_i \gamma_i PRV_i \quad (3)$$

For agriculture,

$$In(A) = \alpha_0 + \alpha_1 ln(R) + \alpha_2 ln^2(R) = \alpha_3(E) + \alpha_4(E^2) + \alpha_5 ln(P) \quad (4)$$

$$In(A) = \alpha_0 + \sum_i \lambda_i PRV_i \quad (5)$$

$$In(A) = \alpha_0 + \alpha_1 ln(R) + \alpha_2 ln^2(R) + \alpha_3(E) + \alpha_4(E^2) + \alpha_5 ln(P) + \sum_i \lambda_i PRV_i \quad (6)$$

where "I" stands for per capita output value by rural enterprises; **"A"** for per capita agricultural output; "R" for land-labor ratio; "E' for percent of people in the county with junior high school or higher education; "P" for rural population size; **PRVi** is a dummy variable for provinces, with i = 1,2 ,..., 26.

Because population size is a component in the dependent variable, it is included in some equations (1,3,4, and 6) as a control variable. Firebaugh and Gibbs (1986, 1987) suggested that when using the ratio variable method to control for population size, one should include the appropriate form of the denominator in the left-hand side of the equation as well. 6

As my data set includes more than 80% of all the counties in China, conventional statistical inference is no longer meaningful. But I will compute standard errors for calibrative purpose. Efron and Tibshirani (1993) recommend bootstrapping standard errors for population data. Bootstrapping is a resampling technique for empirically describing the sampling distribution. The basic operation involves randomizing the data by resampling whole data with replacement repeatedly. The sampling behavior of the data is thus obtained by a large number of replications. Efron and Tibshirani advise (1993, p.52) that for statistical inference 1 ,OOO-2,000 replications are needed; for computation of standard errors, 200 replications are adequate. All computation is done in S-plus (Chambers and Hastie 1992).

DESCRIPTION: HOW BIG IS THE INTER-COUNTY VARIATION?

In 199 1, the average population size of a county was about 474,000; the median population size was 392,000 (Table 1). The largest county had an end-year population

slightly over 2 million and the smallest county about 7,500 people. On average, about 88% of a county's population were registered as rural residents. The remaining 12% were registered as urban residents, mostly living in the county town (xian **cheng)** where the county government is located.

[Table 1]

Figure l]

The development of rural enterprises was highly skewed toward the top. Figure 1 presents the cumulative percentage of the rural industrial and agricultural output value at ten percentile intervals in ascending order. The vertical axis indicates the cumulative percentage of the total output value. The top 10% of the 1,903 counties accounted for more than half of the total output value by rural enterprises; the bottom 50% only accounted for about 6% of the total rural industrial output (Figure 1). The leading county, Wuxi, reported a total output of 14.9 billion yuan by its rural enterprises in 1991; the lagging county reported only 130,000 yuan for the same year (Table 1). The average output was about 422 million yuan per county and the median was about 156 million. In term of per capita rural industrial output, Wuxi county again lead the country: 16,800 ***yuan in*** 199 1 ***The*** lowest county was about 2 yuan per capita. The mean was 903 yuan and the median 467 yuan (Table 1).

Agricultural production was less uneven than rural industrial development, but still had a long tail at the high end (Figure 1). The top 10% of the counties accounted for 70% of the grand total; the bottom 50% accounted for 20% of the grand total. In term of total volume, the mean was 367 million yuan; the median 275 million yuan; the maximum 2,285 million yuan; the minimum 6.6 million yuan. In terms of agricultural output per capita, the mean was 9 10 yuan; the median 8 14 ywan; the maximum 3,89 1 yuan; the

minimum 208 yuan The standard deviation for agricultural output per capita was 440 whereas that for rural industrial output per capita was 1,492, even though their means were quite close (Table 1).

The county level distribution of land-labor ratio was also highly skewed toward the top. The highest county (in Helongjiang) had 194 *mu* of farmland per peasant; the lowest county had less than a quarter *mu* per peasant. The unweighted mean was about 5 *mu* per peasant and the median was 2.8.

The proportion of people with junior-high school education followed a normal distribution, with its mean and median virtually equal: 28% of the population of an average county had completed junior-high schools. The most educated county had 6 1% of its population with junior-high school education; the least educated county had less than 3% (Table 1).

Regression Analyses

Table 2 presents the regression analysis of rural industries; Table 3 that of agriculture. Both the least-squares t-scores and the bootstrapped t-scores are presented alongside with parameter estimates. Analysis of variance is also presented to indicate the net contribution to the explained variance by each variable or set of dummy variables after controlling for all other variables in the equation. The number of cases in each province is presented in place of t-scores as F-tests for the whole set of dummy variables, which are significant, are more useful than individual t-tests. Four general observations can be made from Tables 2 and 3:

[Tables 2 and 3 about here]

(1) The rural industrial output per capita is strongly associated with agriculture, land-labor ratio, and education, controlling for the size of rural population. The four variables together explain over 50% of the total variance (I).' In comparison, only 24% of the variance of the per capita agricultural output is explained by education, land-labor ratio, and the population size (IV).

(2) Education is the strongest predictor of the rural industrial output per capita, with the largest net contribution to R2.

(3) The provinces vary greatly in terms of both agricultural and rural industrial development. Provincial-level variations capture 50% of the total inter-county variances of both variables (II and V).

(4) With provincial variations being controlled for, per capita agricultural output, land-labor ratio, and education still demonstrate significant, albeit reduced to different degrees, effects on the level of rural industrialization. Together with provincial variations, they explain over 70% of the total variance (III).

To illustrate the relationships among rural industrial development, agriculture, surplus labor, and human capital stock, Figure 2 presents a path diagram based on (I) and (IV). In general, agricultural output has a positive effect on rural industries; education has a strong positive effect on rural industries and a weak positive effect on agriculture; land-labor ratio has a **negative** effect on rural industries and a **positive** effect on agriculture. In the following I discuss the individual effects in detail.

[Figure 21

Agriculture

With land-labor ratio controlled for, agricultural output per capita measures agricultural efficiency. Rural industrialization is supported by efficient agriculture. The relationship

between agricultural and rural industrial output is consistent.' According to Model I of Table 2, with the same educational level and land-labor ratio, a double in agricultural output per capita is expected to increase rural industrial output per capita by 73% [$\approx 2^{.79} - 1$].[9] If provincial variations are controlled for, a double in per capita agricultural output is expected to increase per capita rural industrial output by 69% [$= 2^{.755} - 1$] (III).

Land-Labor Ratio

As expected, the land-labor ratio has a negative effect on per capita rural industrial output: less land per peasant, more rural industries (I and III). In other words, more surplus labor, more, rural industries. The parameter estimate is only slightly affected by the controlling of provinces.

[Figure 3]

Figure 3 presents the relationships between the land-labor ratio and per capita rural industrial and agricultural output based on (I) and (IV). The horizontal axis is land-labor ratio in logarithmic scale; the vertical axis indicates the expected percent increase or decrease in per capita output. Other things being equal, rural industrial output per capita is expected to increase by 30% for a 50% decrease in land-labor ratio. When land-labor ratio decreases from 60 mu to 3 mu per peasant, rural industrial output per capita is expected to triple; from 3 mu to 0.5 *mu,* another double is expected."

The effect of the land-labor ratio on agriculture is in the opposite direction to its effect on rural industries, and weaker. When land-labor ratio increases from 3 *mu* to **60** mu per peasant, agricultural output per capita is expected to increase by about 80%.[11] The relationship between land-labor ratio and agriculture is U-shaped, indicating that on average counties with 3-4 *mu* farmland per peasant produce smaller per capita agricultural

output than counties with less farmland. Scrutiny of the data reveals that land-labor ratio has an uneven geographic distribution: the low range consisting mainly of South-eastern provinces (Zhejiang, Guangdong, and Fujian) with favorable climate conditions and advanced sideline production; the median range mainly of central and Northern provinces (Henan, Hebei, Shaanxi, etc.) with harsh climate and barren soil. When the provinces are controlled for, the effect of land-labor ratio on agriculture becomes consistently positive, with its square term insignificant (VI).

