REFORM & THE CONSTRAINTS ON RURAL INDUSTRIALIZATION IN CHINA

by

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I. INTRODUCTION

Over a period of just five years, from 1981 to 1986, the proportion of the Chinese rural labor force employed in agriculture dropped from 94.1% to 80.2%. As shown in Table 1, absolute employment in agriculture was only slightly higher at the end of the period than at the beginning. Thus virtually the entire 18% increase in the rural labor force was absorbed by the manufacturing and service sectors.[2]

This sudden shift in the structure of employment was the outcome of institutional reforms which have dramatically altered economic life in rural China. Within agriculture, households have replaced collectives as the fundamental producing and accounting unit. Each individual household contracts with the local government to farm a plot of land in exchange for the sale of a set amount of output to the state. Beyond this obligation, the household may sell its output on free markets and retain the profits. In the non-agricultural sphere, the management of collectively-owned enterprises has increasingly been contracted out to individuals who are held responsible for

[1]I am grateful to both Louis Putterman and Robert Dernberger for making the Dahe Township data available to me, and to Professor Putterman and Si Joong Kim for their continued expert counsel as I worked with the data. I would also like to thank participants in the University of Hawaii Economics Department faculty seminar for helpful suggestions.

[2]The growth in non-agricultural employment is exaggerated by a change to a broader-based statistical accounting category in 1985. Taylor and Banister (1988) ascribe nearly five percentage points of the shift to this source.

profits and losses. After-tax earnings of the enterprise may be distributed to workers as bonuses or reinvested. In addition, privately-owned firms have come into existence, with many growing to employ dozens of workers.

It will be argued in this paper that the recent change in the sectoral composition of employment depended critically on agricultural reforms to raise the productivity of labor and release workers from food production. During three decades of collective agriculture, food production had barely kept pace with a growing population despite substantial increases in manufactured inputs (Tang 1984). With the reforms of the 1980s, sizable surpluses of output — and hence of labor — emerged. The binding constraint on the growth of rural industry in the post-reform period has thus shifted from labor to capital. To some extent, industrial and service sector reforms permitting private enterprise development have alleviated the capital constraint by facilitating the direct investment of household savings, with that investment presumably tending to favor labor-intensive technologies.

Empirical support for the argument that reform has shifted the factor constraints on rural industrialization will be drawn from a study of Dahe Township (Dahe Commune during the collective era). Dahe Township is located in Hebei Province near the capital city, Shijiazhuang. Louis Putterman and Steven Butler have collected annual accounting data from this township, at the team level for the years 1970 to 1985 and from individual enterprises for the years 1980 to 1985.[3] Several papers by Putterman provide descriptive detail on Dahe's economy and the changes brought about by reform (1988; 1989; and

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[3]The dataset is available on diskette from the University of Michigan Center for Chinese Studies, with an accompanying codebook edited by Louis Putterman. Data pertaining to households and individuals, although not used in this paper, are also available.

Hsiung & Putterman, 1989).

A subset of 44 production teams has been selected for the statistical analysis of this paper. To be selected, a team must have exhibited complete data for a specified set of input and output variables in at least six of the ten years from 1970 to 1979. With some teams yielding more than six years of data, the total number of observations in the 1970s sample is 305. Sample sizes for the earlier years are smaller than for the later years. Parameter estimates derived for the decade as a whole should therefore be regarded as more reflective of the late 1970s to the extent that relationships may have changed within the decade, while estimates specific by year should be regarded as more subject to sampling error in the early years. For the post-reform years 1983 to 1985, a total of 106 observations were available from among the same 44 teams. A listing of the teams and years utilized is contained in Appendix 1.

II. THE PRE-REFORM LABOR CONSTRAINT

The hypothesis to be tested for the pre-reform period is that growth of the non-agricultural sector was constrained by a prior claim on labor in agriculture. Localized self-sufficiency in grain was a fundamental tenet of Mao's economic program. Purchasing grain from outside to meet its consumption needs was not an option for Dahe. Over and above meeting its own needs, the commune was further required to fulfill specified quotas for grain and cotton sales to the state. Only after these local and national obligations were met could resources be diverted to non-agricultural use. And the incentive to divert at that point was strong. The low procurement prices imposed by the state on agricultural products made overfilling quotas unattractive.[4]

The Dahe Setting

In 1978, the total population of Dahe Commune was a little over 20,000. The 44 teams to be analyzed herein accounted for nearly half of that population with a combined membership of 9,772. Of this membership, 4,859 persons were in the labor force for a dependency ratio of about one, considerably below the rural national average of 1.6 (ZTN 1987, 89 & 115).

The teams of the sample held a cultivated land area of 14,532 mu[5], of which 58% was planted collectively to grain and 32% to cotton, while nearly 5% was set aside for private plots. The population density, at 0.67 persons per cultivated mu, was somewhat higher than the rural national average of 0.53 (Chang & Luo 1981, 100; ZTN 1987, 89 & 164). In combination with the low dependency rate then, the ratio of rural labor to cultivated land was much higher than average at 0.33 laborers per mu vs. 0.20.

Grain yields for the Dahe teams were also much higher than the national average at 615 jin[6] per sown mu vs. 338 jin per sown mu nationwide (ZTN 1987, 175). At the same time, the grain marketing rate of near 20% was in line with the rest of the nation (Lardy 1983, 34). As a result, grain retained by the sample teams at 895 jin per capita was way above nationwide grain produced per capita of only 633 jin (ZTN 1987, 89 & 170). The cotton yield for the Dahe

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[4]Wiemer (1989) uses the Dahe data to account for the sources of income growth during the 1970s and finds that virtually all gains in net income arose from the expansion of sidelines while the contribution of agriculture to income was flat.

[5]One mu equals 0.067 hectares.

[6]One jin equals 0.5 kilogram.

teams was 24.0 jin per mu, or less than half the national average of 60 jin per mu (ZTN 1987, 175). Also unlike grain, cotton output was, at 87%, nearly all marketed, leaving 1.44 jin per capita retained compared to a nationwide 45.0 jin per capita produced (ZTN 1987, 89 & 170).

In addition to crop production, the Chinese statistical category for agriculture includes forestry, animal husbandry, fisheries, and sidelines. The combined income for the sample teams from the first three of these sources amounted to only 3.5% of the 1978 total, while the income from sidelines alone came to 29.5%. For the commune as a whole, income from team level sidelines made up 33.8% of the team, brigade, and commune level total. Whereas nationally total sidelines income from all three levels constituted only 14.5% of rural income (ZTN 1987, 157), Dahe's share from sidelines was therefore far higher at 55.9%. By contrast, Dahe's miniscule income share from forestry, animal husbandry, and fisheries was much below the national 17.6%.

As Dahe fared better than the national average in terms of static yields prior to reform, so it did also in terms of agricultural output growth, as Table 2 shows. For the sub-sectors of agriculture, nationwide output time series are available only in constant prices (ZTN 1987, p. 157). How Dahe accountants evaluated the 80% of the commune's grain that was not marketed as prices for the marketed share rose over time is not known. To test for a general rising trend in Dahe's internal accounting prices, reported output value (by team and year) was regressed on grain and cotton output measured by weight, with a time rate of increase incorporated into the price coefficients as follows:

$$\text{Output Value} = P_G(1+r_G)^t\text{Grain} + P_C(1+r_C)^t\text{Cotton} + \text{Constant}(t), \qquad (1)$$

where P_G and P_C represent the prices, r_G and r_C the rates of price increase for grain and cotton respectively, and t is a year index. The constant term is intended to capture output other than grain and cotton, and is allowed to vary by year.

