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ABSTRACT

Chinese rural industry has grown three times faster than national GDP, surpassing agriculture in size in 1987, and now nearing half of the total Chinese economy. We use a rich, new county-level data set to explore this dramatic growth. We find that a Cobb-Douglas production function explains over 80 percent of across-county variation in 1991 rural industrial output per capita, with little role for idiosyncratic regional or provincial fixed effects. There is a very large effect on productivity from being near cities (30 to 35 percent higher productivity for a county one standard deviation above average in nearness to population centers) due to embodied technology transfer from urban residents. We find strong support for the hypothesis that saving from past agricultural income has provided start-up capital for rural enterprises. However, higher land-labor ratios lead to greater allocation of labor and capital to agriculture instead of industry, although induced inflow of migrants reduces the effect on industrial labor. Nearness to cities and more education increase capital and labor in rural industry. Substantial explanatory power (one third or more) for industrial labor and capital is attributed to provincial fixed effects, possibly reflecting local commercial and migration policies.

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CHINESE RURAL INDUSTRIAL PRODUCTIVITY AND URBAN SPILLOVERS

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According to Barry Naughton (1995b: Ch. 4), China is becoming market-oriented through rapid growth of the non-planned rural industry sector, initially township and village enterprises and now also cooperatives and private firms (collectively **TVEs**), rather than transformation of the planned sector.[1] China experts have focused on describing the growth of rural industry relative to other sectors of the economy, its increasing contribution to the Chinese economy, and its perceived concentration in coastal areas. Instead of relying on aggregate data, data from the provincial level, or intensive case studies of particular rural counties to describe Chinese rural industry, we employ a new detailed county-level data set that allows us to explore factors that determine differences in productivity of rural industry across counties.

Rural industrial productivity is increasingly important in defining the overall economic productivity of China. Rural industry has recently been repeatedly singled out as the most dynamic sector in China today (see especially Findlay, Watson and Wu 1994). Official statistics show that from 1984 to 1993 the average annual growth rate of rural industrial output was about 27 percent.[2] Comparatively, the annual GDP growth rate was 9.5 percent in the same period. In 1984 rural industry contributed 13 percent to the gross output value of the society; by 1992 it accounted for one-third of the national economy. Its share in the rural economy surpassed that of agriculture in 1987 (Agricultural Bank of China 1993, p.338).[3] The Ministry of Agriculture has projected that by the year 2000, rural enterprises will produce one half of the total national output, replacing the 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 (Naughton 1995a; Zweig 1992).

Rural industrial development has been very concentrated among Chinese counties with 1991 industrial output per capita (based on registered population) ranging from 2 to 16,834 yuan with 25th and 75th percentile values of 205 and 983 yuan, respectively (sample statistics for these and other variables are reported in Table 1). The map in Figure 1 shows how dramatically the per capita output of rural industry varies across different areas within China. While coastal areas of China do appear to have higher per capita output in general, it must be noted that many -- but not all -- large Chinese cities are also concentrated along the coast.

We find that a Cobb-Douglas production function with efficiency shifted by population-weighted nearness to cities (which we call the **urban population potential**) accounts for over 80 percent of the cross-country variation in Chinese rural industrial output. Although regions are significantly different, with the coastal region stronger as predicted, regional differences do not add substantially to the explanation of cross-county variation nor do they significantly shift coefficients in the production function (nor do provinces). The urban population potential, then, accounts for most of the perceived regional and provincial effects on productivity. Figure 2 presents the bivariate relationship between urban population potential and the logarithm of rural industrial output per capita, showing that the relationship is nearly linear. In multiple regressions reported below, a county one standard deviation above average in urban population potential (other things equal) has 30 to 35 percent higher total factor productivity. This strong productivity effect appears to be due to embodied technology transfer from more highly skilled commuting urbanites, rather than some more generalized urban spillover.[4]

Thus, differences in factor endowments and the urban-population-potential efficiency shift factor in the production function account for most of the variation across counties in rural industrial output. We also examined a second quantitative shift factor, road density, to measure

transportation infrastructure; it was not a significant factor except when provincial differences were entered into the equation. Qualitative shift factors, so far as they are captured by regional or provincial fixed effects, do not seem to play much of a role in determining variations across counties in productivity of rural industry.

In the empirical analysis below we also directly estimate the determinants of rural capital input and rural industrial labor input since many of the hypotheses about variations in TVE output concern variations in input rather than productivity. We turn next to a more detailed review of the institutional background of Chinese rural industry and hypotheses explaining their pattern of development. Section II describes the data we use to test these hypotheses and Section III reports the empirical analysis. Conclusions are in Section IV.

I. Explaining Rural Industry Productivity and Urban Spillovers

Historical policy decisions within China first led to restriction of rural industry, then liberalization, and finally encouragement at both central and local levels. We are studying the outcomes of these changes on the factors that explain productivity of rural industry and its geographic concentration near cities. We begin with a brief review of the relevant history, and then discuss our central hypotheses.

A. Historical Background of Chinese Rural Industrial Development

Rural non-agricultural employment accounted for less than 10% of rural labor force in 1978 on the eve of the Chinese economic reform (State Statistical Bureau 1995, p. 329, 364). This figure was very low even compared with both international standard and the pre-communist

era. Asian countries at similar level of development have a much higher level of non-agricultural activities (Blank and Parish 1990; Ho 1994). The traditional Chinese rural economy was highly diversified and developed in commercial and industrial activities (Ho 1994; Zelin 1991; Zhang 1991). Collectivization of agriculture together with tightened state control of rural economy actually deindustrialized the countryside (Naughton 1995b:145; Fei 1989). Although the state restrictions on rural industrial activities were relaxed in the late 1960s and early 1970s, until 1984 rural industries were exhorted only as auxiliaries to agriculture rather than as an alternative development strategy to provide employment for rural population (Ho 1994; Wong 1988).

The rapid rural industrialization in the 1980s was facilitated, albeit unintended, by Deng Xiaoping's rural reform programs. The implementation of various forms of the 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 (Sicular 1992; Oi 1989). Peasant households gained the right to manage their contracted land and the right to dispose of its residual income, although they did not gain the right to sell the land because the village formally owns it. The change in property relations boosted agricultural production (Nee 1986; Webb and Tuan 1992; Lin 1992), perhaps only 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. Seizing these new opportunities provided by economic liberalization and marketization, the Chinese peasants unleashed their pent-up drive for expanding commune/brigade (later known as township and village) enterprises.

In the early 80s, policy-makers debated over whether the "blind" growth of rural enterprises should be left unchecked or not because it squeezed resources (land, capital, and labor) out of agriculture. It was not until 1984 that the Chinese government decided to endorse and support rural enterprises (Wong 1988: 9-11; Ho 1994: 23-27). By 1994, rural industrial employment accounted for 27% of the total rural labor force (State Statistical Bureau 1995, p. 329, 364). Huang (1990, pp.244-6) points out that the diversion of rural labor from farming to rural industries and sideline production during the reform era reversed a 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.