Stock of Human Capital

Human capital stock is the strongest factor in county-level variations in rural industrialization. Figure 4 presents the relationship of education with rural industries and agriculture. In comparison, the human capital pay-off to rural industries is much greater than that to agriculture. Take a county with 10% of its population having completed at least junior-high schools as the baseline for comparison. Other things being equal, a county with 20% junior-high school graduates is expected to produce 172% more rural industrial output than the baseline county; a county with 30% junior-high school graduates produces about 500% more; and a county with 50% junior-high school graduates 1,587% more.[12] The parallel increases in per capita agricultural output are 40%, 75%, and lOO%, respectively.

The quadratic function of education suggests that the rate of return to human capital declines as more people obtain junior-high school education. This is probably because the rural development in China is still at such a low level that the best educated counties can not yet fully employ their human capital.

Provincial Variations

Provinces differ greatly in the development of rural industries. The inter-provincial variations alone account for 50% of the total variance in rural industrial output per capita (II). Part of the between-province variation is due to the fact that provinces differ in terms of human capital stock, agricultural output, and land-labor ratio. Netting of those effects, provinces account for 20% of the total variance of rural industrial output per capita (III). Thus, 60% [=l- 20/50] of **the** inter-provincial variance in rural industrial output per capita is due to inter-provincial differences in agriculture, land-labor ratio, and education. The remaining inter-provincial variance is to be explained by factors not considered here, such as geographic endowments, access to foreign and overseas investment, provincial government policies and so on.

If we leave the three metropolitan regions (Shanghai, Tianjin, and Beijing) aside as special cases, Jiangsu, Zhejiang, and Fujian lead the country in the development of rural enterprises (II). Closely following the lead are Hebei, Guangdong, and Shandong. At the bottom of the list are Guangxi and Yunnan. The average rural industrial output per capita in Jiangsu is about 27 times [$= e^{3.29}$] that in Yunnan. The rankings of provinces are largely consistent with intuitive understanding of China's economic geography, except Hebei which is ranked above Guangdong." Controlling for agricultural output, land-labor ratio, and education greatly reduces the inter-provincial gaps (III). For example, the ratio of per capita output of Jiangsu over Yunnan is narrowed from 27 folds to about 6 folds [$= e^{1.84}$]. Therefore, the differences between the two provinces in rural industrial development are mainly due to their differences in human capital stock, agriculture, and land-labor ratio. Some provinces (e.g., Zhejiang and Guangdong) are downshifted in (III) because they are best explained by those factors.

The provincial rank-order of per capita agricultural output in (V) is notably incongruent with that of rural industries in (II). Especially, Helongjiang, Jilin, and Xinjiang, quite obscure in rural industrial development, rank at the top rungs above Jiangsu, Zhejiang, and Fujian which lead the country in rural industrialization. The three "agricultural" provinces have the highest land-labor ratios in the country (Appendix C). When land-labor ratio and education are taken into account, they rank below Fujian, Jiangsu, and Zhejiang (VI). Apparently, shortage of farmland and agricultural efficiency have contributed to the high level of rural industrialization in Jiangsy Zhejiang, and Fujian; whereas abundance of farmland has elevated agricultural output but slowed down rural industrialization in Helongjiang, Jilin, and Xinjiang.

SUMMARY AND CONCLUSION

Huang (1990) argued that the recent rural industrialization in China has created a possibility for truly transformative development. The data in this study suggest that at the current stage only a small section of Chinese peasantry are really enjoying a transformative development while a vast majority of rural areas remain agrarian. The bulk of China's rural enterprises is concentrated in a small number of counties along coastal regions and around metropolitan cities. Although limited in scope, the dynamic growth of rural industries is making it the leading sector in the national economy.

I have argued that rural industrialization is funded by agricultural accumulation, driven by surplus labor, and sustained by human capital. Although mandated by the declining'agricultural productivity, rural industrialization is supported by efficient agriculture. Agricultural accumulation provides a mass consumer market and the startup

capital needed for setting up rural enterprises. The market-driven rural industrialization was made possible by Deng Xiaoping's rural reform programs. Under collective farming, agricultural surplus was siphoned away by the bureaucratic redistribution center. Chinese peasants did not have any rights over the management and residual income of agriculture. Central planning suffocated peasants' initiatives and "Grain first" policy restricted diversification. Agricultural reforms and increases in the state purchasing prices of agricultural products allowed Chinese peasants to retain a larger share of the agricultural surplus and to transformed it into capital, via rural credit cooperatives, for more profitable nonagricultural activities. Thus, regions with efficient agriculture are better funded for rural industrialization. Agricultural accumulation helps rural industries take off the ground and start nonagricultural accumulation.

China's rural industrialization at the current stage is driven by the dynamics of extensive growth. Extensive industrialization is achieved primarily through increasing labor input (Komai 1992, pp.180-86). China's rural industrialization is fueled by a huge "underlanded" peasantry and has a long way to go before it exhausts this fuel source. Consequently, Chinese government may have a relatively long period time for gradual reform before it faces the deep structural crisis caused by the transition from extensive growth to intensive growth, which had precipitated the bankruptcy of the Eastern European and Russian economy (Szelenyi, Beckett, and Ring 1994).

Human capital is the strongest factor differentiating regional rural industrialization. Consistent with human capital theory, the proportion of junior-high school graduates in the population has a strong positive effect on the development of rural enterprises. Contrary to credentialing theory (Collins 1979), the aggregate impact of formal schooling on China's rural industrialization is unequivocal, although it may have helped sorting

people into different class positions. I argue that education feeds the development of rural enterprises because it provides an edge in the competition for the survival of firms. Because formal schooling is more relevant to rural industries than to agriculture, its effect on rural industrial output is greater than that on agricultural output. Chinese government's long-time campaign at reducing illiteracy and providing mass education to peasants seem to be paying off finally in the "unexpected" rural industrialization.

The effects of agriculture, surplus labor, and education on rural industrial development have a similar mechanism: increasing the returns to capital, labor, and human capital. In this sense, regional variations in the development of rural enterprises are governed by market forces. When allowed partial property rights and freedom, Chinese peasants, often organized by village and township leaders, followed the principle of rationality, made the best use of available capital, labor, and human resources and created the most dynamic sector in China's economy today.

References

Agricultural Bank of China. 1993. *China 's Statistical Yearbook of Rural Banking 1993* (Zhongguo Nongcun Jinrong Tungji Nianjian). Beijing: **China** Statistical Publishing House.

Bao, Y. 1991. "Township and village enterprises should be developed together with agriculture." *China Industrial Economic Research* (Zhongguo Gongye Jingji Yanjiu) 2,55-56.

Breiman, L. and J.H. Friedman. 1985. "Estimating optimal transformations for multiple regression and correlation (with discussion)." *Journal of American Statistical Association 80:580-619.*

Byrd, William A. 1990. "Entrepreneurship, Capital, and Ownership." Pp. 189-217 in *China 's Rural Industry: Structure, Development, and Reform,* edited by William A. Byrd and Lin Qingsong. Oxford University Press.

Byrd, William A. and Lin Qingsong. 1990. "China's Rural Industries: An Introduction." Pp. 3-l 8 in *China's Rural Industry: Structure, Development, and Reform,* edited by William A. Byrd and Lin Qingsong. Oxford University Press.