A non-linear least squares estimation procedure obtains an R^2 of 0.96, and implies prices in 1978 of ¥0.135[7] per jin for grain and ¥1.53 per jin for cotton. By comparison, the Statistical Yearbook reports 1978 "average mixed purchase prices" of ¥0.132 a jin for grain and ¥1.14 a jin for ginned cotton (ZTN 1987, p. 664). Estimates for the rates of price increase are 3.75% for grain (significant at the 1% level) and 5.93% for cotton (significant at the 5% level). The Statistical Yearbook reports only a 1.11% average rate of increase in the grain purchase price between 1970 and 1978, followed by a 25.6% increase in 1979. A separate regression for Dahe in 1979 reveals no such extreme jump in the grain price; the coefficient on grain by weight for the year 1979 alone is 0.142. Nationwide, the cotton purchase price too rose by a moderate 1.39% a year prior to 1979, with a 17.6% increase then following. This sudden increase for cotton likewise fails to be captured by separate yearly regressions for Dahe, the estimated coefficient on cotton actually declining slightly from 1978 to 1979.

In sum, conclusive evidence that officially implemented price increases are absorbed in the Dahe accounts is lacking. Even if any reasonable adjustment for inflation were made however, Dahe's nominal crop output growth

[7]The official exchange rate as of February 1989 is 3.7 yuan (¥) to the dollar. At this controlled rate, a sizeable premium to foreign exchange can be obtained on the black market. The Chinese yuan (or Renminbi) has been devalued a number of times during the 1980s. The official exchange rate in 1980 was ¥1.2 to the dollar.

rate of 4.53% would likely still compare favorably with the nationwide 3.14% constant price figure.

Table 2 provides some clues as to the potential sources of Dahe's more rapid growth in crop output. Apparently most critical, faster growth in sown acreage was obtained through a rising multi-cropping index on given cultivated land area. Use of machinery and draft animals grew at only slightly faster than national rates, while application of chemical fertilizer rose somewhat more slowly.

Dahe was also successful in developing sidelines during the 1970s relative to national standards. At team level the growth rate was 14.15% a year while at brigade level it was an impressive 27.43% and at commune level 19.19%. A weighted average of these growth rates compares favorably with the national growth rate for the three levels combined which is 18.53%. Although the national rate is expressed in constant prices, the Statistical Yearbook shows that prices for rural industrial products remained constant during the 1970s (ZTN 1987, p. 648), so comparability is preserved.

Production Functions for the Collective Era

Because income from forestry, animal husbandry, and fisheries accounts for such a tiny share of the total at Dahe, the analysis of this paper is confined to crop production and sidelines. The principal crops produced by Dahe are grain and cotton. Dahe's sidelines have been described by Butler (1983, 113) as follows:

> Many brigades and teams set up small enterprises such as brick kilns, sewing shops, casting shops, paper mills, noodle factories, or silk worm raising enterprises. Teams sent their mule carts and 12 horsepower tractors to haul stone from nearby quarries to the city of Shijiazhuang. Many villages set up teams of masons and carpenters to work on temporary contracts at construction sites during the winter slack season in agriculture.

Both agriculture and sidelines output variables, Y_A and Y_S respectively, are measured in value terms.

The inputs for the production functions are labor, land, expenditures on current manufactured inputs, and capital. While the number of workers is provided on a sectoral basis, the more telling measure of labor, days worked, is given only in the aggregate. The labor input variables, L_A and L_S, are therefore taken as the number of workers by sector times a team aggregate ratio of days worked per worker. To the extent that in fact the average number of workdays per worker differs across sectors, such a derived measure of sectoral labor input is distorted. Some adjustment of the simple worker count by sector does, however, seem warranted since the number of days worked per worker varies considerably across teams and over time.[8]

Expenditures on current manufactured inputs are tallied separately with respect to agriculture, M_A, and sidelines, M_S. About half of agricultural expenditures goes for fertilizer. In order of magnitude for the year 1978, other expenditures were for draft animals, seeds, miscellaneous needs, repairs, irrigation, agricultural chemicals (other than fertilizer), and machine plowing. No similar breakdown in sideline expenditures is available.

Land, R, refers to the area cultivated and need enter only the agricultural production function.

For capital in value terms, there is only one aggregate measure in the accounts. Although there are, in addition, such physical measures as the total horsepower of tractors, the total kilowatt power of electric motors, and

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[8]A labor-day in fact differs from a calendar day in that it has an effort or ability component factored in. To the extent that adjustments to calendar time were not made consistently across teams or through the years use of this measure may introduce distortions.

the numbers of various types of farm implements, a basis for disaggregating these assets by sector is hard to imagine. As Butler indicated in the above excerpt, even tractors are fungible. Instead therefore, an attempt has been made to discern the pattern of capital allocation via empirical means. The proportion of total capital allocated to each sector is assumed to vary across teams, but remain constant within a given team over time. Formally, aggregate capital times a team-specific constant is allowed to enter each production function, with the constants constrained to sum to one across equations.

The model to be estimated is then as follows:

$$\ln Y_A = \alpha_0 + \alpha_t t + \alpha_L \ln L_A + \alpha_M \ln M_A + \alpha_R \ln R + \alpha_K \ln[K(\phi_1 D_1 + \ldots + \phi_N D_N)] + \epsilon_A \qquad (2)$$

$$\ln Y_S = \sigma_0 + \sigma_t t + \sigma_L \ln L_S + \sigma_M \ln M_S + \sigma_K \ln[K((1-\phi_1)D_1 + \ldots + (1-\phi_N)D_N)] + \epsilon_S \qquad (3)$$

where t indicates the year, the D_n are team dummies, the assorted α, σ, and ϕ coefficients are parameters to be estimated, and ϵ_A and ϵ_S are stochastic error terms. To facilitate estimation, the error terms are assumed independent and identically distributed, and constant returns to scale are imposed for both sectors.[9] A least-squares estimation procedure has been used.

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[9]To the extent that serial correlation and heteroskedasticity are present in the error terms, the parameter estimates obtained will be biased. Unfortunately, the already complex nature of the computer algorithm required to estimate 55 parameters within a simultaneous non-linear equations system makes the application of standard panel data techniques impractical. The constant returns to scale assumption is necessary to assure convergence in the presence of multi-collinearity between the dummy variables and constant term. Using fitted values for sectoral capital stock to re-estimate the two equations independently and without the constant returns constraint yields virtually identical estimates for the α and σ parameters.

The parameter estimates and their standard errors are presented in Table 3. All the output elasticity estimates are significant at the 1% level, with the exception of capital in agriculture which is significant only at the 10% level. R^2 values are 0.79 for agriculture and 0.68 for sidelines.

In agricultural production, the input showing the highest elasticity, at 0.63, is land — a not surprising finding in intensively farmed China. Labor makes the next strongest contribution with an elasticity of 0.23. The elasticities with respect to manufactured inputs and capital are much lower at 0.093 and 0.043 respectively. In sidelines, with no binding land constraint, the elasticities of all other inputs, but most notably that of capital at 0.21, are higher. Total factor productivity gains accrued at rates of 2.4% a year in agriculture and 3.9% a year in sidelines.[10]

The 44 ϕ_n estimates (not shown in the table) imply that on average, teams allocated capital 68% to agriculture and 32% to sidelines during the 1970s. Sidelines were thus more capital-intensive than agriculture since the sidelines share in output had risen to only 24% by the end of the decade.

Observed average team output and the fitted values for average inputs, by year and sector, are shown in Figure 1. Actual agricultural output rose steadily through the early 1970s, then took a dip in 1975 and 1976 from which it reemerged decisively by the end of the decade. The fitted values from the regression show a dip also, but it arrives a year early suggesting that perhaps a decline in key inputs in fact affects output only with a lag. The decline is nevertheless reflected immediately using the estimated production

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[10]These elasticity estimates differ importantly from values previously adopted in other studies to calculate sources of growth for Chinese agriculture. See Wiemer (1989) for a comparison with previous studies. (The elasticity estimates reported by Wiemer in that paper differ slightly from those given here due to a revision in the estimating technique.)

function since most of the variation captured by the regression estimates occurs in cross section. Sidelines output takes off from virtually nothing to reach a pinnacle in 1973, subsides, then climbs for two years before falling off again at the end of the decade. The peak in 1973 and at least a moderation in growth for 1978 and 1979 are captured by the regression model.