The rural enterprises are primarily owned -- at least formally -- by the local government or collectively by members of a village, except for cooperatives and private firms. By some observers they are viewed as "an important and highly successful institutional innovation, melding market incentives with public ownership," while others expect rural enterprises to eventually become privatized and hence view them as a transitional institutional form (Sachs and Woo 1997: 33-34). Local officials have not only public incentives related to the revenue that these enterprises raise for the local government, but they also have the private incentives to maximize profits of the rural enterprises since their careers and salaries heavily depend on rural enterprise performance and growth in their jurisdiction (Oi 1995). Further, because of the limited ability of villages or townships to bail out failing enterprises, the 1990 economic downturn produced business failures; hence, rural enterprises actually face hard budget constraints not faced by state enterprises -- which grew in number during the same downturn (Sachs and Woo 1997: 39).

B. Hypotheses about the Distribution of Chinese Rural Industrial Output

As noted above, there are enormous differences in the magnitude of rural industrial enterprise across counties. These differences are obvious to a host of China experts who have developed hypotheses to explain this diversity of experience. Conceptually these hypotheses can be divided into four types: (a) differences in factor endowments, (b) quantitative shift factors in production functions, (c) qualitative shift factors in production functions, and (d) qualitative differences in the extent to which market forces are allowed to shift resources from the state sector. The first group of explanations relate to differences such as relative scarcity of land or availability of accumulated saving for start-up capital. The second group relates to quantifiable differences such as in flow of highly skilled or experienced urban labor across the city border to rural industry, in accessibility to urban markets or technology or transport infrastructure. The third and fourth groups of hypotheses relate to more difficult to quantify differences such as whether the county or provincial leaders are enthusiastic supporters of or defenders against reforms which create the market economy. Since rural industrialization or re-industrialization is at least partially the result of loosening of restrictions, it is plausible that unequal loosening would result in unequal development, and these effects could be reflected either in the production function or in the resources shifted from the state to private sector. Let us now review the important hypotheses in the literature.

Differences in Factor Endowments

Labor Input: The labor input is the product of the number of workers and their average quality index. We expect that the number of workers available to rural enterprise will decrease as the land/labor ratio increases, providing more opportunities for labor in agricultural production. Nationwide the average land-labor ratio is about 3 *mu* (one-half acre) per peasant.

We expect that the average quality of the labor force in each Chinese rural county increases as a function of the percent who have graduated from junior high school. A higher quality labor force employed in rural enterprises should enhance the productivity of those enterprises. There are few college graduates in the countryside, among employees in China's rural enterprises junior high school education brings the highest return in wages (Peng 1992; Gelb 1990).

Capital Input: The availability of accumulated saving for start-up capital for rural enterprise depends on the success of county agriculture (Knight and Song 1993: 200-201; Byrd and Gelb 1990: 364; Wang 1990: 222-223). Strong agricultural output, especially when coupled with a large local market for that output, provides the basis for capital accumulation within the county. Local bank deposits constitute the basic source of credit available for developing rural enterprise, because the banking system in China is highly regionalized (Byrd 1990). Township and village government are reluctant to allow capital built up within the county to flow outside of it (Wang et al. 1995), and use barriers such as village credit cooperatives to channel agricultural-derived saving into rural industry (Zweig 1992: 428).

Quantitative Shift Factors in Production Functions

Transportation Networks: Rural industry needs to move inputs into the county and goods out of the county. As the transportation networks become more extensive, productivity is expected to increase.

Population-weighted Nearness to Cities: Growth in rural industry has been especially strong near the large coastal cities (see Naughton 1995a, Perkins 1990), suggesting that spillovers from industrial production in the cities increases the productivity of nearby rural industry. This may be a suburbanization effect created by moving city-based production to areas with cheaper

land and lower wages; in China, there is some evidence that urban state factories have moved production across the city boundaries in their search both for lower costs and for lower bureaucratic surveillance. Inhibited by bureaucratic restriction on and the high cost of hiring permanent city workers, urban state factories have expanded their operation in the immediate region outside of the city boundaries through subcontracting, joint ventures, and investment in rural enterprises (Naughton 1995a: 38; Perkins 1990; Tao 1988).

Labor remains more of a fixed factor in China: the relative immobility of highly skilled and/or highly experienced labor in urban areas because of their special, privileged, "entitled" status is well documented (Cheng and Selden 1994). The value of being an urban resident has remained high, so high that peasant families will sometimes 'invest' in creating a 'city worker' job for one of their children. The investment required is so high that 10 or 20 peasant families had to combine resources to create one "investment worker" or *jizigong* (see Cao 1989). These city workers are therefore not likely to give up their residence with its privileges; the most highly skilled of these workers are recruited by high wages across the city boundaries to work in rural industry (Li and Wang 1993; Ma, Huang, Wang, and Yang 1994).

Further, in 1985, the government lifted its restriction on urban-rural technology transfer and allowed urban factories and research institutes to provide technical consulting services to rural enterprises and encouraged technical personal in the urban areas to take leaves of absence (*Ting Xin Liu Zhi*) and work in the rural firms without losing urban residency (Ho 1994:25). It is estimated that 3 million urban workers now work in rural enterprises (*China Daily*, February 9, 1993). Thus, being near a city provides rural industry with a very valuable and rare labor resource, a factor that has also been identified as important in determining the location of high technology industries in more developed economies (Zucker, Darby, and Brewer 1997; Darby and

Zucker 1996).

Qualitative Shift Factors in Production Functions

Regions and Provinces: It is widely accepted in the literature that being in the coastal region causes a quantitative shift upward in the production function. Differences in productivity can occur because of different infrastructures across regions or provinces that provide different environments in which to run an enterprise. While the distinctiveness of the coastal region has been mentioned most commonly by China experts, political differences at the provincial level have also been noted as influencing openness to market reforms.

Sachs and Woo (1997: 34-35) suggest that three main types of government oversight of township, village, cooperative, and private enterprises have profoundly different consequences for the productivity of those enterprises. The "Jiangsu Model" involves limiting the number of enterprises that can be set up and exercising tight controls over existing enterprises, from participating in production and investment decisions to regulating wages and labor mobility. This model was preferred because of its close adherence to traditional socialist concepts until failure of a number of "deficit ridden" enterprises in 1992 led to rental or auction sales to private businessmen.

The other two types operate under more market-oriented systems, a "semi-private" form of governance (Peng 1992). The "Zhejiang Model" retains significant local government shareholding in the enterprises, but provides for "arms length" oversight as long as the enterprise contributes to village funds annually. The only significant government control is the power to remove managers. The third form of collective township and village enterprise is a masquerading "red capped" private firm, where capital comes from an individual or small group and the enterprise pays a fee to local government be able to register as a collective enterprise in order to

obtain lower tax rates and fewer operating restrictions.

Because of the need to disguise the true nature of the rural enterprise--especially if it follows the third model--there is no reliable source of data concerning the actual form of governance except for in-depth case studies such as those underlying the taxonomy above. Thus, we rely on region and province dummies to estimate the significance of variations in governance of rural enterprise and the other local policies related to market forces on the production function.