Chambers, John M. and Trevor J. Hastie. 1992. *Statistical Models in S.* California: Wadsworth & Brooks/Cole Advanced Books & Software.

Chang, Kyung-Sup. 1993. "The Peasant Family in the Transition from Maoist to Lewisian Rural Industrialization." *The Journal of Development Studies 29:220-244.*

Cheng, Tiejun and Mark Selden. 1994. "The Origin and Social Consequences of China's *Hukou* System." The *China Quarterly 644-68* (1994).

Collins, Randall. 1979. *The Credential Society: A Historical.Sociology of Education and Stratification. New* York: Academic Press.

Denison, Edward 1967. Why *Growth Rates Differ: Postwar Experiences in Nine Western Countries.* Washington, DC: Brookings Institution

Efron, Bradley, and Robert J. Tibshirani. 1993. *An Introduction to the Bootstrap. New* York: Chapman & Hall.

Firebaugh, Glenn, and Jack P. Gibbs. 1986. "Using Ratio Variables to Control for Population Size." *Sociological Methods and Research 15:* 101-l 17.

---------. 1985. "User's Guide to Ratio Variables." *American Sociological Review 50:713-22.*

Fleisher, Belton M., Yunhua Liu, and Hongyi Li. 1994. "Financial Intermediation, Inflation, and Capital Formation in Rural China." China Economic *Review* 4: 1 01- 15.

Fuller, Bruce. 1983. "Youth job structure and school enrollment, 1890-1920." Sociology of *Education 56:145-56.*

Gamier, Maurice and Jerald Hage. 1990. "Education and Economic Growth in Germany." *Research in Sociology of Education and Socialization 9:25-53.*

Gamier, Maurice, Jerald Hage, and Bruce Fuller. 1989. "The strong state, social class, and controlled school expansion in France, 188 1-l 975." *American Journal of sociology 95:279-306.*

Gelb, Alan. 1990. "TVP Workers' Incomes, Incentives, and Attitudes." Pp. 280-98 in *China 's Rural Industry: Structure, Development, and Reform,* edited by William A. Byrd and Lin Qingsong. Oxford University Press.

Hage, Jerald, Maurice A. Gamier, and Bruce Fuller. 1988. "The Active State, Investment in Human Capital, and Economic Growth: France, 1825-1975." *American Sociological Review 53~824-37.*

Huang, Philip CC. 1990. *The Peasant Family and Rural Development in the Yangzi-Delta, 1350-1988.* Stanford: Stanford University Press.

Islam, Rizwanul. 1991. "Growth of Rural Industries in Post-reform China: Patterns, Determinants and Consequences." *Development and Change 22~687-724.*

Komai, Janos. 1992. *The Socialist System: the Political Economy of Communism. New* Jersey: Princeton University Press.

Knight, John, and Lina Song. 1993. "The Spatial Contribution to Income Inequality in Rural China." *Cambridge Journal of Economics 17:* 159-2 13.

Lu, Xueyi. 1995. "Rethinking the Chinese peasantry: Ten years of transformation." *Chinese Law and Government 28(l): 39-80.*

--------. 1993. "*The* Use of Chinese Rural Labour Resources and its Impact on the Rural Environment." *International Sociology 8:227-37.*

Luo, Xiaoping. 1990. "Ownership and Status Stratification." Pp. 134-171 in *China 's Rural Industry: Structure, Development, and Reform,* edited by William A. Byrd and Lin Qingsong. Oxford University Press.

Ministry of Agriculture (PRC). 1992. *A Statistical Survey of China 's Rural Enterprises* I992 (Zhongguo Xiangzhen Qiye Tungji Zaiyao, compiled and published by the Division of Rural Enterprises, Ministry of Agriculture.

Nee, Victor. 1986. "The Peasant Household Economy and Decollectivization in China." *Journal of Asian and African Studies XXI* 185-203.

------- 1992. "Organizational Dynamics of Market Transition: from Redistribution to Markets in State Socialism." *Administrative Science Quarterly 37:1-27.*

Oi, Jean C. 1990. "The fate of the collective after the Commune." Pp. 15-36 in *Chinese Society on the Eve of Tiananmen,* edited by Deborah Davis and Ezra F. Vogel. Massachusetts: The Council on East Asian Studies/Harvard University.

------- 1992. "Fiscal reform and the economic foundations of local state corporatism in China." *World Politics* 45:99-126.

Orleans, Leo A. 1992. "Loss and Misuse of China's Cultivated Land." Pp. 403-17 in *China s Economic Dilemmas in the 1990s* edited by The Joint Economic Committee, Congress of the United States. New York: M.E. Sharpe.

Peng, Yusheng. 1992. "Wage determination in rural and urban China: A comparison of public and private industrial sectors." *American Sociological Review 57:198-213.*

Rubinson, Richard and Irene Browne. 1994. "Education and the Economy." Pp. 582-599 in The *Handbook of Economic Sociology,* edited by Neil J. Smelser and Richard Swedberg. Princeton University Press /Sage.

Sengupta, Jati K., and Bo Q. Lin. 1993. "Recent Rural Growth in China: the Performance of the Rural Small-Scale Enterprises, 1980-86." *International Review of Applied Economics 7:* 177-96.

Shultz, Theodore W. 196 1. "Investment in human capital." *American Sociological Review 51:1-16.*

Sicular, Terry. 1992. "China's Agricultural Policy During the Reform Period." Pp. 340-64 in *China 's Economic Dilemmas in the 1990s* edited by The Joint Economic Committee, Congress of the United States. New York: M.E. Sharpe.

Smelser, Neil J. 199 1. *Social Paralysis and Social Change: British Working-Class Education in the Nineteenth Century.* Berkeley: University of California Press.

State Statistical Bureau, PRC. 1994. *Statistical Yearbook of China 1994.* Beijing: China Statistical Publishing House.

--------- 1993. *China Rural Statistical Yearbook 1993.* Beijing: China Statistical Publishing House.

--------- *1992. Chinese Yearbook of Rural Household Survey 1992* (Zhongguo Nongcun Zhuhu Diaoca Nianjian). Beijing: China Statistical Publishing House.

Svejnar, Jan and Josephine Woo. 1990. "Development Patterns in Four Counties." Pp. 63-84 in *China's Rural Industry: Structure, Development, and Reform,* edited by William A. Byrd and Lin Qingsong. Oxford University Press.

Szelenyi, Ivan, Katherine Beckett, and Lawrence P. King. 1994. "The socialist economic system." Pp. 234-5 1 in The *Handbook of Economic Sociology,* edited by Neil J. Smelser and Richard Swedberg. Princeton University Press /Sage.

Wang, Hansheng, Weimin Cheng, Xiaofeng Yan, and Weiming Yang. 1995. "Industrialization and social differentiation: Changes in rural social structure in China since the reform." Forthcoming in *Chinese Law and Government.*

Wang, Xiaolu. 1990. "Capital Formation and Utilization." Pp. 222-242 in *China 's Rural Industry: Structure Development, and Reform,* edited by William A. Byrd and Lin Qingsong. Oxford University Press.

Webb, Shwu-Eng H. and Francis C. Tuan. 1992. "China's Agricultural Reforms: Evaluation and Outlook." Pp. 365-84 in *China's Economic Dilemmas in the 1* 990s, edited by The Joint Economic Committee, Congress of the United States. New York: M.E. Sharpe.

Wong, Christine P. W. 1988. "Interpreting Rural Industrial Growth in the Post-Mao Period." *Modern China 14:3-30.*

Wu, W. Harry. 1994. "Rural to Urban Migration in the People's Republic of China." *The China Quarterly 669-98* (1994).