Volatility over time in agriculture is expected due to the effects of weather. While sidelines are not so directly influenced by the vagaries of nature, the ready mobility of resources between sectors at the team level may make sidelines indirectly vulnerable. Because of the difficulties in capturing year to year fluctuations in output, the focus in this study is on the long term trend relationship between the two sectors. Predicted trend growth is the third plot shown in the figure for each sector. The predicted trends were generated using the input growth rates of Table 2 and the regression model.

Factor Productivity

The estimated production functions imply value marginal products at team average values of the inputs as shown in Table 4. Value marginal products were, without exception, higher in sidelines than in agriculture.

Labor's value marginal product in agriculture remained constant through the decade at about ¥0.24 per labor-day despite the rapid increases in current inputs and capital noted in Table 2. The constancy of land clearly limited the potential for labor productivity increases within the agricultural sphere. The unit of measure "labor-day" differs from a calendar day in that it contains an effort or ability component. In 1978, Dahe workers accumulated an average 450 labor-days each. At that rate, value marginal product per worker per year was ¥107.[11] Labor-days per worker rose during the 1970s at an annual rate of 1.82%. Value marginal product of labor calculated in yearly terms therefore shows a slight rising trend over time. The labor-day provided the basis on which team income was distributed to workers under the collective system. The average remuneration for one labor-day at Dahe in 1978 was ¥0.48, or twice labor's estimated value marginal product. Sidelines labor shows a value marginal product nearly four times higher than that in agriculture.

The value marginal product of land exhibited a pronounced rising trend over the decade. This is as expected given the increase in other inputs while cultivated land area remained fixed.

The marginal return to current inputs was only about ¥0.2 per yuan spent in agriculture. The implication is that current inputs were utlized well beyond profit-maximizing levels. Value marginal products for current inputs in sidelines were generally above ¥1 per yuan spent, although the magnitudes varied a great deal from year to year.

Rates of return to capital at the margin would appear to have declined steadily over time in agriculture. It should be recalled, however, that capital allocation between sectors was assumed to occur in fixed proportions over time. If in fact the proportion of capital allocated to agriculture fell, as indeed the proportion of output from agriculture fell, the return to capital would be increasingly understated over time by the figures in Table 4. Even allowing for a corresponding overstatement in rates of return to

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[11]To the extent that on a yearly basis, workers also applied themselves to activities not captured in the team accounts (for example, farming private plots or producing household handicrafts), such an annualized marginal product measure based on prorating the collective labor day fails to reflect the true return to an additional worker or the true opportunity cost of a worker who migrates to alternative full-time employment.

sidelines capital, however, the marginal product of capital in that sector is undoubtedly higher than in agriculture.

Any output price increases that occurred during the 1970s would introduce an upward shift in all value marginal product series. The pronounced increases in state purchasing prices for agricultural products known to have occurred in 1979 are not translated into clear gains in nominal productivity at the Dahe team accounts level.

Labor as a Binding Constraint on Development

Was availability of labor a binding constraint on rural industrialization at Dahe during the 1970s? Let labor available for team sidelines be defined as workers in excess of the number needed in crop production to sustain a given baseline magnitude of agricultural value added per team member, including non-participants in the labor force. This assumption is in the spirit of Jorgenson's 1967 neoclassical model of development in which the income elasticity of demand for food above some subsistence threshold is zero.

Value added is calculated as gross crop output value minus material input expenses and depreciation on capital figured at 5% a year. 1970 is taken as the baseline year, with magnitudes for the input variables projected along trend using the growth rates of Table 2 and 1974 team means, and with output value obtained from the regression model.[12] The ratio of agricultural value added per capita yielded as the reference figure is ¥74.81.[13] Suppose

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[12]The 1974 team input means and fitted outputs are: L_A=32,870 days (78.41 persons); L_S=4,427 days (10.56 persons); M_A=¥13,572; M_S=¥1,924; R=329.4 mu; K_A=¥12,309; K_S=¥5,663; Y_A=¥32,566; Y_S=¥8,911; and to be defined shortly in the text, P=227.2 persons (with a trend growth rate of 0.522% a year).

[13]Details of the calculations used to obtain this and further results are contained in Appendix 2.

that labor cannot leave agriculture as time passes unless this constraint continues to be met. Would the implied change in the composition of the labor force correspond to that actually observed?

Suppose further that the team must meet an exogenously specified output quota for sale of crops to the state in addition to feeding its own population. This output sales quota is assumed to be binding at the low procurement prices offered by the state through most of the 1970s. Land, capital, the aggregate labor force, and population will also be treated as exogenous. The team itself is assumed to decide how to allocate available labor and how much to spend on material inputs to agriculture. The team then makes its material input choice subject to the value added per capita constraint so that

$$M_A(t) = Y_A(t) - \delta K_A(t) - ¥74.81 \cdot P(t) \qquad (4)$$

where P(t) represents the team population in time t. Applying this formula to the exogenously given trend values of P, Y_A, and K_A, implies a growth rate for M_A of 8.30% a year. This predicted growth rate comes very close to the observed 8.48% rate given in Table 2.

The predicted growth rate for agricultural labor can be expressed as a function of the growth rates of output and other inputs by differentiating the logarithmic form of the production function with respect to time and solving. The result obtained is 2.52% a year. To convert this measure of labor expressed in days to one expressed in persons the 1.82% annual rise in the number of days worked per person must be subtracted, leaving 0.70% — a rate very near the 0.61% of Table 2. Finally, given an aggregate labor force growth rate of 1.35%, the predicted rate of growth in labor available for sidelines is 5.95% vs. the observed 6.60%.

The proposed model involving a labor constraint in agricultural performs well in explaining the observed pattern of labor reallocation during the 1970s, especially when contrasted with the implications of more standard models. A model based on profit-maximizing behavior subject to given prices is obviously untenable in light of the pronounced differences in labor's marginal productivity across sectors. Nor would an assumption of profit-maximization admit of purchased inputs being so heavily utlized as to return only a fraction of their cost at the margin. The labor-constrained model on the other hand justifies such heavy use of purchased inputs because they substitute for labor which is then freed for its higher marginal product use in sidelines.[14]

A Lewis-Fei-Ranis model of labor allocation is also not supported by the data. In the extreme version of this model, labor's marginal product in agriculture is presumed to be zero. The positive elasticity of output with respect to labor obtained in the production function estimation clearly rules out such a premise, and this despite the extremely high labor to land ratios found at Dahe. In the less extreme version of the model, labor's marginal product in agriculture is positive but below the wage floor in the manufacturing sector. In either case, labor reallocation follows immediately from new investment in manufacturing. At Dahe Commune in the 1970s, the aggregate rate of capital growth far outstripped the rate of sidelines labor absorption, which suggests the absence of a ready pool of available workers.

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[14]An alternative explanation that has been given for the uneconomic use of purchased inputs is that minimum purchase requirements were imposed by higher authorities (Lardy, 215).

III. REFORM & THE RELAXATION OF THE LABOR CONSTRAINT

Agricultural reform at Dahe began in 1980. The style and pace of change varied across teams during an initial few years of experimentation. Then in 1983, the system of contracting output to households (baogan daohu) was adopted uniformly. Each household was allotted a parcel of land to cultivate in exchange for which it agreed to sell a fixed quantity of output to the state at the state's price. Output produced above the quota could be sold at higher prices either to the state or on free markets.