Qualitative Differences in Acceptance of Market Forces

The above discussion of qualitative differences is focused on variations that are expected to shift the production function. However, many qualitative differences may not affect the production function, but still alter the total output of rural enterprises.

Inward Migration at the County Level: Restrictions on inward migration of labor will limit the labor inputs and hence decrease the total amount of output, but will not usually alter the production function itself. By estimating the net in-migration and part-time workers (generally from agriculture) of labor in rural enterprises, we are directly exploring effects of restrictions on inward migration of labor on labor inputs into rural enterprises.

Regions and Provinces: Most of the policies relevant to labor input and to capital input remain unmeasured in our analyses, so we again rely on region and province dummies to provide a proxy for these policy differences. Given the wide range of response to reforms instituted by the central Chinese government across both regions and provinces, we expect strong effects of our proxy measures of differences in acceptance of market forces. Table A.1 gives the unweighted means for county level variables by provinces and regions, showing the high variability across China in actual output of rural enterprise and in the factors related to that output.

II. The Data

A. County-Level Data

In this paper we define rural industries broadly to include all nonagricultural enterprises that are owned by township (*xiang*), village (*cun*), group (*zu*), and single or multiple peasant households. All data have been collected at or aggregated to the county level. Knight and Song (1993) argue that the county should be an appropriate unit of analysis because every county behaves like a little kingdom.

The county-level data used in this study come from four sources. (1) A survey of counties as of 1991 which was conducted by the State Statistical Bureau and the Chinese Academy of Social Sciences (1992) for the purpose of evaluating affluent counties (*xiaokang xian*). (2) *Zhongguo Fenxian Nongcun Jingji Tongji Gaiyao, Vol. 1980-87 and Vol. 1991 (Summary Statistics of Rural Economy of Chinese Counties)* (State Statistical Bureau 1988, 1992a). (3) Geographical data of counties collected from *Encyclopedia of Chinese Counties Vol. 1-6* (Ministry of Civil Administration 1992). (4) Geographical data of 195 cities of district level or above (including Hong Kong and Macau) from *Statistical Yearbook of Chinese Cities* (State Statistical Bureau 1992b) and Chen and Wang (1991). Information about cities is used for estimating urban proximity of the counties.

The 1992 survey of affluent counties collected 1991 data for 2,044 rural counties, excluding suburban districts (*Qu*), from 24 provinces (missing Liaoning, Hainan, and Tibet) and the three metropolitans (Beijing, Shanghai, and Tianjin). We excluded from our sample (a) 123 counties in Qinghai and Inner Mongolia for which the provincial statistical office reported identical (perhaps average) values for rural industrial output in 1991 and (b) another 37 counties

due to either missing values or internally inconsistent data. This resulted in a clean sample of 1884 counties for the empirical analysis.

Each of the following variables was taken from the survey of affluent counties (State Statistical Bureau jointly with the Chinese Academy of Social Science, 1992) unless specified otherwise.

Rural population is the 1991 year-end total number of people who are registered as rural residents in the specified county (excluding those with urban registration). All "per capita" values have been divided by this rural population.

Rural industrial output is the 1991 gross value of output by all rural enterprises in industry, construction, transportation, commerce, and catering in a county.

Rural industrial employment is the total labor force employed in rural enterprises, including migrant workers from outside of the county.

Rural industrial capital stock data are not available corresponding exactly to the concept of rural industry used in the output and employment data. We use as a proxy the fixed and fluid capital stock for all government-run firms with independent accounting. This measure includes capital for a small number of firms owned by county-government and its bureaus which are not counted as rural industrial enterprises and lacks coverage for village-government, team-run, and private firms.

Gross value of agricultural output in 1985 is the 1985 total output of farming, forestry, animal husbandry, sideline production, and fishery taken from *Summary Statistics of Rural Economy of Chinese Counties, vol. 1980-87* (State Statistical Bureau 1988)..

Farmland/registered total rural labor (or the land-labor ratio) is the total amount of farmland in *mu* (State Statistical Bureau 1992a) divided by the total rural labor force (from the

survey of affluent counties). The total rural labor force includes some people who are registered as rural residents in the specified county but work and probably live outside of the county, and excludes other people who work inside the county but are not registered as local residents.

Education is measured by the **percentage with at least junior high school education** or equivalent in the whole population of the county.

Urban population potential is an index of urban proximity for each county and computed as the sum of the ratios of urban population over distances from the 195 district or provincial level cities, including Hong Kong and Macau, according to a formula in Stewart and Warntz (1958).[5] Distances are the arc distance of each county from each of the 195 cities, computed from their geographic coordinates using standard formulae in Robinson, Morrison, Muehrcke, Kimberling, and Guptill (1995, p. 50). Geographic coordinates of counties are taken from *Encyclopedia of Chinese Counties Vol. 1-6* and those of cities from Chen and Wang (1991). Urban population of cities includes only the "entitled" population with urban registration, taken from *Statistical Yearbook of Chinese Cities 1992* (State Statistical Bureau 1992b). The index was normalized as a z-score by subtracting the mean and dividing by the standard deviation.

Road density is computed by dividing each county's total road distance in kilometers by its total land area in kilometer squares, both taken from *Encyclopedia of Chinese Counties Vol. 1-6.*[6]

B. Provinces and Regions

The 25 provinces for which data are available are listed in Appendix Table A.1 together with mean values for variables used in the analysis. These 25 provinces are allocated to four regions (where the Metro and Other East Coast regions together make up the Eastern Economic

Region as used in Chinese government statistics):

Region	Provinces
Metro	Beijing, Shanghai, Tianjin
Other East Coast	Jiangsu, Zhejiang, Fujian, Guangdong, Guangxi, Hebei, and Shandong (missing Hainan and Liaoning)
Central	Anhui, Henan, Hunan, Hubei, Jiangxi, Shanxi, Jilin, and Helongjiang (missing Inner Mongolia)
West	Yunnan, Guizhou, Sichuan, Shaanxi, Gansu, Ningxia, and Xinjiang (missing Qinghai and Tibet)

As seen at the bottom of Table A.1, the Metro region provinces have the greatest amount of rural industrial output, the Other East Coast provinces are second, then the Central region, and finally the West.

III. Empirical Analysis

A. Production Functions

We assume that the production function for industrial output in rural county i can be approximated by a standard Cobb-Douglas production function:

(1) $\log y_i = A_i + \gamma \log l_i + \delta \log k_i + \epsilon_i$

where the efficiency factor A_i is to be modelled, l_i is labor input, and k_i is capital input. The labor input l_i is the product of the number of workers n_i and their average quality index $q_i \approx \exp(\rho E_i)$, where ρ is the return to a year of schooling.