Zhu, Qingfang. 1995. "The rural-urban gap and social problems in the countryside." *Chinese Law and Government 28(l): 81-101.*

Zucker, Lynne G., Michael Darby, and Marilynn B. Brewer. 1994. "Intellectual capital and the birth of U.S. biotechnology enterprises." Working Paper No. 4653. National Bureau of Economic Research (Massachusetts).

Zweig, David. 1992. "Rural Industry: Constraining the Leading Growth Sector in China's Economy." Pp. 418-36 in *China 's Economic Dilemmas in the 1990s,* edited by The Joint Economic Committee, Congress of the United States. New York: M.E. Sharpe.

Endnotes

1 This growth rate is deflated according to the national overall retail price index. The statistical office does not report constant-priced indices of rural industrial output values because enterprises below township level are often unable to convert their output value to constant prices (Wong 1988, p. 16). On the basis of official overall retail price index, the (geometric) average inflation rate from 1984 to 1993 is 9% (State Statistical Bureau 1994, p.23 1).

2 *The* offkial definition of gross output value of the society is the sum of the gross output value of agriculture, industry, construction, transportation and postal services, and commerce (including food catering). Note that it is different from GNP or GDP. This indicator is absent from the 1994 *Statistical Yearbook of China.*

3 *The Chinese* government was unwilling to ratify rural enterprises except those for making and repairing agricultural equipment until 1984 (Wong 1988, PP. 9-l 1).

4 Using two-stage least squares method, Knight and Song (1993, pp. 198-9) simultaneously estimated two equations with reciprocal effects between agricultural and nonagriculural income. Their results were quite nonsensical: 1 *yuan* increase in agricultural income increases nonagricultural income by 0.28 *pan* whereas 1 *yuan* increase in nonagricultural income increases agricultural income by 1.9 *yuan.* Knight and Song explained that some of the correlation was spurious due to factors such as human capital and provincial government policies. I think the problem is in the method: estimates of reciprocal effects are contingent upon the particular model specification.

5 The offkial distinction between rural versus urban laborers or "residents" is not a natural distinction between rural and urban dwellers. Rather, it is a purely administrative classification of "grain source" and other privileges (Cheng and Selden 1994; Wu 1994).

For example, some cadres in the township government have urban registration or *Hukou* because they eat state-supplied grain. On the other hand, in recent years there are more and more rural laborers live in the city without urban registration as "floating population," buying food on the newly emerged free market (Lu 1995; Zhu 1995).

6 Firebaugh and Gibbs (1986, 1987) examined the application of ratio variables in linear equations. For multiplicative equations, as used in this study, the logic is similar. Consider a simple equation:

$$Y = e^{\alpha} X^{\beta} Z^{\gamma},$$

where Y is, say, rural industrial output; X is agricultural output; Z is population size. This equation is identical to

$$Y/Z = e^{\alpha} X^{\beta} Z^{\gamma-1}$$

or $$\ln(Y/Z) = a + \beta \ln(X) + (\gamma-1)\ln(Z) = a + \beta \ln(X/Z) + (\beta+\gamma-1)\ln(Z).$$

Therefore, omitting the size factor from the left-hand side of the equation may lead to biased estimates,

7 The net contribution to R2 by the log rural population size is less than 1%. By itself, it explains less than 2% of the total variance of the log rural industrial output per capita.

8 The results of generalized additive model of per capita rural industrial output show curvature in the function of agricultural output at the lower range (Appendix A). For the bottom 200 or so counties (below 400-500 yuan per capita), agricultural output does not seem to affect rural industrial output. These are the poorest counties struggling for subsistence. Their differences in agricultural output are the difference between those below subsistence and those barely above it, and thus do not constitute surplus to be transferred to nonagricultural activities. I ignored this curvature in my regression

analyses, however, because adding a square term contributed less than 1% to R^2 and would probably overestimate the slope at the top.

9 Assume County X has a per capita agricultural output of A and County Y has 2A. Then, other factors being equal and dropped, the log ratio of expected per capita industrial output of County Y over County X is:

$$.79\ln(2A) - .79\ln(A) = .79\ln(2).$$

Therefore; the ratio is $2^{.79} \approx 1.73$.

10 Let land-labor ratio R_0 be the baseline for comparison. According to (I) of Table 2, the log ratio of expected per capita industrial output I from any R over I_0 from R_0 is

$$\ln(I/I_0) = -.374\ln(R) - [-.374\ln(R_0)] = .374\ln(R_0/R),$$

or $$I/I_0 = (R_0/R)^{.374}$$

For R = 3 versus $R_0 = 60$, $I/I_0 = 20^{.374} = 3.07$.

11 Let land-labor ratio $R_0 = 3$ be the baseline for comparison. According to (IV) of Table 3, the log ratio of expected per capita industrial output A from any R over A_0 from R_0 is

$$\ln(A/A_0) = -.16\ln(R) + .086\ln^2(R) - [-.16\ln(3) + .086\ln^2(3)]$$

$$= -.16\ln(R) + .086\ln^2(R) + .094.$$

For R = 60, $\ln(A/A_0) = .579$; or $A/A_0 = 1.78$. That is 78% increase.

12 Let $E_0 = 10\%$ be the baseline. Then, according to (I) of Table 2,

$$\ln(I/I_0) = 12.96E - 9.85E2 - [12.96x0.1 - 9.85x0.12]$$

$$= 12.96E - 9.85E2 - 1.2.$$

For E = 20%, $\ln(I/I_0) = 1$; or $I/I_0 = 2.72$. That is 172% increase. The percent increase in per capita agricultural output is derived likewise.

13 Note that the rankings of provinces are based on the geometric average. Taking logarithm implies that the arithmetic mean of log per capita industrial outputs is the logarithm of their geometric mean. The geometric mean reflects both the arithmetic mean and the variation. For example, 1+5=3+3 but 1x5 < 3x3. The fact that Hebei is ranked above Guangdong simply indicates that the latter has large inter-county inequalities in the levels of rural industrialization. In terms of (unweighted) arithmetic mean of rural industrial output per capita, Guangdong ranks two provinces (Fujian and Shandong) higher than Hebei (Appendix C).

Table 1: Descriptive statistics for county-level variables (China, 1991; N = 1,903).

	. Rural industrial output (million yuan)	Per capita rural industrial output (yuan)	Agricultural output (million yuan)	Per capita Agricultural output (Yuan)	Junior-high schooling (%)	Rural labor force	* Land-labor ratio (mu/person)	Rural population	Total population
Max.	14,890	16,834	2,285	3,891	61.16	925,ioo	193.50	1,821,000	2,071,000
75%	428	984	518	1,114	33.50	279,500	4.51	573,400	641,100
50%	156	467	275	814	27.90	160,000	2.81	339,500	391,700
25%	46	205	145	610	22.11	83,300	1.94	193,700	231,600
Min.	0.13	2.13	6.57	208	2.89	1,800	0.23	4,400	7,500
Mean	422	903	367	910	27.97	201,300	5.09	417,500	473,800
Std. Dev.	912	1,492	302	440	9.13	155,100	10.38	298,500	324,900

Table 2. Regression analysis of log rural industrial output per capita on agricultural output, land-labor ratio, human capital stock, controlling for the size of rural population (China, 199 1; N = 1,903 counties).