The delegation of responsibility and reward to individual households would be expected to motivate greater worker effort, and hence higher factor productivity.[15] A series of procurement price increases no doubt further enhanced incentives at the margin. At the same time, however, fragmentation of land and a loss of scale economies would be expected to have eroded productivity. That the motivational effect dominated across China generally is apparent from the dramatic burst of agricultural output growth which accompanied reform. From 1981 to 1984, real growth in crop production averaged 9.07% a year for China as a whole (ZTN 1987, 157), up from the 1970s trend growth rate of 3.14% shown in Table 2.

The hypothesis to be tested in this section is that reform so raised factor productivity in agriculture that with given labor inputs, food requirements at the 1970s threshold would vastly have been exceeded by 1983. In this sense a labor surplus can be said to have emerged.

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[15]Although see Putterman (forthcoming) for an argument that incentive measures available within a collective framework were perhaps not used as effectively as they might have been at Dahe.

The Post-Reform Agricultural Production Function

To compare factor productivity in agriculture before and after reform, a post-reform agricultural production function has been estimated for Dahe — now Dahe Township. Because of the organizational changes brought by reform, some problems with data continuity arise. In the post-reform period teams are no longer the basic unit of production, and therefore do not continue to keep comprehensive accounts of inputs and outputs. Rather, such production data must be obtained through team level sampling of individual households.

Within the household, the concept of "labor-day" is no longer essential to determining distribution, so only the number of household members engaged in farm work is available as a measure of labor. As for capital, team assets were in large part sold to households with reform. Although a summary asset value figure was as a result lost from the accounts, household sampling does yield information on the numbers of various types of machinery, tools, and draft animals possessed. Such physical measures of capital are similarly available for the pre-reform years. By regressing team asset value on the assorted physical capital items for the 1970s, a set of aggregation weights has been obtained for application to the post-reform data.

Another problem in comparing pre- and post-reform productivity involves the treatment of private plots. Even in the wake of reform, private plots are distinguished from collectively-assigned land in that they bear no tax or quota obligations. Private plot output was not included in the team accounts for the 1970s. In the 1980s data, private plot output is apparently sometimes included and sometimes not depending on individual team accountant preferences, which the data themselves do not expressly reveal. Putterman notes that as a result, it is "exceedingly difficult" to disentangle real increases in aggregate output from simply the change to a more inclusive statistical reporting system (1989, note 26).

The sampling error introduced by the less rigorous data tabulation methods of the 1980s would be expected to lead to more uncertain parameter estimates, as indeed it does. The estimates and their standard errors are shown in the last two columns of Table 3. The adjusted R^2 of the regression is 0.29. Only the land elasticity estimate and the time-induced shift factor are significant at the 1% level. The elasticity estimate for current manufactured inputs is significant at the 10% level. The land elasticity estimate has declined relative to the 1970s by half. The capital elasticity estimate has risen to supplant it.

The more revealing comparison of pre- and post-reform input-output relations derives from marginal productivity estimates. These are presented in Table 5, along with the team mean values for inputs and outputs on which they are based. Output in 1983 was up over its 1979 level by 75% in nominal terms. A regression of output value on real production of grain and cotton, in the manner of Equation 1, yields a 1983 price coefficient for grain of ¥0.174. The mixed average purchasing price for grain in that year given by the Statistical Yearbook is ¥0.196 (SYC 1985, 547). For cotton the figures are ¥1.20 from the regression and ¥1.7 from the Yearbook (SYC 1985, 548).[16] The data-derived price for grain is moderately above its 1978 level, while that for cotton is actually lower. Even admitting of price increases on the

[16]Although the standard errors are small relative to the magnitudes of these price estimates, the validity of the estimates must remain highly suspect. The same regression yields the implausibly large values for r_G and r_C of -0.40 and 0.48 respectively — which are nonetheless insignificantly different from zero statistically.

order of those given by the Statistical Yearbook, however, leaves at least half the rise in output between 1979 and 1983 attributable to real growth.

This real aggregate growth may contain an element of changing output composition. Grain yields per mu as well as the proportion of agricultural land sown to grain were little changed following reform. Rising aggregate output value in real terms must therefore be due to higher yields for non-grain crops. These higher yields may reflect a reallocation of labor and current inputs away from grain. For purposes of this analysis, such a reallocation is regarded as a legitimate source of productivity growth.[17]

Input magnitudes were little changed immediately following reform with the distinct exception of capital which more than doubled. Since capital values for the 1980s are inferred from physical asset counts, price increases are not a factor in the rise. The likely explanation for the rapid pace of asset acquisition is that decollectivization necessitated widespread individual purchase of assets that had formerly been shared. It is possible as well that the household sampling approach to asset tabulation used in the 1980s has captured assets not formerly reflected in the team accounts. For current inputs on the other hand, price increases may influence reported value. The Statistical Yearbook shows an 18% price increase for the "means of agricultural production" between 1978 and 1984 (SYC 1985, 532). In real terms then, purchased inputs to agriculture at Dahe may in fact have declined with reform.

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[17]Township authorities probably required a certain minimum acreage to be planted to grain. The yield growth differentials between grain and other crops are thus more pronounced than would be the case in an unconstrained setting, and overall income from agriculture is lower than if all inputs were optimally allocated.

The value marginal products of labor and land remained basically stable following reform. Those of material inputs and capital rose notably. Without a change in the production function parameters, the enormous increase in capital relative to other inputs would have lowered that factor's marginal product. An interpretation of the higher productivity acompanying more capital is that reform, by providing incentives to work harder and manage resources better, actually raised labor and land inputs relative to capital in "efficiency terms". In other words, if each worker were working several times harder, and each plot of land were being managed several times better than before reform, the effective ratio of labor and land to capital would have risen — yet available physical measures of the inputs would fail to capture this rise. Capital's marginal product would increase, as would that of the stable material inputs, and although the marginal product of an efficiency unit of labor or land would fall, the marginal products of measured units of these inputs could fall, rise, or, as was the case at Dahe, stay the same.

Emergence of a Labor Surplus

By the mid-1980s, agricultural output was substantially higher than in the late 1970s, although a big increase in capital stock at least in part underlay this higher output. To control for input changes and test the effect of reform on the productivity of given inputs, 1979 trend input values were entered into the 1980s production function. The output value predicted in this manner is ¥63,372, a figure 67% higher than the ¥37,986 yielded using the pre-reform production function with the same inputs.

As a result of both productivity gains and the higher capital/labor ratio, average value added per agricultural worker was elevated to ¥605 in 1983 from barely ¥200 in 1979. The total population to be supported out of this bounty was little changed from its pre-reform level, if anything having declined slightly since the late 1970s. The per capita value added threshold that had been maintained through the 1970s was therefore far exceeded by 1983, even in real terms under the most pessimistic assumptions about inflation, and even after any warranted adjustments have been made to offset statistical bias.

The 1970s threshold cannot, however, continue to serve as a reasonable guide to surplus labor in agriculture. By 1983 households were selling above-quota output at market-determined prices that made agricultural employment much more attractive than it had been in the pre-reform period. Increased latitude to change the crop mix and to raise pigs and fowl privately would moreover be expected to bolster the local demand for farm products. As a result, labor would no longer be so readily inclined to leave agriculture once given marketing quotas and a subsistence threshold for the local population had been met. Lacking a clearly defined benchmark for labor requirements, it is difficult to say precisely how many agricultural workers were made superfluous by productivity-raising reforms. The production function estimates do reveal that very modest sacrifices in output would release a large proportion of the workers employed in agriculture. Specifically, nearly 40% of agricultural labor at Dahe would be freed in exchange for an output reduction of just 5%, all other inputs constant.[18]

It is worth noting that the production function estimates for Dahe clearly imply that surplus labor does not exist in the technological sense of a zero marginal product of labor. Such is the concept of surplus labor apparently intended by Chinese economists who have developed estimates in the

[18]See Appendix 2, item B.

vicinity of one-third for the proportion of the rural labor force that is redundant.[19] These estimates do not necessarily mean, however, that one-third of agricultural workers could be removed from crop production with no loss in output. Rather, they refer to one-third of all available work days being unneeded while granting that nearly all individuals can be put to productive use during the busy planting and harvesting season. Since the measure used for labor in the production function estimates for post-reform Dahe is one of individuals and not days, it is not sensitive to seasonal or part-time work distinctions.