The major factors which we allow to shift the efficiency factor are urban-population

potential $\mathbf{u_i}$ (the sum of the ratios of urban population over arc distances from the 195 district or provincial level cities, including Hong Kong and Macau), road density $\mathbf{D_i}$ (kilometers of road per square kilometer of area for the county) as a measure of infrastructure investment, and either region $\mathbf{R_{ij}}$ (j = 1,2,3,4) or province $\mathbf{P_{ij}}$ (j = 1,2,...,25) dummy variables. Accordingly, the estimating equations are of the form:

(2) $\mathbf{\log y_i = C_i + \theta u_i + \phi D_i + \gamma \log n_i + \gamma \rho E_i + \delta \log k_i + \epsilon_i}$

where $\mathbf{C_i}$ is either a constant or a set of coefficients times provincial or regional dummy variables. The variables $\mathbf{u_i}$ and $\mathbf{D_i}$ are the primary candidates for quantitative shift variables in the production function while the provincial or regional dummy variables attempt to capture qualitative shifts.

Unfortunately, we do not have a direct measure of average years of education and must substitute the percentage of population with at least a junior-high education $\mathbf{J_i}$ as a proxy for $\mathbf{E_i}$. This approximation is only as good as the first-order Taylor expansion of the true functional relationship (e.g., logistic) between $\mathbf{J_i}$ and $\mathbf{E_i}$, but it appears to work well in the regressions reported below. Note that the constant term from the linearization will be combined with the constant term in $\mathbf{A_i}$.[7]

Regression estimates for three variants of equation (2) are reported in Table 2: with no dummy variables, with dummy variables for the central and eastern or coastal economic regions (other coastal region excluded corresponding to the constant), and with 24 provincial dummy variables (Jiangsu in the other coastal region excluded corresponding to the constant). In the first version (model a), we first note a rather good explanatory power with over 80 percent of the cross-section variation explained by these five variables. Supporting the suburbanization hypothesis, we see that other things equal a county one standard deviation above the mean in

nearness to large cities has about 35 percent higher productivity ($e^{0.296} - 1 = 0.344$) than a county with mean nearness. Road density, in contrast, is not a significant factor. The coefficients on labor, education, and capital are all highly significant and of reasonable magnitude. The estimated sum of labor and capital coefficients indicate mild decreasing returns to scale, but that may well reflect errors-in-the-variables bias.[8] We came equipped with Samuel Johnson's comparison to the talking dog (the remarkable thing is not that it is done so well but that it is done at all), but find that allowing for the significant technology transfer between central cities results in a good equation.

In model b, we ask whether these results might not simply reflect the importance of being in the three metro provinces or elsewhere in the coastal region. Including the regional dummies slightly increases the adjusted R^2 (although the increase is quite significant statistically with our large number of observations), lowers the coefficient on urban population potential by about 20 percent, and otherwise has unremarkable effect on the estimated coefficients. It should be noted that the regional coefficients (not reported in the table) are significantly higher for the metro region (0.268*) and lower for the central (-0.087***) and western (-0.199***) regions, all compared to the other coastal region. That is, there are significant regional differences corresponding to the general pattern of Chinese rural industrial development, but accounting for these differences has little effect on either the explanatory power or coefficients of our basic model.

In model c, we instead allow for idiosyncratic variation across provinces and again get a small and statistically significant increase in explanatory power, but the general magnitude and significance of the systematic variables are unchanged with one exception: Road density significantly increases productivity when provincial fixed effects are accounted for.

Taken together, models a-c in Table 2 lead to four conclusions: (a) A standard production function accounts for the bulk of the cross-county variation in Chinese rural industrial output per capita. (b) Nearness to cities substantially increases the productivity of rural industry, in line with reports of substantial technology transfer embodied in commuting workers who live in the cities. (c) Road density may also have a positive effect on productivity, but it is significant only when provincial dummies are included in the regression. (d) There are significant regional or provincial fixed effects, but their inclusion matters little to overall explanatory power or significance of individual coefficients except for road density.

Thus, a standard production function explains cross-county differences in productivity primarily in terms of urban spillovers and possibly infrastructure, with only a supporting role for provincial effects. An important part of the rural-industrialization story remains untold, however, because we have not yet explained what accounts for cross-county variation in per-capita rural industrial employment and in the per-capita stock of capital. We turn to those questions next.

B. Determinants of Rural Industrial Capital Input

Lacking data specifically on the capital stock of rural industrial enterprises, we have had to settle on a measure which includes some capital not used in these enterprises (county-government firms) and which excludes some capital used in these enterprises (private, team-run, and village-government firms). Despite these measurement problems, the capital stock variable enters the production function regressions strongly. Table 3 reports our attempt to explain the amount of capital applied to this sector.

First note that, in contrast to the production function estimates, there is a substantial improvement in explanatory power when we add provincial (but not regional) dummies to the

core independent variables. Accordingly, we focus on model c in Table 3. We find that counties with higher agricultural output in 1985 had more industrial capital in 1991, consistent with the view that Chinese capital markets are localized and saving from agricultural income was an important source of start-up capital for rural industrial enterprises. Counties with higher education levels also had higher industrial capital stocks, consistent with both a local saving argument and the view that industrial enterprises require a more highly skilled and educated work-force. Where the land-labor ratio is high, industrial capital is lower consistent with expectation that in those counties more of the work-force and capital will be devoted to agriculture.

The negative sign on rural (registered) population indicates that there are generally somewhat lower saving rates -- or at least rates of allocation of capital to industry -- in more populous counties. This may reflect the important role of county and town governments in investing in rural industrial enterprise and that these governments do not increase in number as rapidly as population. Returning to urban population potential, we note that this variable changes sign and becomes insignificant when provincial fixed effects are included in the model. Taking account of other, less dramatic changes in coefficient in moving from model a to model c, we see that there appear to be significant variations in investment policy or behavior across provinces which the regression attributes to the systematic variables in the absence of provincial dummies. However, since labor input is positively related to urban population potential (see below), the insignificant positive effect may reflect measurement problems with the dependent variable such that city investments in suburban enterprises are less likely to be recognized.[9]

C. Determinants of Rural Industrial Labor Input

Table 4 presents estimates for rural industrial employment by county in 1991. We note that, in contrast to the production function estimates but like the capital stock regressions, there is a substantial improvement in explanatory power when we add provincial (but not regional) dummies to the core independent variables. Accordingly, we focus on model c in Table 4.

Again, past success in agriculture appears to be a powerful predictor of resources devoted to industrial enterprises. Nearness to cities is also an important factor increasing labor input to industrial enterprises, consistent with the higher productivity of enterprises located near cities. Higher percentage of junior high education also leads to more workers per capita in the higher skilled industrial area. A higher land-labor ratio raises productivity in the agricultural sector and thus reduces the amount of labor in the industrial sector. Rural population was insignificant, implying no differences between more and less populous but otherwise similar counties in their allocation of labor between industry and agriculture.

We observe that in 39 percent of the counties rural industrial enterprise employment is larger -- sometimes much larger -- than the (registered) nonagricultural labor force even though government, health, self-employed and other workers are also classified as nonagricultural labor. This apparent paradox is related to two factors: (a) The registered agricultural labor force includes both full and part-time agricultural workers, so the registered nonagricultural labor force (total labor force - agricultural labor force) excludes workers who are part-time or seasonally employed in agriculture. Sokoloff and Tchakerian (1997) explain geographic variation in rural industry across U.S. counties in 1860 according to the seasonal nature of labor demand by the crops grown in local agriculture; we will attempt in future work to relate labor inputs and productivity to county crop specialization. (b) Since official population figures are based on

registered population in a county and there are large number of workers employed outside of the county in which they are supposed to be working, provincial policies on acceptance of migrant workers may explain important provincial fixed effects.