	(I)	(II)	(III)
MULTIPLE R'	0.517	0.503	0.717
NET CONTRIBUTION TO R BY EACH VARIABLE a			
Log agricultural ouput [In(A)]	0.064	-	0.03 1
Log ratio of land over labor [In(R)]	0.043	_	0.014
Percent with junior-high schooling $[\beta_3 E+\beta_4 E^2]$	0.232	_	0.086
Log rural population [In(P)]	0.008	_	0.002
Provinces [24 df.]	_	0.503	0.200
PARAMETER ESTIMA TES			
Intercept	-3 .537 (7.69)b (7.3 1)'	4.253 (53.51)	-2.456 (5.308) (4.60)
Log agricultural ouput [In(A)]	0.790 (15.87) (15.39)	_	0.755 (14.21) (11.53)
Land-labor ratio [In(R)]	-0.374 (13.02) (13.52)		-0.368 (9.50) (8.27)
Percent with junior-high schooling [E]	12.96 (12.62) (10.35)		7.937 (8.88) (8.66)
Education squared $[E^2]$	-9.849 (5.78) (4.84)	_	-3.83 1 (2.67) (2.71)
Log rural population [In(P)]	0.157 (5.84) (5.00)		0.076 (5.3 1) (3.00).

(Continued)

Table 2.--Continued

	(I)	(II)	(III)
PARAMETER ESTIMATES--CONTINUED			
Provinces			
Shanghai *(14)*		4.313	2.292
Tianjing (5)		4.310	2.864
Beijing (8)		4.307	1.988
Jiangsu (59)		3.293	1.836
Zhejiang (66)		3.144	1.737
Fujian (63)		2.695	1.823
Hebie (137)		2.659	1.853
Guangdong (75)		2.618	1.140
Shandong (98)		2.542	1.270
Helongjiang (69)		2.183	1.162
Hubei (7 1)		2.181	1.178
Henan (117)		2.124	1.087
Jiangxi (83)		2.038	1.227
Hunan (95)		1.858	0.788
Shanxi (100)		1.808	1.298
Sichuan (181)		1.671	1.105
Jilin (40)		1.586	0.285
Gansu (74)		1.548	1.647
Anhui (72)		1.460	0.813
Shaanxi (93)		1.413	0.906
Xinjiang (80)		1.189	0.504
Ningxia (18)		0.760	0.555
Guizhou (8 1)		0.735	0.660
Guangxi (83)		0.266	-4343
Yunnan (123)		0.000	0.000

Notes:

a. This is the net increment in R' when the particular variable(s) is added to that regression.

b. The figures in the first pair of parantheses are the least squares t scores.

c. The figures in the second pairs of parentheses are the bootstrapped t scores.

d. Numbers of observations for each category are provided in place oft scores. T-tests for individual dummy variables are not as useful as the F-test for the whole set, which is significant.

Table 3. Regression analysis of log agricultural output per capita on land-labor ratio, human capital stock, controlling for the size of rural population (China, 1991; N = 1,903 counties).

	(IV)	(V)	(VI)
MULTIPLE R^2	*0.240*	*0.501*	0.591
NET CONTRIBUTION TO R^2 BY EACH VARIABLE [a]			
Log ratio of land over labor $[\alpha_1 ln(R)+\alpha_2 ln^2(R)]$	0.037	--	0.014
Percenf with junior-high schooling $[\alpha_3 E+\alpha_4 E^2]$	0.153		0.102
Log rural population [In(P)]	0.005	--	0.011
Provinces [24 df.]	--	0.501	0.351
PARAMETER ESTIMATES			
Intercept	-6.389 (41.47)b (39.80)'	6.479 (215.7)	6.528 (48.8) (37.45)
Log land-labor ratio [In(R)]	-0.160 (5.37) (4.84)	--	0.145 (4.98) (3.20)
Log land-labor ratio squared $[ln^2(R)]$	0.068 (14.9) (8.32)	--	-0.004 (0.49) (0.34)
Percent with junior-high schooling [E]	4.933 (10.88) (10.99)	--	**5.089** (13.74) (12.76)
Education squared $[E^2]$	-5.338 (6.97) (6.7 1)	--	-5.516 (9.00) (8.34)
Log rural population [In(P)]	-0.043 (3.54) (3.47)	--	-0.072 (6.95) (5.58)

(Continued)

Table 3.--Continued

		(IV)	(V)	(VI)
PARAMETER ESTIMATES-CONTINUED				
Provinces				
	Beijing (8)		1.332	1.379
	Helongjiang (69)		1.151	0.958
	Shanghai *(14)*		1.067	1.240
	Tianjing (5)		1.058	1.175
	Xinjiang (80)		0.973	0.978
	Jilin (40)		0.929	0.910
	Guangdong (75)		0.913	1.251
	Sharidong (98)		0.833	1.086
	Fujian (63)		0.754	1.171
	Jiangsu (59)		0.747	1.010
	Zhejiang (66)		0.633	1.011
	Jiangxi (83)		0.588	0.921
	Hubei (7 1)		0.553	0.83 1
	Hunan (95)		0.436	0.759
	Hebei (137)		0.435	0.611
	Guangxi (83)		0.372	0.764
	Sichuan (181)		0.357	0.778
	Ningxia (18)		0.345	0.515
	Anhui (72)		0.3 11	0.712
	Henan (117)		0.267	0.487
	Shaanxi (93)		0.257	0.430
	Yunnan (123)		0.253	0.783.
	Gansu (74)		0.119	0.412
	Guizhou (8 1)		0.101	0.688
	Shanxi (100)		0.000	0.00

Notes:

a. This is the net increment in R^2 when the particular variable(s) is added to that regression.

b. The figures in the first pair of parantheses are the least squares t scores.

c. The figures in the second pairs of parentheses are the bootstrapped t scores.

d. Numbers of observations for each category are provided in place oft scores. T-tests for individual dummy variables are not as useful as the F-test for the whole set, which is significant.

Figure 1. Cumulative percentage of rural industrial and agricultural output by counties in ascending order (China, 1991; N=1,903)