IV. THE POST-REFORM CAPITAL CONSTRAINT

Although reform made it possible in principle for a large number of agricultural workers to leave crop production without reducing output per rural resident below the pre-reform standard, limited capacity to create alternative jobs imposed a new constraint on the labor reallocation process. Reforms within the non-agricultural sphere of the rural economy have to some extent alleviated the bottleneck. Nevertheless, the very small base from which rural manufacturing and services began the 1980s means that even at double digit growth rates some years will have to pass before a significant fraction of the rural labor force is absorbed. The role of capital formation in facilitating labor reallocation is examined in this section.

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[19]See Taylor (1988) for a report on Chinese methods of estimation and results.

An Enterprise Production Function

With the demise of the collective structure in agriculture, sidelines were organized within distinct accounting entities having their own responsibility for profits and losses. Management of township- and village-owned enterprises was with growing frequency contracted out to individuals. In addition, two new types of privately-owned enterprise were sanctioned — the new economic union and the individually-owned firm. New economic unions are similar to partnerships in the U.S.[20] Partners invest their own funds and share in the profits according to individual contributions of investment capital and labor.

The Dahe dataset contains accounting records from a sample of Dahe's non-farm enterprises for the years 1980 to 1985. The township statistical office has separately provided aggregate data covering the same period and broken down by township, village, and private levels. The sample data comprise nearly the same number of township-level enterprises as recorded in the statistical office aggregate, initially half rising to two thirds of the village-level enterprises, and by 1985 about a quarter of the private enterprises. Unfortunately the two sets of data are not consistent. Total revenues, assets, and employment calculated from the sample enterprises exceed the official aggregates in some years even though the official aggregates supposedly pertain to a much larger and all-encompassing number of entities. One must guess that the township records suffer from incomplete financial reporting. In the analysis to follow, township records will be treated as a reliable source of information only for the total numbers of enterprises in

[20] In fact, the term partnership has been adopted to refer to the Chinese xin jingji lianheti in a joint World Bank - Chinese Academy of Social Sciences study (Byrd and Lin, forthcoming).

operation. The sample data will be used to draw inferences regarding factor productivity and the expansion rates of existing firms.

The number of non-farm enterprises tabulated by the Dahe Township statistical office grew rapidly with reform from 54 in 1980 to 231 in 1985. Seven of the initial 54 were operated at the township level, the remaining 47 at the village or team level. By 1985, one township level enterprise had been added, the number of village and team enterprises had grown to 77, and 146 new private enterprises had been formally registered[21]. The enterprises manufactured a wide range of products including bricks, fertilizer, flour, furniture, starch, straw matting, three-wheeled pedicabs, rolled steel, and spare parts for machinery.

The sample enteprises record revenue both in gross terms and net of expenditures, where expenditures are inclusive of payments made to labor. To calculate value added, VA_E, for use as the dependent variable in an enterprise production function, wage payments must be reintroduced to reported net revenue. For most collective firms the calculation is straightforward since wage payment figures are explicitly recorded. For private firms, the data are of generally poorer quality, with wage payment figures for the most part absent or clearly inconsistent with other reported magnitudes. The statistical analysis to follow is therefore confined to those collective firms for which adequate data are available. Only a few summary remarks will be

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[21]To be registered, a new economic union must 1) have an organization of some scale, a fixed place of operation, and permanent personnel, 2) produce comparatively stable products, and 3) maintain an accounting system and a system for distributing its earnings; an individually-owned firm must 1) have a license and have been in operation for at least three successive months 2) have a fixed place of work, and 3) maintain an independent accounting system.

made regarding private firms. The total sample size for the collectives is 165.[22] The number of firms represented in each year is given in Table 6.[23]

The arguments for the enterprise production function are labor, L_E, and capital, K_E. Although a distinct reporting category for managers exists, a consistent definition of what constitutes a manager does not appear to have been applied across enterprises, hence a single consolidated measure of labor has been adopted. Capital refers to the original value of fixed assets.

The estimated production function is:

$$\underset{}{\ln VA_E} = \underset{(0.41)}{6.22} + \underset{(0.027)}{0.070t} + \underset{(0.052)}{0.924\ln L_E} + \underset{(0.044)}{0.108\ln K_E} + \epsilon_E \qquad (5)$$

where again t is a time index, ϵ_E represents indendent and identically distributed errors, and the numbers in parentheses are the standard errors of the estimates. The adjusted R^2 for the regression is 0.77. All parameter estimates are significant at the 2% level. The elasticity of output with respect to labor is much higher than with respect to capital. Total factor productivity gains have accrued at a respectable 7% annual rate.

[22]Inclusion of enterprises above the team level makes the 1980s data more comprehensive than that for the 1970s. In effect, workers who left team-level employment during the 1970s were treated as no longer belonging to the study population.

[23]From within the collective group seven observations for which the capital/value added ratio is extraordinarily high have been excluded from the analysis. A value of 10 was used as the cut-off, although several of the excluded observations show ratios a great many times that. The excluded observations encompass all four available years for one firm, and one year each for three other firms. The unusually high values might be attributed to errors in reporting, to plants operating temporarily at less than planned capacity, or to gravely wasteful investment from the start. Including the observations in the production function estimation drives the elasticity estimate for capital to zero and that for labor to one.

Annual average magnitudes for labor, capital, and value added for the sample enterprises are given in Table 6. The input magnitudes show an erratic pattern until 1985 when they take a decided upward jump. Value added by contrast shows an increase in every year, with the 1985 rise especially sharp. Attaching too much significance to yearly differences would be unwarranted however, since the sample does not encompass the same enterprises in each year.

The estimated production functions imply value marginal products of labor and capital at mean values for the inputs as shown in the last two columns of Table 6.[24] Labor's marginal product rises steadily over time. The marginal rate of return to capital shows deviations around a level of about 13%.

The Rate of Labor Absorption

The general question to be addressed is: What determined the rate of labor absorption into non-agricultural employment during the reform era once the food constraint holding workers in agriculture was relaxed? The Lewis-Fei-Ranis model of development posits an institutionally-set wage in agricultural lying above labor's marginal product in the presence of surplus labor. This institutional wage defines the supply price at which labor migration into manufacturing will occur. With profit-maximizing behavior assumed in the manufacturing sector, the marginal product of labor there is equated to agriculture's institutional wage, and a marginal product gap between the two sectors is sustained. Although welfare gains would result

[24]The marginal product figures for collective enterprises presented in Table 6 are actually derived from a version of the production function in which factor elasticities are constrained to sum to one, as discussed below.

from the immediate reallocation of labor out of agriculture into manufacturing, such reallocation will nevertheless only gradually take place as capital formation creates new demand for workers at the fixed wage floor.

In Dahe's case, the marginal productivity of labor in agriculture is certainly far below that in manufacturing based on the evidence of Tables 5 and 6. Even the average product of labor in agriculture, which would constitute an upper bound on any institutional wage, is well below the marginal product of labor in enterprise activity. Average product per worker in agriculture (net of expenditures on current inputs and depreciation at 5%) was ¥604 in 1983, and rose to ¥970 by 1985.

The remaining gap between the compensation received in agriculture and labor's marginal product in manufacturing might be explained in several ways. Perhaps there are non-wage opportunity costs to leaving agricultural work, with its nearness to home and flexible work hours, that must be met by the manufacturing wage. Perhaps those workers selected for manufacturing jobs possess specialized skills that make them more productive than other contenders from the agricultural labor pool. Or perhaps workers who become secure in manufacturing jobs are able to push through wage increases for themselves to the detriment of new hiring.

