Journal of Agribusiness 31, 1 (Spring and Fall 2013)

Industrial and Agricultural Development in Rural China

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China's industrial development has had profound impacts on its rural economy. While the resource flows between the urban industrial and rural agricultural sectors are well studied, little attention has been paid to the interactions of industrial and agricultural development within rural areas. Using a nationally representative panel data, we find a strongly significant association between rural industrial development and agricultural productivity. Further, we ascertain that, while rural enterprises do withdraw labor out of agriculture and dampen productivity, the productivity loss is negligible in comparison with land productivity improvement brought by added infrastructure capital financed through tax revenue from rural enterprises.

Key words: agricultural development, infrastructure capital, labor migration, rural industry

Agriculture plays a synergistic role in industrial development, providing inexpensive labor to the industrial sector and affordable food for its labor force. In the early stage of industrialization when farm labor is overly abundant, no trade–off is necessary between these two supportive functions. Tensions may arise, however, when labor's departures start dampening the agricultural production, creating inflation pressures, and weakening competitiveness of the agricultural sector. China's recent food price rise has raised concerns among policy makers about the food-security implications of labor migration from agriculture to industry. They are particularly concerned that, as an increasing number of young adults are flowing into industrial sector, an old and weak farm labor force remaining in the agricultural sector is incapable of meeting China's growing food demand (Mundlak, 1992).

These concerns have drawn research interests to rural-to-urban migration's implications for the migrant-sending rural economy. The impact of urban industry's withdrawal of agricultural labor on farm productivity has been analyzed by several researchers (De Brauw and Giles, 2008; Rozelle, Taylor, and De Brauw, 1999). However, little attention has been paid to the implications of rural industrial development on

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agricultural production. Since a unique feature of China's industrialization is the simultaneous development of urban and rural industry, rural industrial development can affect the labor supply and the productivity of agricultural sector necessitating detailed analysis in this regard. Considering the fact that rural industry accounted for over 30% of China's national GDP and 49% of industrial value added (Xue, 2006) in 2005, the labor migration among industrial and rural sectors in rural areas will have a significant impact on labor supply and productivity in both the sectors. Hence the objective of this paper is to provide an overall assessment, with nation-wide village survey data, of rural industrial development's impacts on agricultural development in China. The data is a part of annual survey data from Research Center for Rural Economy (RCRE), Ministry of Agriculture, China. A detailed discussion of the RCRE data can be found can be found in Benjamin, Brandt, and Giles (2005).

Economists have studied the relationship between industrial and agricultural development by analyzing the flows of labor and capital between the two sectors. Early literature in development economics note the presence of surplus labor in the developing world's agricultural sector, and suggest that labor's departures will not affect agricultural production (Lewis, 1954; Ranis and Fei, 1961). The neoclassical Agricultural Household Model points to a similar outcome: if the labor market is perfect, lost family labor can be perfectly substituted for by hired labor, leaving farm productivity unchanged (Singh, Squire, and Strauss, 1986). The surplus labor thesis has been challenged by empirical evidence showing that, even if labor is in surplus over most of the year, labor shortage may arise in peak seasons, resulting in production losses (Gregory, 1986). The assumption of agricultural labor market perfection is intuitively inconsistent with the reality in less developed countries and has been rejected in a large body of empirical analysis (Barrett, 1996; Carter, 1984; Jacoby, 1993; Kevane, 1994; Udry, 1998) with some exceptions (Benjamin, 1992; Pitt and Rosenzweig, 1986).

Even if the labor market is imperfect or in the absence of surplus labor, labor drain from agriculture to nonagricultural sectors may not necessarily dampen agricultural production. The New Economics of Labor Migration (NELM) postulates that while productive labor lost to nonfarm sectors reduces farm production in the short run, migrant remittances home can compensate for the loss by financing new farm technology (Stark and Bloom, 1985). However, empirical evidence shows that remittances are invested in productive assets only in the presence of profitable investment opportunities and when the household is facing liquidity constraints (Taylor, 1992). De Brauw and Giles (2008) show, with a nationally representative dataset, that rural Chinese households have not invested migrant remittances in productive assets. This is not surprising in light of the limited investment opportunities facing Chinese farmers, whose land holdings are generally small and whose land rights are ambiguous and limited.

While the intersectoral resource flows described above apply to rural-to-rural migration as they do to rural-to-urban migration, industrial employment in rural areas has several advantages over that in urban areas in terms of benefiting agriculture. Rural enterprises tend to hire local people, who can work on the farm in their spare time to fill up the peak-season labor shortage. Thus, rural industrial employment has a less severe labor drain effect than the urban industrial employment. Rural industry is a main source of tax revenue in rural areas. The tax paid by rural enterprises may be used to finance public goods such as irrigation and transportation infrastructure, which in turn will enhance farm productivity. In other words, while urban industrial employment may support agricultural development by enabling financially constrained households to invest in new technology, rural industrial development can do so by stimulating both private and public investment.