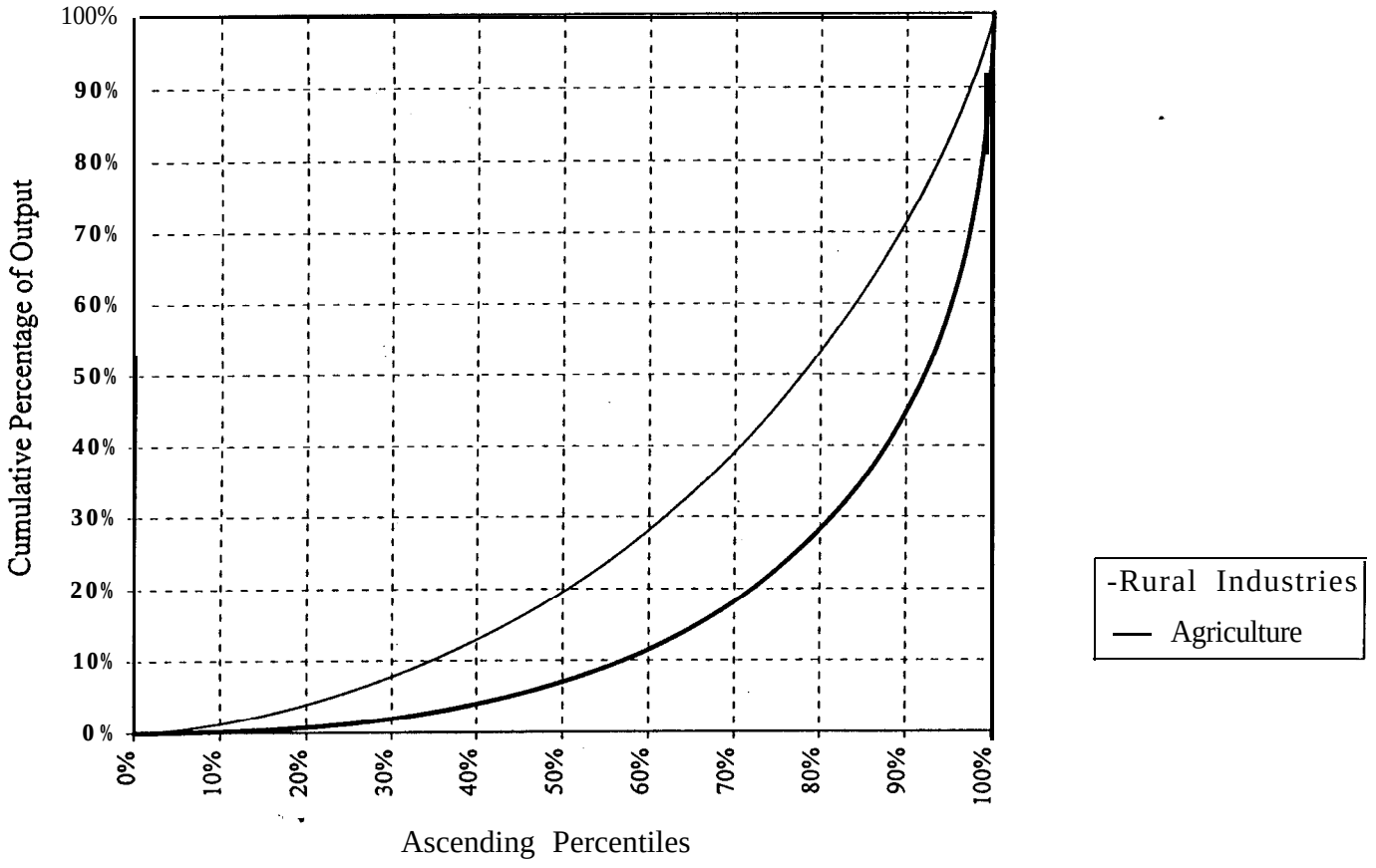


Figure 2. A path diagram of the relations of rural industrial development with agriculture, surplus labor, and human capital, controlling for population size (China, 1991; N = 1,903 counties)

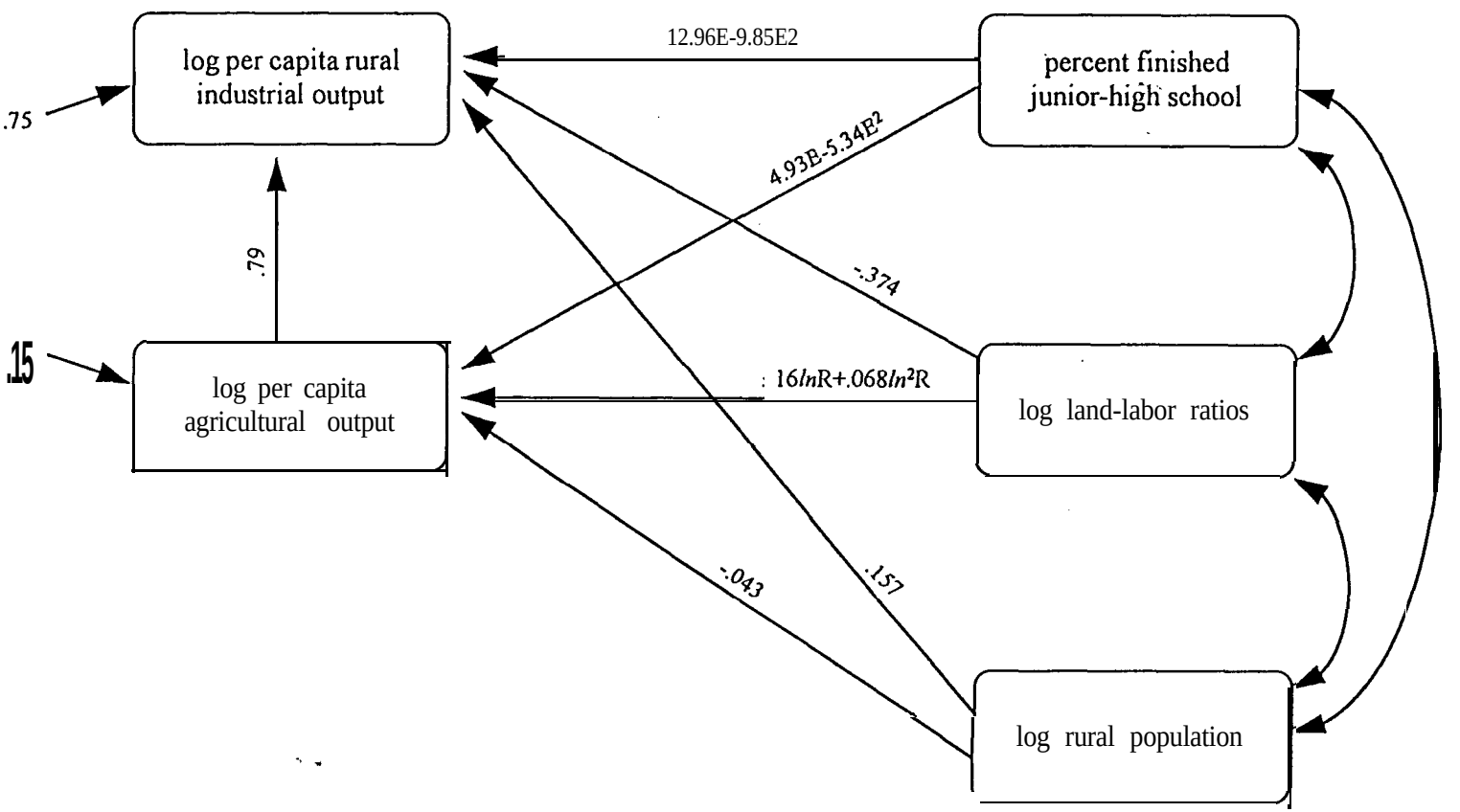


Figure 3. The effects of the land-labor ratio on rural industries and agriculture (China, 1991; N=1,903 counties)