In order to explore the determination of labor input to rural industry, we report in Table 5 regressions of the logarithm of the ratio of rural industrial enterprise employment to the nonagricultural labor force on the same variables used in Tables 3 and 4. In those Tables model a (and b) R^2 values were over half those of model c with provincial fixed effects; in Table 5 the explanatory power of the systematic factors alone (model a) or those factors augmented with regional fixed effects (model b) is less than 20 percent of that of model c. We infer that although the systematic factors are important determinants of the total amount of labor used in rural industry, provincial-level variations in policy toward migrant workers and in dominant crops on farms are the primary determinants of migrant inflows/outflows and availability of part-time or seasonal workers.

It appears to us that migrant worker flows are consistent with the coefficients estimated in model c of Table 5: The first three factors increasing the marginal productivity of labor in industry all have positive coefficients, consistent with drawing in migrant workers. More abundant farmland, which increases the attractiveness of farming for local workers, also increases actual industrial employment relative to the registered nonagricultural labor force even as it decreases overall industrial employment. That is, in land-rich counties more local workers will farm, reducing labor available for industrial enterprise, but some of the reduction will be offset by immigration. Finally, there is a tendency toward more emigration and less immigration, other things being equal, in more densely populated counties.

IV. Conclusions

We have used a rich, new data set to explore a number of popular explanations for the dramatic growth of rural industrial enterprises which are the largest contributor to China's sustained high growth rate over the last decade. We discovered that a reasonable production function explains the bulk of across-county variation in rural industrial output per capita, with little role for idiosyncratic regional or provincial fixed effects. There is, however, a very large effect on productivity from being near cities amounting to a 35 percent increase for a county that is one standard deviation above average in nearness to population centers. This effect may reflect one or more of three factors: achieving normal urban spread into suburbs, technology transfer embodied in registered urban workers who commute to suburban enterprises, capital and labor inputs from the cities which are not counted in the available data.

The high explanatory power of the production function implies that successful explanations of industrial development differences (other than nearness to cities) must explain differences in the availability of labor and capital to rural industry. Among these explanations, we find strong and robust support for the view that saving from past agricultural income has been an important source of start-up capital for these rural enterprises. On the other hand, a high ratio of farmland to labor leads to greater amounts of labor and capital being devoted to agriculture and hence less to industrial enterprise, although it appears that an induced inflow of migrant workers reduces the effect on labor available for rural industry. Nearness to cities and a more educated work-force also is associated with devoting more resources to rural industry.

While these systematic quantitative variables provide most of our ability to explain across-county variation in inputs of labor and capital into rural industry, a substantial amount (from a

third to nearly half) of explanatory power is attributed to provincial (but not regional) fixed effects. These provincial effects are consistent with provincial differences in policies affecting the ability and incentives of lower-level governments and private entrepreneurs to engage in rural industry and in their ability to employ migrant workers from other counties. They may also reflect differences in dominant crops and hence seasonal or part-time supply of agricultural workers to rural industry. Only when provincial fixed effects are included do we find a significant positive impact on productivity from road density, our measure of local infrastructure as emphasized by Parish (1994).

We have attempted here not so much to find the ultimate factors accounting for the very uneven distribution of rural industrial productivity and output in China, but rather to develop an econometric approach which first determines the four main proximate channels of influence (work-force, education, capital, and nearness to cities), and then begins to examine the forces which have shaped the amounts of labor and capital engaged in rural industry in each county. We believe that this framework provides a useful foundation for further research on this important topic.

REFERENCES

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

Blank, Grant, and William Parish. 1990. "Rural Industry and Nonfarm Employment," pp. 109-139 in *Chinese Urban Reform.* Reginald Kwok, William L. Parish, and Anthony Yeh, eds. Armonk, N.Y.: M.E.Sharpe.

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: Oxford University Press.

Byrd, William A. and Alan Gelb. 1990. "Why industrialize? The incentives for rural community government." Pp. 358-387 in *China's Rural Industry: Structure, Development, and Reform*, edited by William A. Byrd and Lin Qingsong. Oxford: Oxford University Press.

Cao, Wenyi 1989 "Miwang, Zhenhan he Sisuo--Guanyu Guoying Qiye Laodong Jihuawai Guanli Ruogan Wentizhi Wojian" ("Perplexed, Shocked and Composed Again--My Opinion about Some Question of Managing Outside Plan Labour in State-run Enterprises"), *ZLK*, no. 7, p. 9.

Chen, Chao, and Wang Xiguang. 1991. *A Handbook of the County and City Administrative Regions in China (Zhonggou Xianshi Zhengqu Ziliao Shouce).* Beijing: Ditu Chubanshe.

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

China Daily, February 9, 1993.

Darby, Michael R., and Lynne G. Zucker. 1996. "Star Scientists, Institutions, and the Entry of Japanese Biotechnology Enterprises," National Bureau of Economic Research Working Paper No. 5795, October.

Fei, Hsiao-t'ung. 1989. *Rural Development in China: Prospect and Retrospect.* Chicago: University of Chicago Press

Findlay, Christopher, Andrew Watson and Harry X. Wu. 1994. Rural Enterprises in China. New York: St. Martins Press. (reprinted from The Macmillan Press Ltd. 1994 London)

Fleisher, Belton M., Yunhua Liu, and Hongyi Li. 1994. "Financial Intermediation, Inflation, and Capital Formation in Rural China." *China Economic Review* 4:101-15.

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.

Ho, Samuel P.S. 1994. *Rural China in Transition: Non-agricultural Development in Rural Jiangsu, 1978-1990.* Oxford: Oxford University Press.

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

Knight, John, and Lina Song. 1993. "The Spatial Contribution to Income Inequality in Rural China." *Cambridge Journal of Economics* 17:159-213.

Li, Peilin and Cunguang Wang. 1993. *Xin Shehui Jiegou de Shengzhang Dian: Xianzhen Qiye Shehui Jiaohuan Lun (The growth point of a new structure: a social exchange theory of township and village enterprises).* Jinan, China: Shangdong Renmin Chubanshe.

Lin, Yifu, Justin. 1992. "Rural reform and agricultural growth in China" *American Economic Review* Vol 82, No. 1.

Ma, Rong, Caohan Huang, Hansheng Wang, and Mo Yang. 1994. *Jiushi Niandai Zhonggou Xianzhen Qiye Diaocha (A study of Chinese rural enterprises in the 90s).* Hong Kong: Oxford University Press.

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

Ministry of Civil Administration, PRC. 1992. *Encyclopedia of Chinese Counties Vol. 1-6.* Beijing: Tuanjie Chubanshe.

Naughton, Barry. 1995a. "Cities in the Chinese economic system: changing roles and conditions for autonomy." Pp. 61-89 in *Urban Spaces in Contemporary China*, edited by D. S. Davis, R. Kraus, B. Naughton, and E. Perry. Cambridge University Press.