The role of capital formation in new job creation, as well as the mitigating influence of any wage increases, can be assessed quantitatively by applying the estimated production function. An expression for the rate of growth of employment is obtained by first differentiating the production function with respect to labor and solving explicitly for labor in terms of capital and the marginal product of labor, MP_L, then taking logarithms of the resulting expression, and differentiating with respect to time. Let γ_L and γ_K

represent output elasticities with respect to labor and capital respectively, γ_t the rate of growth of total factor productivity, and ^ over a variable its proportional growth rate, to yield the following:

$$\hat{L}_E = \frac{1}{\gamma_L - 1} (\widehat{MP}_L - \gamma_t - \gamma_K \hat{K}_E). \quad (6)$$

To apply this equation to collective manufacturing at Dahe in the aggregate and obtain reasonably valid predictions from comparative statics, three conditions must hold. First, the average sample firm must be representative of all collective firms at Dahe. Given the large variation in size and factor proportions that exists within the sample, as well as the small size of the sample relative to the total number of enterprises at Dahe, especially in earlier years, this condition must be regarded as holding loosely at best. Nevertheless, a rough approximation to aggregate capital and labor magnitudes can be obtained by multiplying the sample means by the total number of collective enterprises in the township. The implied growth rate for capital is 15.6% a year and for labor 15.8% a year over the 1980 to 1985 period.

The second and more empirically plausible condition is that constant returns to scale prevail. Re-estimating Equation 5 with constant returns to scale imposed leaves the R^2 of the regression unchanged to three decimal places. The labor elasticity estimate yielded is 0.903. The estimated rate of total factor productivity growth is unchanged.

The third condition that must hold is that marginal products of labor be equalized across firms. The standard behavioral premise for such an outcome is that firms face a competitive wage and hire workers so as to maximize profits. This behavioral premise can be tested by regressing the log of the observed wage rate (calculated as a firm's total wage bill divided by its total employment) on the log of the capital/labor ratio and a time index. The coefficient estimate for the capital/labor term should equal γ_K. The estimate actually obtained is right on target at 0.107. The standard error of this estimate is 0.041, indicating significance at the 1% level. It should be noted however, that the adjusted R^2 of the regression is only 0.08, so that while wages are on average equal to labor's marginal product, there is wide variation around this mean across firms. The presence of these firm-level deviations from a universal marginal product of labor may distort the true aggregate relationship relative to that obtained by using a mean value for labor's marginal product in Equation 6.

In Jorgenson's formulation of the surplus labor model, labor's marginal product growth is zero since the supply of labor at the exogenously established wage is perfectly elastic. The manufacturing labor force then grows at the rate of capital formation plus the ratio of the rate of total factor productivity growth to the elasticity of output with respect to capital, as per a simplified form of Equation 6. At Dahe, marginal product of labor growth for the average firm is seen from Table 6 to have occurred at a 6.89% annual rate — which clearly exceeds zero. In fact, the rate of marginal product growth coincides almost exactly with the rate of total factor productivity growth. A possible explanation for this is that already-employed workers have enough bargaining power to extract wage increases equal to their productivity gains. This is certainly a plausible scenario within the context of collective ownership, even in the face of surplus labor.

With $\widehat{MP}_L$ equal to γ_t, and given constant returns to scale, Equation 6 states that non-agricultural employment should grow at exactly the same rate as the capital stock, hence desired increases in the rate of labor absorption into manufacturing can be achieved only by mustering equivalent increases in the rate of capital formation. There is, however, a potentially more powerful route to boosting job creation provided the political will exists to use it. While increases in $\hat{K}_E$ are matched on a one-to-one basis with increases in $\hat{L}_E$, each one percentage point reduction in $\widehat{MP}_L$ will produce a ten percentage point rise in $\hat{L}_E$. The very pronounced responsiveness of employment growth to, in effect, the imposition of restraint in wage increases is due to the high elasticity of output with respect to labor.

The actual empirical relationship between job creation on the one hand and capital formation and wage rate increases on the other can be examined at the micro level using the enterprise-specific data. Letting w represent the wage, and entering its absolute magnitude as well as its time rate of change as explanatory variables, the regression equation is:

$$\hat{L}_E = \underset{(0.087)}{0.210} - \underset{(0.0865)}{0.0244\hat{w}} - \underset{(0.000117)}{0.000330w} + \underset{(0.101)}{0.230\hat{K}_E} + \epsilon. \qquad (7)$$

The need for lead values to be used in calculating growth rates reduces the sample size to 108 observations. The adjusted R^2 of the regression is only 0.10 indicating that much variation in labor force growth across firms is left unexplained by this relationship. Capital formation contributes positively and significantly (at a 2.5% level) to labor growth, although at much less than the one-to-one correspondence implicit in Equation 6. The coefficient on $\hat{w}$ is negative, as expected, but not very different from zero either in absolute terms or statistically. The coefficient on w does register as significantly negative. Its value implies that for every ¥30 reduction in a firm's yearly wage rate, employment growth is higher by one percentage point. Firms that maintain lower wage rates thus generally create new jobs at a faster pace than firms that pay their workers more. Again a story of bargaining power can be proposed: workers who are able to push their wages up relative to the market are successful in maintaining their clout by restricting the number of new hires.

If indeed workers in the collective type firm are able to sustain wage increases at the expense of new job creation, the emergence of the privately-owned firm in 1984 might be viewed as a welcome event for those workers seeking jobs in industry. Private firms would permit rapid mobilization of household savings on a small scale. Moreover, competitive forces and the profit motive would presumably encourage maximum utilization of abundant labor resources. It is surprising then that the Dahe data show a much higher average capital/labor ratio for private firms than for collectives at roughly ¥4800 vs. ¥1300 per worker in 1985.[25]

A few caveats may be noted with regard to the private firm data. First, the sample firms are no doubt drawn disproportionately from the larger end of the private firm distribution since the larger firms are more often officially registered and in general keep more detailed financial records. Second, the private firm average is extremely sensitive to the presence of outliers. Removal from the 1985 sample of the four firms with the highest capital/labor ratios reduces average firm capital by more than half without changing average labor. And third, workers in private firms are likely to often be employed only part-time, permitting simultaneous work in agriculture. How or whether part-time workers were counted in the employment figures is not known. In

[25]Indeed, this is at odds with Byrd's findings of generally lower capital/labor ratios for private enterprises elsewhere in China (1988, 17).

view of these caveats, it would be premature to draw any definitive conclusions about private rural enterprise from the Dahe data.

V. SUMMARY AND CONCLUSIONS

Experience at Dahe Township supports the broadly held conception in China that the reforms of the 1980s have released a substantial portion of the rural labor force from agriculture. Under a system offering greater incentive to individual effort and initiative, fewer workers are required to produce the same output as under collectivization. Although manufacturing and services have expanded rapidly to absorb rural surplus labor in recent years, Chinese economists continue to regard the magnitude of rural underemployment as worrisome.

Until 1984, the creation of non-agricultural jobs in the countryside took place, for the most part, in collectives owned by village and township governments. Evidence from Dahe suggests that modest-paced capital formation in rural industry has constrained the rate of new job creation. More importantly, however, wage rate increases have matched productivity gains to limit the propensity for new hiring. If indeed surplus labor is a problem, far more rapid rates of absorption could be achieved by only slightly restraining wage increases. Private enterprise has emerged explosively on the scene since 1984 and would arguably be expected to manifest greater effectiveness in putting people to work than collective enterprise alone, although the Dahe data do not permit convincing investigation of this matter.