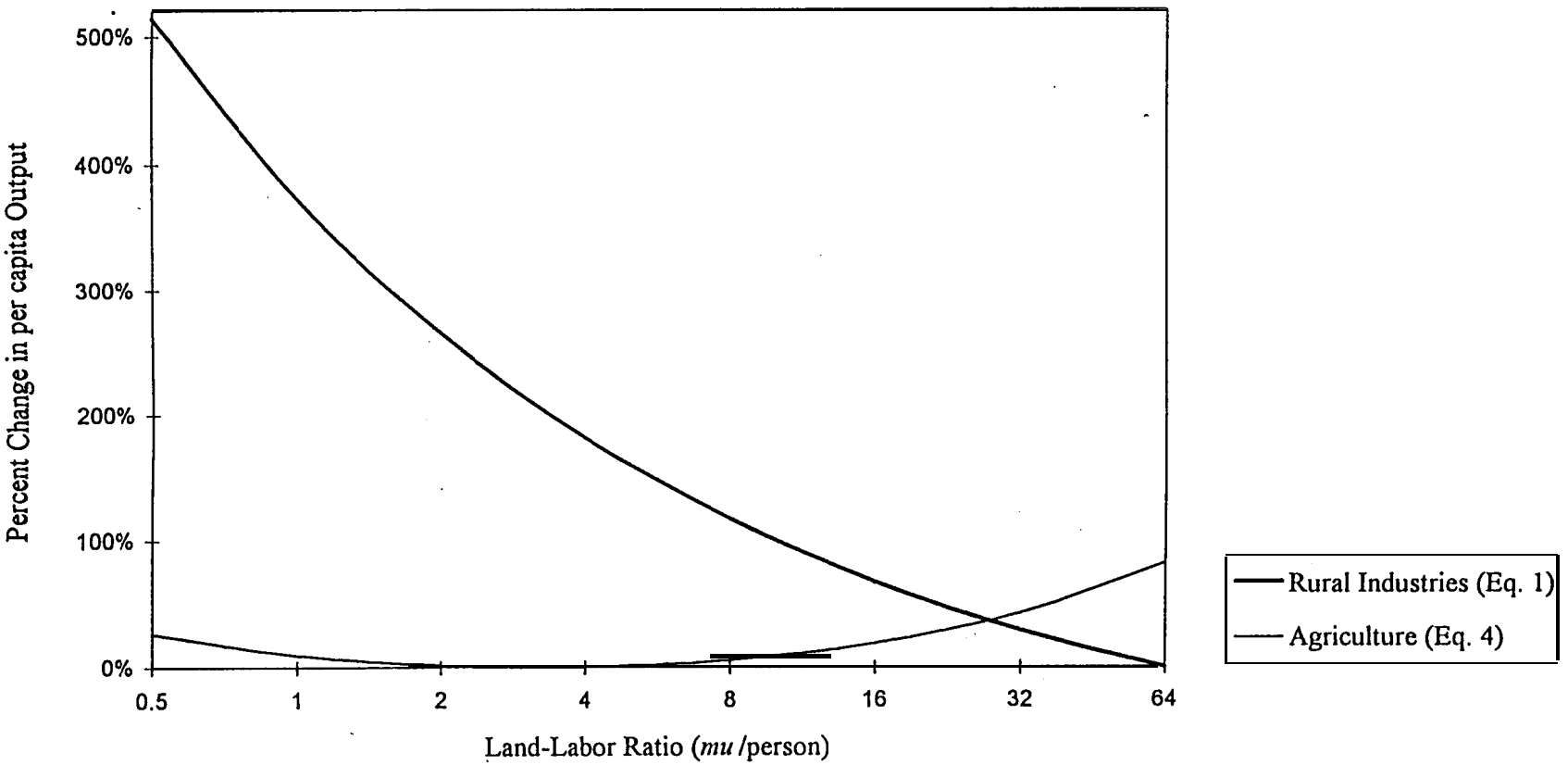
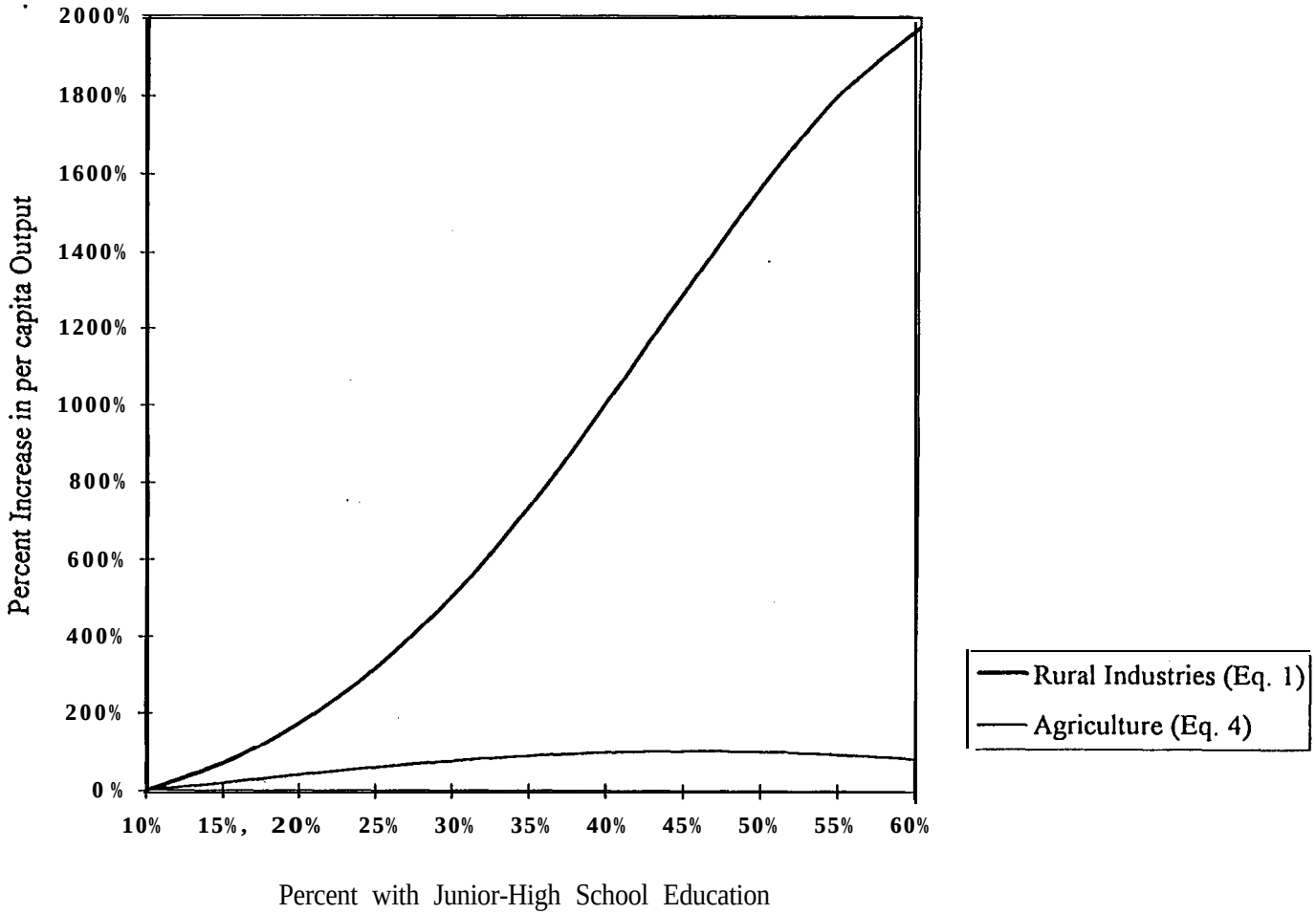
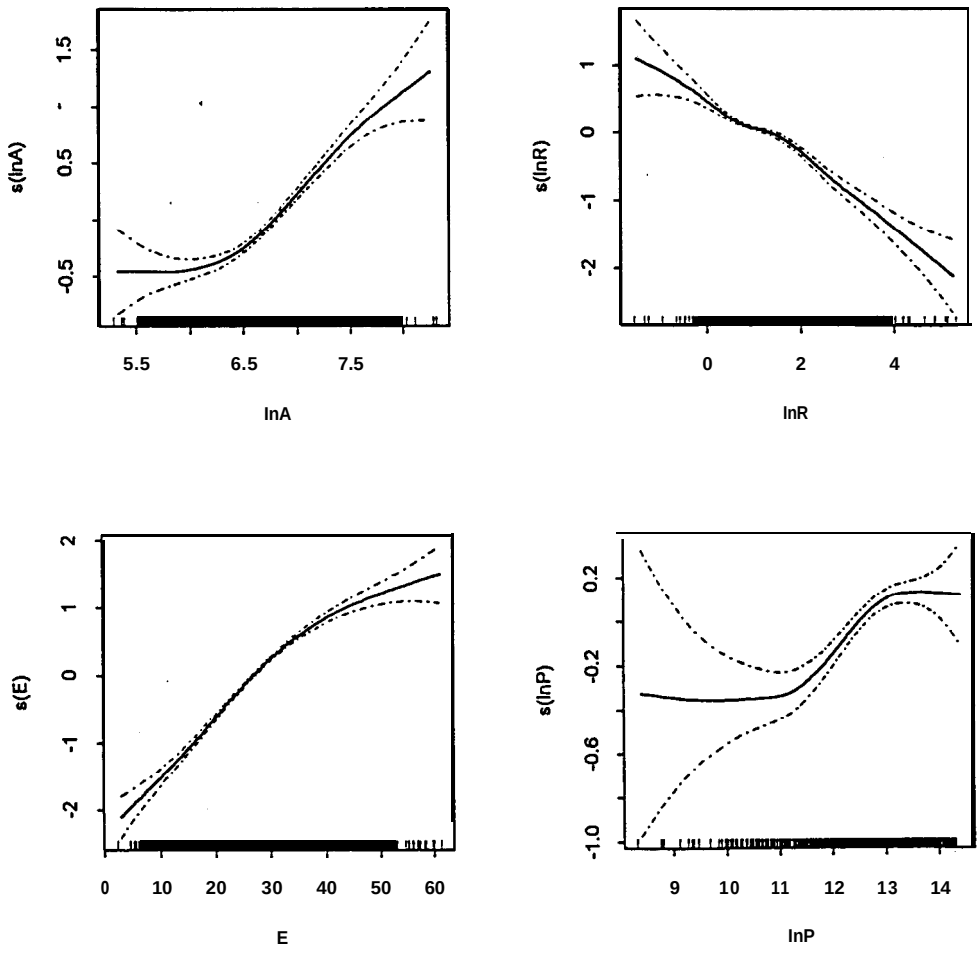