Naughton, Barry. 1995b. *Growing out of the Plan: Chinese Economic Reform, 1978-1993.* Cambridge University Press.

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

Oi, Jean C. 1989. *State and Peasant in Contemporary China: The Political Economy of Village Government.* Berkeley, California: University of California Press.

Oi, Jean C. 1995. "The Role of Local State in China's Transitional Economy." *The China Quarterly* No. 144, December, pp. 1132-1149.

Parish, William. 1994. "Rural Industrialization: Fujian and Taiwan," in *The Economic Transformation of South China: Reform and Development in the Post-Mao Era*, Thomas P. Lyons and Victor Nee, eds., Cornell East Asia Series, no. 70, Ithaca: Cornell East Asia Program, 1994.

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

Perkins, Dwight. 1990. "The Influence of Economic Reforms on China's Urbanization," pp. 78-106 in *Chinese Urban Reform*. Reginald Kwok, William L. Parish, and Anthony Yeh, eds. Armonk, N.Y.: M.E.Sharpe

Renmin Ribao Sept. 22, 1993.

Robinson, Arthur H., Joel. L. Morrison, Phillip C. Muehrcke, A Jon Kimberling, and Stephen C. Guptill. 1995. Elements of Cartograpgy. New York: John Wiley & Sons, Inc.

Sachs, Jeffrey D., and Wing Thye Woo. 1997. "Understanding China's Economic Performance," National Bureau of Economic Research Working Paper No. 5935, February.

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.

Sokoloff, Kenneth L., and Viken Tchakerian. 1997. "Manufacturing where Agriculture Predominates: Evidence from the South and Midwest in 1860." Working paper, UCLA Department of Economics.

State Statistical Bureau, PRC. 1988. *Zhongguo Fenxian Nongcun Jingji Tongji Gaiyao, Vol. 1980-87 (Summary Statistics of Rural Economy of Chinese Counties)*. Beijing: China Statistical Press.

State Statistical Bureau, PRC. 1992a. *Zhongguo Fenxian Nongcun Jingji Tongji Gaiyao, Vol. 1991 (Summary Statistics of Rural Economy of Chinese Counties)*. Beijing: China Statistical Press.

State Statistical Bureau, PRC. 1992b. *Statistical Yearbook of Chinese Cities, Vol. 1992*. Beijing: China Statistical Press.

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

State Statistical Bureau, PRC. 1995. *Statistical Yearbook of China 1995*. Beijing: China Statistical Publishing House.

State Statistical Bureau jointly with the Chinese Academy of Social Science, PRC. 1992. *The Survey of Affluent Counties: 1991*. Beijing.

Stewart, John Q., and William Warntz. 1958. "Macrogeography and Social Science." *The Geographical Review* 48(2):165-184.

Tao, Youzhi. 1988. *Sunan Moshi Yu Zhifu Zhi Dao (The Southern Jiangsu Model and the Road to Prosperity)*. Shanghai: Shanghai Shehui Kexue Yuan Chubanshe.

Wang, Hansheng, Weimin Cheng, Xiaofeng Yan, and Weiming Yang. 1995. "Industrialization and social differentiation: Changes in rural social structure in China since the reform." *Chinese Law and Government* 28(1):9-37.

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: 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 1990s*, 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.

Zelin, Madeleine. 1991. "the Structure of the Chinese Economy during the Qing Period: Some Thoughts on the 150th Anniversary of the Opium War." Pp. 31-67 in *Perspectives on Modern China: Four Anniversaries*, edited by K. Lieberthal, J. Kallgren, R. MacFarquhar, and F. Wakeman. Armonk: M.E. Sharp.

Zhang, Shiwen 1991 [1936]. An Investigation of Rural Industries in Dingxian (Dingxian Nongcun Gongye Diaocha). Sichuan: Sichuan Minzhu Chubanshe.

Zucker, Lynne G., Michael R. Darby, and Jeff Armstrong, "Geographically Localized Knowledge: Spillovers or Markets?", *Economic Inquiry*, January 1998, 36(1): in press.

Zucker, Lynne G., Michael R. Darby, and Marilynn B. Brewer. 1997. "Intellectual Human Capital and the Birth of U.S. Biotechnology Enterprises," *American Economic Review*, 87: in press.

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.

FOOTNOTES

1. The State Statistical Bureau (1994) reports that in the early 1990s about two thirds of total rural industrial output was produced by township-and-village-owned enterprises and the rest by (the even more rapidly growing) group-owned and privately owned enterprises. Sachs and Woo (1997, pp. 34-35) report that many officially registered township-and-village-owned enterprises are in fact owned by private individuals or groups ("wearing the red cap") who pay the local governments a fee to obtain lower taxes, regulatory relief, and political protection. While it seems unfortunate that the acronym TVE was not restricted in popular usage to township-and-village-owned enterprises after group-owned and privately owned enterprises were legalized, it may well reflect the underlying reality that the distinction may not imply a difference.

2. 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 percent (State Statistical Bureau 1994, p.231).

3. The official 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 *China Statistical Yearbook 1995* (State Statistical Bureau 1995).

4. Zucker, Darby, and Armstrong (1998) find that specific academic scientist-firm collaborations representing ownership, employment, consulting and other market relationships accounts for nearly all the apparent geographically localized knowledge spillovers from universities in biotechnology.

5. We thank William Parish for suggesting and providing references for this measure.

6. For 83 counties with missing values for roads (out of 1884 counties), road density is imputed from the following regression:

$$\log(\text{road density}) = -6.0748 + 1.7886 \log(\text{area}) - 0.1519 (\log(\text{area}))^2$$

with N=1801and adjusted R^2 =0.455. Inclusion or exclusion of these 83 cases in the following analysis has little impact on the regression coefficient of this variable.

7. We also tried to include the illiteracy rate as a measure of human capital, but this variable was never significant.

8. Recall that the only available capital stock data included some capital not used in rural industry and excluded capital of village-level and private enterprises. We would expect that this would result in classic bias toward zero for the capital coefficient and, perhaps more speculatively, upward bias on the labor coefficient to the extent that rural industrial labor and capital are fairly highly correlated.

9. Inhibited by bureaucratic restriction on and the high cost of hiring permanent city workers, urban state factories have expanded their operation in the immediate region outside of the city boundaries through subcontracting, joint ventures, and investment in rural enterprises (Naughton 1995a, 1995b, Perkins 1990, Tao 1988).