The reallocation of labor out of agriculture that characterizes economic development generally has been exaggerated in 1980s China because labor mobility was inhibited for three decades under Mao. The response of rural workers to more lucrative opportunities outside of agriculture is now being promoted, and yet not without a rising ambivalence on the part of authorities. China succeeded in feeding a large and rapidly growing population on fixed and ever more intensively farmed agricultural land during the Mao years. Impressive gains in productivity in the early years following institutional reform permitted the release of workers from agriculture while grain self-sufficiency was simultaneously maintained. The outcome was a dramatic rise in standards of living.

There comes a point, however, when by continuing to follow market signals and further specializing in the production of labor-intensive manufactures, agricultural output — but more particularly grain output as within agriculture greater diversification takes place — is likely to be sacrificed. This eventuality has in fact come to pass in China in the latter half of the 1980s. Whether strategic considerations will motivate a re-emphasis on applying resources to agriculture in the future remains to be seen. While the potential for China to expand industrial output by continuing to develop rural manufacturing is clearly enormous, smooth continuation along that path is certainly not assured.

APPENDIX 1: Sample Observations

For a team to be admitted to the sample it must have exhibited data for all variables contained in the regression model of Equations 2 and 3 in at least six years during the 1970s. The teams and years included in the sample, totaling 305 observations for the 1970s and 106 observations for the 1980s, are shown in Table A1. Sample sizes by year are given in Table A2.

TABLE A1: Teams & Years Included in the Sample

VILLAGE	TEAM	YEARS		VILLAGE	TEAM	YEARS	
1	1	1972-9,	1983-5	12	1	1972, 4-8,	1985
1	2	1972-9,	1983-5	12	2	1974-9,	1984-5
2	5	1974-9,	1983-5	12	3	1972-9,	1983-5
4	1	1972-9,	1983-5	12	4	1974-9,	1983-5
4	2	1972-9,	1983-5	12	5	1972, 4-9	
4	3	1972-9,	1983-5	13	1	1970-1, 3-9,	1983-5
5	1	1972-9,	1983-5	13	2	1974-9,	1983-5
6	2	1974-9,	1983-5	13	3	1970-1, 3-9,	1983-5
6	3	1974-9,	1983-5	13	4	1973-9,	1983-5
6	5	1974-9,	1983-4	13	5	1970-1, 3-8,	1983-5
7	1	1970-1, 4-9,	1983-5	13	7	1970-1, 3-9,	1983-5
7	2	1970-2, 4-9,	1983-5	13	8	1973-4, 6-9,	1983-5
7	3	1970-2, 4-9,	1983-5	14	3	1972-9,	1983-5
10	2	1974-9,	1983-5	14	4	1972, 4-6, 8-9,	1983-5
10	3	1974-9		14	5	1974-9,	1983-5
10	4	1974-9,	1983-5	15	1	1972, 4-9	
10	5	1974-9,	1983-5	15	2	1974-9	
10	6	1974-9,	1983-5	15	3	1970, 2-5, 7-9	
10	7	1974-9,	1983-5	15	4	1973-9	
10	8	1974-9,	1983-5	16	1	1974-9	
10	9	1974-9,	1983-5	16	3	1974-9,	1983-5
10	11	1974-9,	1983, 5	16	4	1974-9,	1983-5

TABLE A2: Sample Size by Year

1970	8	1983	35
1971	7	1984	35
1972	15	1985	36
1973	16		
1974	44	TOTAL	136
1975	43		
1976	43		
1977	43		
1978	44		
1979	42		
TOTAL	305		

APPENDIX 2: Mathematical Computations

A. 1970s Predicted Labor Force Growth in Sidelines (p. 14)

1. Calculate value added per capita from base year trend magnitudes, where a ^ over a variable represents its proportional growth rate:

$$\frac{Y_A(74)e^{4\hat{Y}_A} - M_A(74)e^{4\hat{M}_A} - \delta K_A(74)e^{4\hat{K}_A}}{P(74)e^{4\hat{P}}} = \frac{25{,}684 - 9669 - (0.05)(7308)}{209.2} = ¥74.81.$$

2. Infer material inputs needed in 1979 to sustain base year value added per capita:

$$\frac{37{,}986 - M_A(79) - (0.05)(23{,}619)}{219.3} = 74.81 \Rightarrow M_A(79) = ¥20{,}399,$$

for a predicted growth rate of 8.30% pa vs. the actual 8.48% pa.

3. Solve for the growth rate in agricultural labor requirements, $\hat{L}_A$, from the time-differentiated logarithmic production function:

$$4.35 = 2.42 + 0.631(0.019) + 0.0928(8.30) + 0.0430(13.03) + 0.233\hat{L}_A$$

$$\Rightarrow \hat{L}_A = 2.52\% \quad \text{vs. actual } 2.43\% \text{ pa.}$$

4. Convert from labor-days to persons:

2.52 - 1.82 = 0.70% vs. actual 0.61% pa.

5. Obtain initial and terminal values for total labor force consistent with estimated sectoral labor force growth and 1974 means:

	LYR_A		LYR_S		LYR
1970	76.52	+	8.11	=	84.63
1974	78.41	+	10.56		
1979	80.84	+	14.69	=	95.53
	@0.61%		@6.60%		hence 1.35% vs. the 1.63% pa regression estimate of Table 2.

6. Predict labor available for sidelines from model:

	LYR		LYR_A		LYR_S
1970	84.63	-	76.24	=	8.39
1979	95.53	-	81.20	=	14.33

for a growth rate in sidelines labor of 5.95% vs. actual 6.60% pa.

B. Labor Released by a 5% Output Reduction Post-Reform (p. 21)

1. Calculate labor required:

$$71{,}139(0.95) = 192.5(L_A)^{0.101}(19{,}231)^{0.150}(310.1)^{0.294}(46{,}187)^{0.214}$$

$$\Rightarrow L_A = 50.56.$$

2. Express labor released as a percentage of actual 1983 labor:

$$\frac{81.9 - 50.56}{81.9} = 38\%.$$

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TABLE 1: Sectoral Composition of the Chinese Rural Labor Force[1]
(in thousand persons)

YEAR	AGRICULTURE		INDUSTRY		SERVICES		TOTAL
1981	303,100	(94.1%)	12,320	(3.8%)	6,850	(2.1%)	322,270
1982	311,530	(93.6)	12,580	(3.8)	8,670	(2.6)	332,780
1983	316,450	(92.4)	13,560	(4.0)	12,570	(3.7)	342,580
1984	316,850	(89.5)	18,450	(5.2)	18,380	(5.2)	353,680
1985	303,510	(81.9)	38,710	(10.4)	28,430	(7.7)	370,650
1986	304,680	(80.2)	44,480	(11.7)	30,740	(8.1)	379,900

[1]Sources: Statistical Yearbook of China: 1981, 106; 1983, 121; 1984, 108; 1985, 214; and Zhongguo Tongji Nianjian: 1986, 124; 1987, 115.

TABLE 2: 1970s Growth Rates for Dahe Commune and China as a Whole

	Dahe[1]	China[2]
CROPS		
Output Value[3]	4.53%	3.14%
Laborers	0.61	
Labor-Days/Laborer	1.82	
Land		
cultivated	0.02	
sown	2.17	0.44
Current Input Expenses	8.48	
fertilizer	11.52	12.02
Asset Value		
machine power	21.68	18.01
draft animals	2.07	-0.06
SIDELINES		
Output Value[3]		18.53
team level	14.15	
brigade level	27.43	
commune level	19.19	
Laborers[4]	6.60	
Current Input Expenses[4]	7.57	

[1]Rates were in general obtained by regressing the log of each variable, measured annually and by team, on a time index and the set of 44 team dummies. The only exception is for brigade-level sidelines where a growth rate was calculated from a single aggregate series according to the procedure described in note 2.