Figure 4. The effects **of human capital stock on rural industries and agriculture (China, 1991; N=1,903 counties)**

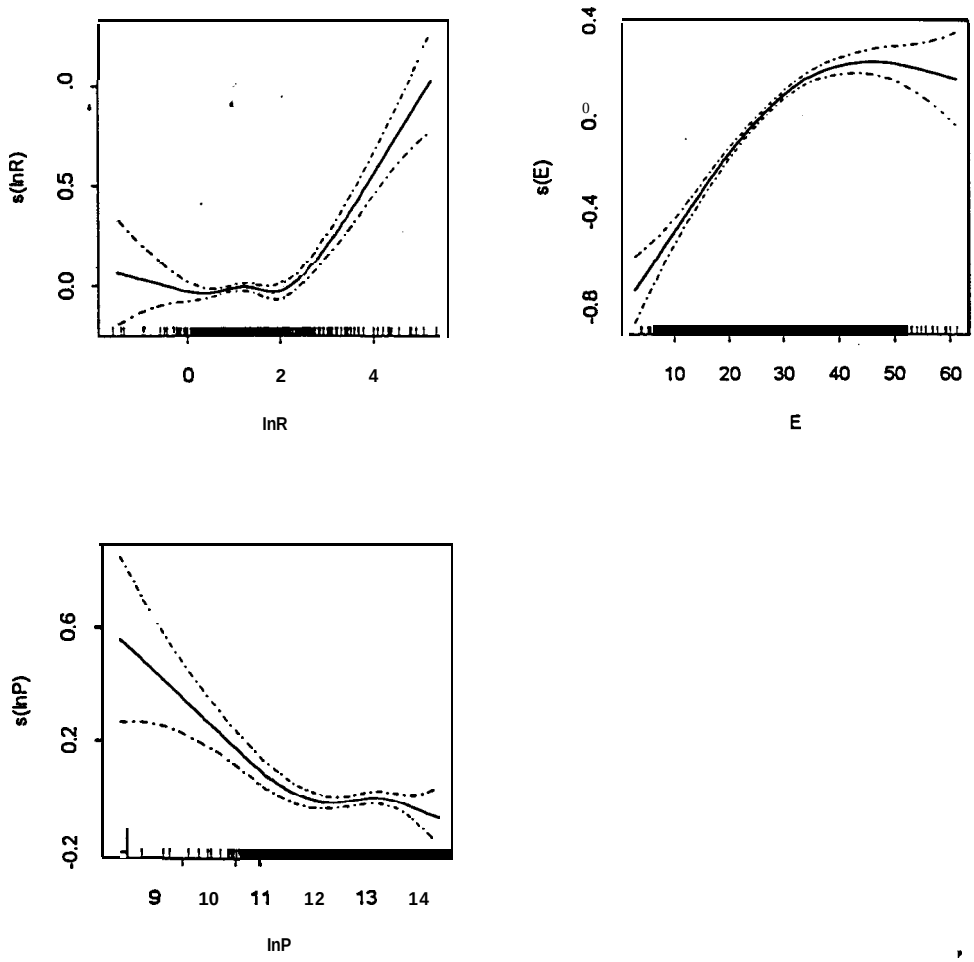


Appendix A: Generalized additive model of rural industrial output per capita on agricultural output per capita, land-labor ratio, education, and rural population. (China, 1991; N = 1,903 counties).



Note: The generalized additive model is specified as: ln(I) = s(lnA) + s(lnR) + s(E) + s(lnP), where ln(I) is the log rural industrial output per capita, lnA the log agricultural output per capita, lnR the log land-labor ratio, E the proportion of people who have finished junior high school, and lnP the log rural population size. Letter “s” stands for the spline smoother.

Appendix B: Generalized additive model of agricultural output per capita on land-labor ratio, education, and rural population. (China, 1991; N = 1,903 counties).



Note: The generalized additive model is specified as: lnA = s(lnR) + s(E) + s(lnP), where lnA is the log agricultural output per capita, lnR the log land-labor ratio, E the proportion of people who have finished junior high school, and lnP the log rural population size. Letter "s" stands for the spline smoother.

Appendix C: The unweighted arithmetic means of county-level attributes by provinces (China, 1991; N = 1,903 counties).

	N	Rural industrial output per capita	Agricultural output per capita	Junior-high school graduates	Land-labor ratio (mu/person)
Shanghai	14	7390	1533	39.4%	2.18
Beijing	8	6037	1968	46.0%	3.82
Tianj in	5	5624	1472	33.6%	5.04
Jiangsu	'59	3213	1106	33.3%	2.55
Zhej iang	66	2295	995	29.8%	1.24
Guangdong	75	1521	1368	29.5%	1.78
Fujian	63	1353	1158	23.1%	2.3 1
Shandong	98	1341	1207	30.8%	3.26
Hebei	137	1225	833	30.1%	4.41
Henan	117	916	710	34.0%	2.98
Hubei	71	822	921	29.1%	2.91
Helongjiang	67	752	1685	38.1%	38.65
Shanxi	100	703	538	35.0%	7.39
Jiangxi	83	635	956	25.5%	2.64
Sichuan	181	581	746	23.6%	2.32
Hunan	95	566	807	29.5%	1.92
Gansu	74	469	659	22.2%	6.34
Anhui	72	465	724	25.0%	2.58
Shaanxi	93	408	688	29.1%	5.47
Jilin	40	389	1311	38.4%	9.45
Xinjiang	80	382	1412	29.9%	13.16
Ningxia	18	222	831	26.0%	8.17
Guizhou	81	182	581	17.9%	1.90
Guangxi	83	151	765	23.9%	2.40
Yunnan	123	149	702	17.4%	2.97

Appendix D: Correlation coefficients, standard deviations, and means of the continuous variables used in the regression analysis (China, 1991; N = 1,903 counties)

	Log rural industrial output per capita (1)	Log agricultural output per capita (2)	Log land-labor ratio (3)	Log land-labor ratio squared (4)	% of junior-high school graduates (5)	% of junior-high school graduates squared (6)	Log rural population (7)
(1)	1						
(2)	0.4610	1					
(3)	-0.1139	0.2130	1				
(4)	-0.0735	0.2764	0.9185	1			
(5)	0.:016	0.4235	0.2059	0.23 83	1		
(6)	0.5441	0.3892	0.2178	0.2549	0.9733	1	
(7)	0.1812	-0.0986	-0.4015	-0.3729	-0.0458	-0.1191	
Std. dev.	1.2429	0.4490	0.7765	2.7892	0.0913	0.0543	0.8555
Mean	6.0826	6.7114	1.1774	1.9887	0.2797	0.0866	12.6459