Incorporating these unique features into analysis of intersectoral resource flows offers new insight into the mechanism of the linkages between rural industrial and agricultural development. Specific issues addressed here include rural industrial development's impact on agricultural productivity, the relative strengths of the labor-drain effect and investment-inducement effect, and rural industry's differential effects on collective and private investment in agricultural capital.

China's Rural Industrial Development

Before 1949 China was largely an agrarian economy and rural industry was almost nonexistent, comprising of small workshops and family-owned handcraft businesses. The end of the Civil War and the founding of the People's Republic of China in 1949 stabilized the rural economy, and sideline production developed rapidly in rural areas. But the development was set back in 1958 by the Great Leap Forward Campaign which forced all rural productive activities into commune and brigade enterprises. Most of such enterprises soon discontinued operation because of farmers' lack of enthusiasm for work when the incentives are not linked to individual productivity. Little progress was made during the 1966-1976 Cultural Revolution, though a growing momentum developed in the latter part of that period when some rural factories emerged to fill the shortage gap left by the urban industry, which was deeply engaged in Cultural Revolution. The end of the Cultural Revolution shifted the government's efforts from ideology struggles back to economic development. The government became willing to accept, and gradually began encouraging, entrepreneurship, which had long been viewed as the "tail of capitalism." Tax breaks and exemptions were offered to rural enterprises, and rural residents were given more and more freedom to conduct businesses (Byrd and Lin, 1990).

These economic reforms greatly stimulated rural industrial development. In the 25 years from 1978 to 2003, the number of Township and Village Enterprises (TVEs) were growing at a 20 % annual rate. By the end of 2003, China had 21.85 million officially registered TVEs (National Bureau of Statistics of China, 2003). In 2005 TVEs accounted for over 30 % of the national GDP, 49 % of industrial value added, and 69 % of value added in rural areas (Xue, 2006).

The most challenging tasks facing China's leaders in the post-Cultural Revolution era were job creation and poverty reduction for the large, mostly poor, population. The contributions of TVEs in these areas are remarkable (Démurger, Fournier, and Yang, 2010; Lanjouw and Lanjouw, 2001). Only 28.26 million people worked in rural industry in 1978, but that number quickly grew to 92.65 million in 1990 and 128.62 million in 1995. By 1996 TVEs surpassed State-Owned Enterprises in job creation. Structural adjustments of the economy and institutional reforms in the late 1990s slowed down the growth of TVE employment. But it soon recovered as China became a member of the WTO in 2003. TVE employment rose to a historic high of 138.66 million in 2004, and the income of TVE employees accounted for 33.7 % of rural household income (He, 2006).

Rural industrial development has greatly contributed to agricultural development in rural areas. Although few studies have formally examined such contributions, the social responsibilities of Township and Village Enterprises for community development are clearly stated in China's Township and Village Enterprises Law (The Central People's Government of the People's Republic of China, 1996). Articles 2 and 3, for example, specify supporting agriculture and rural social welfare as one of the obligations of TVEs. Article 17 stipulates that TVEs turn in a proportion of after-tax profits to local governments for agricultural and rural social undertakings.

The ownership structure in rural industry has undergone a marked transformation over the past three decades. At the beginning of the economic reform, most township and village enterprises originated from the commune and brigade enterprises that were either under the administrative control of local governments or leased out for private management. Private ownership accounted for only a small proportion of the industry (Byrd and Lin, 1990). Private TVEs grew rapidly because they face less fiscal burdens and regulations. In 2007, 85% of China's TVEs were privately owned (Li, 2010).

The development of TVEs has been uneven across China, exhibiting a clear declining pattern from the developed coastal provinces in the east to the resource-abundant hinterland and to the underdeveloped west frontiers. Because most TVEs are in upstream sectors of the urban industry, such as mining, machinery manufacturing, and materials processing, the level of rural industrial development is largely determined by natural resource endowments and regional economic conditions (Wang, 1990).

Empirical Framework

Recall from the introduction that our purpose is to examine the influences of Chinese rural industry on agricultural development. Our empirical strategy is to explore, with a three-year nationally representative village sample, the extent to which regional imbalances in rural industrial development account for regional differences in agricultural development. The size of a village's rural industry is measured by its industrial output value, and agricultural productivity is measured by agricultural output value per unit of land area. In order to gain insight into the mechanism by which industrial development affects agricultural development, we explicitly examine intersectoral resource flows by regressing farm labor employment and capital stock per unit of land area on industrial output value. Formally, the econometric model consists of the following three equations:

$$L = \alpha_{L0} + \alpha_{L1} IGO + \alpha_{L2} IGO^2 + \theta_L Z + \varepsilon_L \tag{1}$$

$$K = \alpha_{K0} + \alpha_{K1} IGO + \alpha_{K2} IGO^2 + \theta_K Z + \varepsilon_K \tag{2}$$

$$Y = \alpha_{Y0} + \alpha_{Y1} IGO + \alpha_{Y2} IGO^2 + \theta_Y Z + \varepsilon_Y \tag{3}$$

where $L, K,$ and Y are the logarithms of the village's agricultural employment, capital stock, and output value per unit of land area, respectively. IGO stands for the logarithm of the village's industrial gross output value. Z is a vector of control variables, including crop price index P, and the village's population size POP, each in logarithm form.