[2]Rates were obtained by regressing the log of each variable, measured annually, on time and a constant term. Sources: Zhongguo Tongji Nianjian, 1987 for aggregate output in current prices, p. 43; for aggregate output, crop output, and sidelines output in constant prices, p. 157; for agricultural machinery in kilowatts, p. 137; for draft animals, p. 178; for sown acreage, p. 164; for fertilizer, p. 139; and Statistical Yearbook of China, 1985 for agricultural labor, p. 213. Observations utilized as available from 1972 to 1979, with in addition, 1965 data for machinery and fertilizer, and 1970 data for sown acreage, draft animals, and labor.

[3]Current prices used for Dahe, constant prices for China as a whole.

[4]Team level only.

TABLE 3: Team Production Function Estimates

	1970s		1980s	
Parameter	Estimate	St. Error	Estimate	St. Error
α_0	2.9	0.15	5.3	1.4
α_t	0.024	0.0052	0.096	0.032
α_R	0.63	0.039	0.29	0.099
α_M	0.093	0.037	0.15	0.087
α_K	0.043	0.026	0.21	0.14
α_L	0.23	na[1]	0.10	0.083
σ_0	0.72	0.27		
σ_t	0.039	0.013		
σ_M	0.21	0.030		
σ_K	0.44	0.072		
σ_L	0.36	na[1]		

[1]Elasticity with respect to labor constrained to preserve constant returns to scale.

TABLE 4: 1970s Value Marginal Products

YEAR	LABOR (¥/labor-day)		LAND (¥/mu)	MANF INPUTS (¥/¥1)		CAPITAL (¥/¥1)	
	Agric	Sides		Agric	Sides	Agric	Sides
1970	0.250	0.381	42.5	0.370	1.076	0.164	0.979
1971	0.263	0.502	44.4	0.300	0.913	0.177	0.926
1972	0.224	0.819	52.2	0.219	1.436	0.137	0.546
1973	0.230	0.905	53.1	0.216	0.563	0.166	0.865
1974	0.216	0.798	58.5	0.209	1.084	0.106	0.764
1975	0.228	0.771	60.9	0.193	1.530	0.093	0.728
1976	0.249	0.963	61.8	0.190	1.319	0.084	0.713
1977	0.245	1.020	64.7	0.193	1.150	0.080	0.795
1978	0.239	0.953	68.7	0.175	1.450	0.081	0.823
1979	0.236	0.907	70.4	0.201	1.769	0.080	0.851

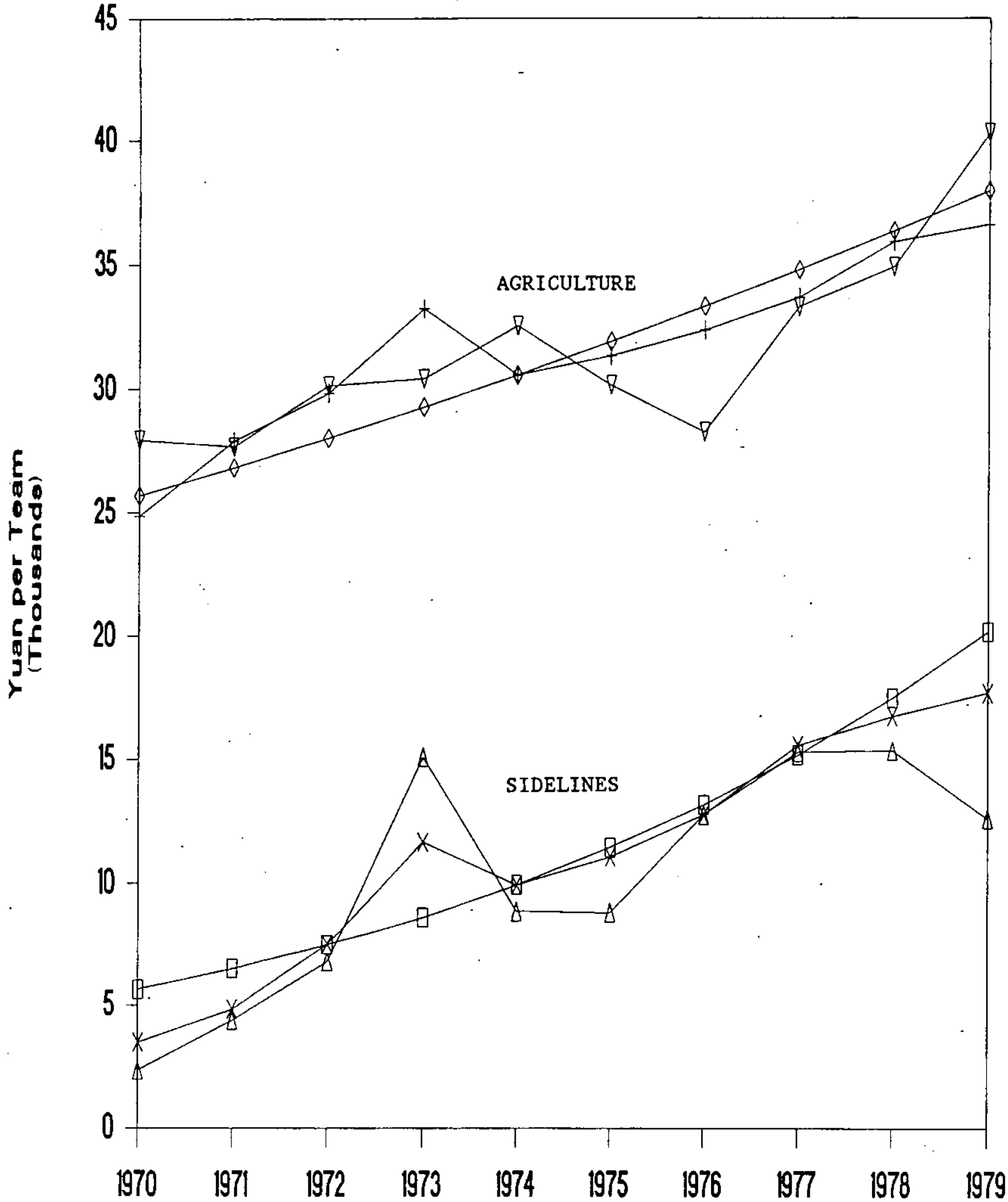
TABLE 5: Pre- & Post-Reform Inputs, Outputs, & Marginal Products in Agriculture

	OUTPUT & INPUT MAGNITUDES					VALUE MARGINAL PRODUCTS			
Year	Output (¥)	Labor (Person)	Land (mu)	Cur.In. (¥)	Capital (¥)	Labor (¥/pers)	Land (¥/mu)	Cur.In. (¥/¥1)	Capital (¥/¥1)
1978	34,946	81.6	330	18,988	19,007	102	68.7	0.175	0.081
1979	40,296	78.2	328	16,857	19,570	109	70.4	0.201	0.080
1983	70,969	81.9	310	19,230	46,187	87	67.3	0.555	0.330
1984	80,246	70.1	312	18,109	55,080	114	74.6	0.659	0.309
1985	91,663	69.5	309	21,399	56,924	130	85.4	0.631	0.338

TABLE 6: 1980s Inputs, Value Added, and Marginal Products in Enterprises

YEAR	# OF FIRMS		INPUT & OUTPUT MEANS			MARGINAL PRODUCTS	
	Township	Sample	Labor (Person)	Capital (¥)	Value Added (¥)	Labor (¥/pers)	Capital (¥/¥1)
1980	54	13	39.6	53,485	48,677	1101	0.087
1981	62	17	42.8	52,129	63,541	1168	0.103
1982	64	18	46.8	40,944	71,561	1212	0.148
1983	74	32	42.2	47,034	77,950	1330	0.128
1984	82	40	43.7	50,583	79,368	1430	0.132
1985	85	45	55.5	74,096	105,738	1554	0.125

FIG. 1: 1970s Output



AGRICULTURE		SIDELINES
∇	Observed Team Means	Δ
+	Actual Mean Fitted Values	X
◊	Trend Mean Fitted Values	▯