Table 1: Descriptive statistics for county-level variables used in analysis, China, 1991; N =1,884

	Gross TVE output per capita (*yuan*)	Ratio of TVE labor force to rural population	Industrial capital stock per capita (*yuan*)	Per cent with junior high education in whole county	Urban proximity index (standardized)	Land-labor ratio (*mu*/person)	1985 gross agricultural output value per capita (*yuan*)	Ratio of TVE labor force over fulltime nonagricultural labor force	Road density (km per km^2)
Max.	16,834	214%	78,960	61.16%	4.91	193.50	1,777	34.74	3.11
75%	984	9.9%	991	33.50%	0.70	4.52	530	1.27	0.41
50%	467	5.8%	489	27.97%	-0.11	2.82	411	0.85	0.28
25%	205	2.9%	240	22.13%	-0.61	1.95	321	0.54	0.18
Min.	2.13	0.003%	1.6	2.89%	-2.22	0.23	21	0.002	0.002
Mean	909	7.44%	1,115	27.99%	0	5.10	442	1.04	0.33
Std. Dev.	1,511	7.9%	2,975	9.16%	1	10.41	178	1.36	0.26

Table 2: Production Function Estimates for Rural Industrial Output by County
Dependent Variable: Logarithm of Rural Industrial Output Per Capita, China, 1991

Independent Variables	Coefficients (standard errors)		
	model a	model b	model c
constant	7.317***	7.446***	7.569***
	(0.088)	(0.092)	(0.120)
urban population potential (standardized z-score)	0.296***	0.238***	0.259***
	(0.014)	(0.018)	(0.024)
road density (kilometers per square kilometer)	-0.012	0.024	0.116*
	(0.049)	(0.050)	(0.047)
log (rural industrial employment per capita)	0.801***	0.802***	0.787***
	(0.015)	(0.015)	(0.018)
percent with at least junior-high education	0.023***	0.022***	0.021***
	(0.002)	(0.002)	(0.002)
log (rural industrial capital stock per capita)	0.085***	0.084***	0.069***
	(0.011)	(0.011)	(0.011)
provincial or regional dummies?	none	regional	provincial
F-stat for dummy coefficients =0	n/a	9.388***	21.304***
[degrees of freedom for F]	-	[3, 1875]	[24, 1854]
standard error of estimate	0.518	0.515	0.462
R^2 (adjusted)	0.826	0.829	0.862

*Significantly different from 0 at the 5-percent level.
**Significantly different from 0 at the 1-percent level.
***Significantly different from 0 at the 0.1-percent level.
Notes: N =1884. OLS estimates; standard errors are in parentheses below coefficients.

Table 3: Determinants of Rural Industrial Capital Stock by County
Dependent Variable: Logarithm of Rural Industrial Capital Per Capita, China, 1991

Independent Variables	Coefficients (standard errors)		
	model a	model b	model c
constant	3.360***	2.580***	6.531***
	(0.651)	(0.681)	(0.730)
log (gross value of agricultural output per capita in 1985)	0.613***	0.688***	0.285***
	(0.073)	(0.075)	(0.079)
urban population potential (standardized z-score)	-0.204***	-0.189***	0.062
	(0.032)	(0.037)	(0.050)
percent with at least junior-high education	0.083***	0.081***	0.086***
	(0.003)	(0.003)	(0.003)
log (farmland/registered total rural labor force)	-0.347***	-0.378***	-0.177**
	(0.037)	(0.037)	(0.055)
log (rural population)	-0.222***	-0.208***	-0.306***
	(0.036)	(0.036)	(0.034)
provincial or regional dummies?	none	regional	provincial
F-stat for dummy coefficients =0	n/a	14.888***	27.699***
[degrees of freedom for F]	-	[3, 1875]	[24, 1854]
standard error of estimate	1.098	1.086	0.948
R^2 (adjusted)	0.364	0.378	0.526

*Significantly different from 0 at the 5-percent level.
**Significantly different from 0 at the 1-percent level.
***Significantly different from 0 at the 0.1-percent level.
Notes: N =1884. OLS estimates; standard errors are in parentheses below coefficients.

Table 4: Determinants of Rural Industrial Employment by County
Dependent Variable: Logarithm of Rural Industrial Employment Per Capita, China, 1991

Independent Variables	Coefficients (standard errors)		
	model a	model b	model c
constant	-5.129***	-5.801***	-5.093***
	(0.466)	(0.488)	(0.449)
log (gross value of agricultural output per capita in 1985)	0.363***	0.398***	0.216***
	(0.052)	(0.054)	(0.049)
urban population potential (standardized z-score)	0.278***	0.331***	0.284***
	(0.023)	(0.027)	(0.031)
percent with at least junior-high education	0.039***	0.042***	0.045***
	(0.002)	(0.002)	(0.002)
log (farmland/registered total rural labor force)	-0.288***	-0.273***	-0.328**
	(0.026)	(0.027)	(0.034)
log (rural population)	-0.063*	-0.038	0.012
	(0.026)	(0.026)	(0.021)
provincial or regional dummies?	none	regional	provincial
F-stat for dummy coefficients =0	n/a	11.991***	64.794***
[degrees of freedom for F]	-	[3, 1875]	[24, 1854]
standard error of estimate	0.785	0.778	0.583
R^2 (adjusted)	0.373	0.383	0.654

*Significantly different from 0 at the 5-percent level.
**Significantly different from 0 at the 1-percent level.
***Significantly different from 0 at the 0.1-percent level.
Notes: N =1884. OLS estimates; standard errors are in parentheses below coefficients.

Table 5: Determinants of Rural Industrial Employment/Nonagricultural Employment
Dependent Variable: Logarithm of Rural Industrial Employment/Nonagricultural Employment
China, 1991

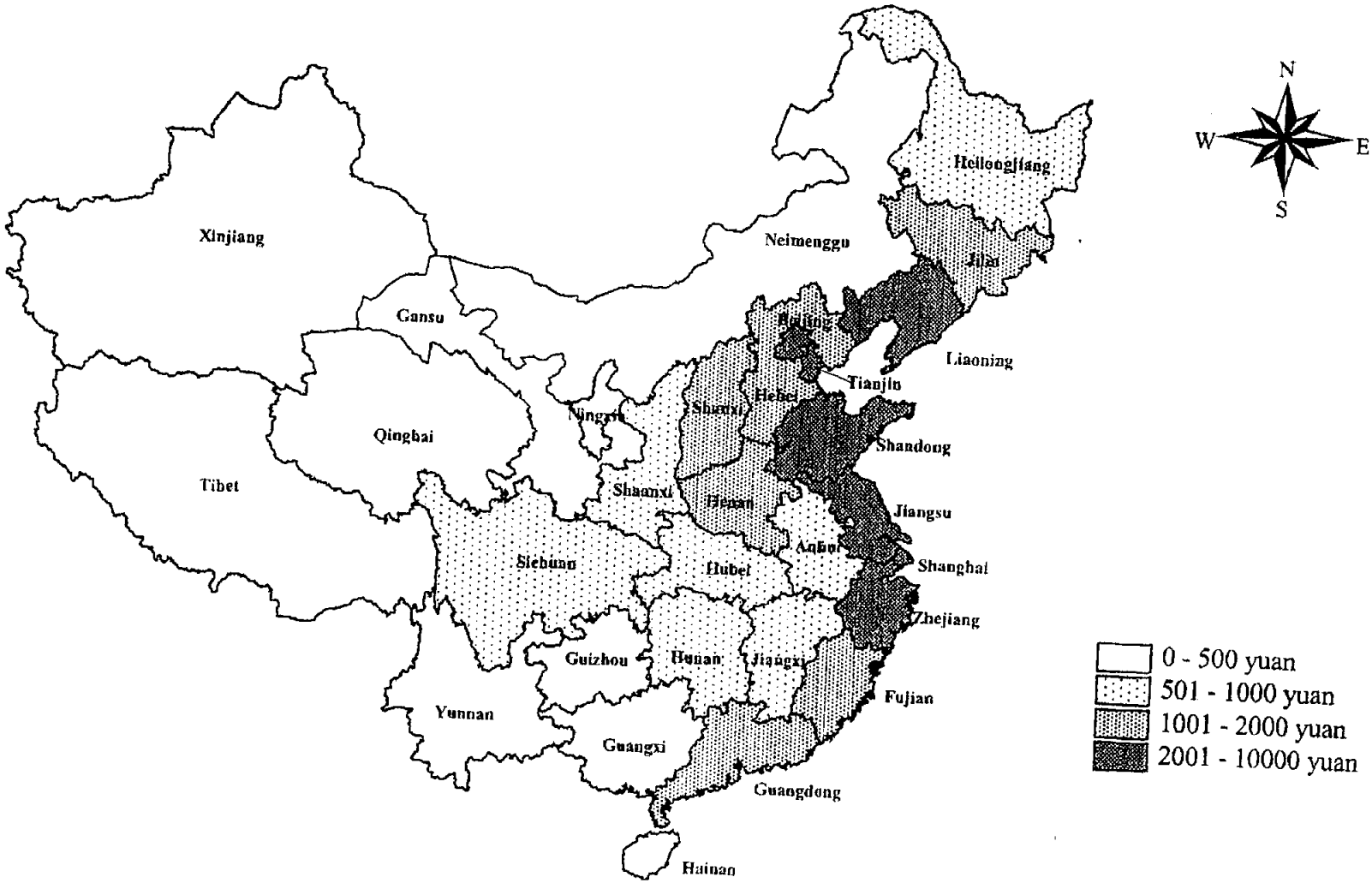
Independent Variables	Coefficients (standard errors)		
	model a	model b	model c
constant	-0.792	-1.283**	-0.167
	(0.441)	(0.465)	(0.466)
log (gross value of agricultural output per capita in 1985)	0.349***	0.390***	0.201***
	(0.050)	(0.051)	(0.050)
urban population potential (standardized z-score)	0.005	0.049	0.072*
	(0.021)	(0.026)	(0.032)
percent with at least junior-high education	0.005*	0.005*	0.011***
	(0.002)	(0.002)	(0.002)
log (farmland/registered total rural labor force)	0.013	0.011	0.081*
	(0.025)	(0.025)	(0.035)
log (rural population)	-0.134***	-0.124***	-0.140***
	(0.024)	(0.025)	(0.022)
provincial or regional dummies?	none	regional	provincial
F-stat for dummy coefficients =0	n/a	3.705*	40.780***
[degrees of freedom for F]	-	[3, 1875]	[24, 1854]
standard error of estimate	0.743	0.741	0.605
R^2 (adjusted)	0.069	0.073	0.383

*Significantly different from 0 at the 5-percent level.
**Significantly different from 0 at the 1-percent level.
***Significantly different from 0 at the 0.1-percent level.
Notes: N =1884. OLS estimates; standard errors are in parentheses below coefficients.

Table A.1: Unweighted Arithmetic Means of County Variables by Provinces and Regions, China, 1991; N =1,884

	N	Gross TVE output per capita (yuan)	Capital stock per capita (yuan)	Ratio of TVE labor over rural population	Ratio of TVE labor over fulltime non-agricultural labor	Urban proximity Index (stnddized)	% with junior high education	Road density (km per km2)	Land-labor ratio (mu per person)	1985 gross agricultural output per capita (yuan)	Registered rural population (person)
Metropolitans	22	7777	3491	28.0%	0.93	2.65	42.2	0.62	3.34	655	414107
Beijing	8	6037	2117	19.3%	0.84	2.92	46.0	0.78	3.82	640	349000
Tianjin	5	5624	957	16.7%	1.09	3.46	33.6	0.81	5.04	520	527007
Shanghai	9	10519	6119	42.0%	0.93	1.96	43.5	0.36	1.97	743	409259
Coastal Region	518	1511	994	10.5%	0.88	0.68	29.6	0.32	2.88	501	518701
Hebei	137	1232	484	11.8%	1.21	1.19	30.0	0.35	4.43	448	363665
Shandong	98	1341	1336	6.9%	0.67	0.95	30.8	0.32	3.26	571	639958
Jiangsu	64	3100	1735	16.3%	0.82	1.27	33.2	0.35	2.55	614	787094
Zhejiang	66	2295	1478	12.9%	0.75	0.82	29.8	0.30	1.24	513	490133
Fujian	62	1304	1025	10.7%	1.56	-0.26	23.2	0.44	2.33	477	383568
Guangdong	72	1677	930	14.5%	0.94	0.23	30.1	0.35	1.77	567	532647
Guangxi	81	150	520	2.5%	0.68	-0.69	23.9	0.20	2.41	346	433035
Central Region	702	740	1378	6.6%	1.07	0.19	30.9	0.37	7.09	454	443699
Heilongjiang	67	752	2372	7.0%	2.59	-0.75	38.1	0.18	38.65	663	269020
Jilin	40	389	3181	3.7%	0.76	-0.11	38.4	0.17	9.45	673	343956
Henan	116	920	1633	3.9%	0.45	0.76	34.1	0.36	2.97	377	624368
Anhui	69	464	804	4.3%	0.52	0.88	25.1	0.35	2.62	460	657610
Jiangxi	83	635	1025	7.5%	1.07	0.11	25.5	0.37	2.64	437	344122
Hubei	71	822	910	8.5%	1.12	0.37	29.1	0.46	2.91	477	558310
Hunan	95	566	1146	7.6%	1.35	-0.15	29.5	0.42	1.92	407	522595
Western Region	642	373	844	5.2%	1.14	-0.85	23.1	0.30	4.76	376	310243
Sichuan	179	569	811	7.4%	1.57	-0.57	23.4	0.32	2.33	397	474394
Guizhou	80	174	480	3.8%	1.08	-0.64	17.7	0.34	1.91	273	350787
Yunnan	122	150	838	2.0%	0.50	-1.28	17.5	0.30	2.98	341	260028
Shaanxi	93	408	875	6.7%	1.02	-0.11	29.1	0.41	5.47	329	273450
Gansu	73	461	929	7.3%	1.22	-0.82	22.1	0.26	6.32	334	236900
Ningxia	17	213	1061	2.4%	0.51	-0.65	25.5	0.18	8.31	364	199631
Xinjiang	78	386	1144	3.6%	1.38	-2.01	29.8	0.12	12.96	583	107115

Figure 1: Gross Output Value of Rural Enterprises Per Capita by Provinces, China, 1991



Source: Ministry of Agriculture (1992).

Figure 2: Logarithm of Rural Industrial Output Per Capita versus Standardized Urban Population Potential, China, 1991
Scatter Plot and Locally Fitted Smoothing