Industrial gross output value is exogenous to agricultural production because, as mentioned above, the distribution of China's rural industry is largely determined by natural resource endowments and market proximity. This is because most rural enterprises in China are producing for the urban market. Small landholdings and low-profitability of agriculture have restrained the growth of rural enterprises serving the agricultural sector.

The estimation of equation system (1-3) generates the elasticities of farm labor, capital, and land productivity with respect to industrial gross output value:

$$E_L = \alpha_{L1} + \alpha_{L2} IGO; \tag{4}$$

$$E_K = \alpha_{K1} + \alpha_{K2} IGO; \tag{5}$$

$$E_Y = \alpha_{Y1} + \alpha_{Y2} IGO. \tag{6}$$

The sign of E_L tells whether rural industrial development has dampened farm labor use intensity. The sign of E_K tells whether industrial development has boosted agricultural capital accumulation. The sign of E_Y tells the overall effect of rural industrial development on agricultural land productivity. Including the quadratic term of IGO in regression system (1-3) allows these elasticities to change sign at a threshold level of industrial development.

We estimate the regression system (1-3) with a Fixed-Effects-SUR model, accounting for potential missing-variable bias and cross-equation correlations in disturbances. In our study, there might exist village specific factors affecting agricultural productivity, such as the quality of the land, the distance from the village to nearest main road, natural resource endowment, etc. Analyzing the panel data with a fixed effects model can attenuate the estimation bias from such missing variables. This is done by taking the difference from mean of all the dependent and independent variables before running the SUR model (Freedman, 2005).

Data

Our dataset is a panel derived from a multi-year nationwide village survey conducted by the Research Center for Rural Economy at China's Ministry of Agriculture. The survey includes more than 300 villages across all 31 provincial cities, provinces, and autonomous regions of China for years 2004, 2005, and 2006. The local RCRE Survey Offices across China coordinated the survey, and the questionnaires were answered by the heads of the surveyed villages. The surveyed villages were chosen to represent villages in five different levels of economic development, from the most to least developed. The complete RCRE survey covers around 300 villages in 31 provinces and administrative regions. Depending on village size, between 40 and 120 households were also randomly surveyed in each village. In each province, counties in the upper, middle and lower income levels were selected, from which a representative village was then chosen. Subject to the limits of this stratification, the RCRE sample should reasonably capture both inter and intra-provincial income variation.

After deleting observations with missing values of the key variables in equation system (1-3), we were left with an unbalanced panel of 384 valid observations for 136 villages. The map of China in figure 1 shows the geographic distribution of village observations in our dataset. The number below a province's name indicates the number of villages from that province that appear in our dataset. Our sample covers all provincial-level administrative areas except Bei-Jing, Hai-Nan province, and Xi-Zang (Tibet) autonomous region. Bei-Jing's lack of representation is because extensive urbanization has turned most of its rural areas into suburbs. Hai-Nan and Xi-Zang are not represented in the sample because of their paucity of industrial development.

Source: Adapted from Benjamin, Brandt, and Giles (2005).

Figure 1. Geographic Distribution of the Village Observations

Table 1 contains the descriptive statistics of key variables used in our analysis. Agricultural labor intensity is the number of farm laborers per mu of planted land (1 acre = 6.07 mu). Capital intensity is a village's total asset value of farm machinery, cattle, and irrigation and electricity infrastructure divided by the planted land area. Land productivity is per mu crop revenue. Crop price index is a weighted average of crop prices with weights being the crop acreage shares within a village. We define three types of crops: grains, cash crops and fruits. The crop price data are from the Chinese Agricultural Statistics Year Book (China's Ministry of Agriculture, 2008). The crop price index controls for the regional difference in crop mix. Population size exhibits mild variations over time, reflecting such demographic changes as migration, birth, marriage, and death. We, therefore, retain it in the regression despite the use of the fixed-effects model. All monitory values used in this analysis are deflated to the base year 2000.

Table 1. Summary Statistics of Key Variables Analyzed

Variable	Definition	Unit	Mean	Std. Dev.	Min	Max
L	Agricultural Labor Intensity	Headcount per mu	0.28	0.59	0.01	9.35
K	Agricultural Capital Intensity	Thousand Yuan per mu	0.56	24.92	0.001	30.14
Y	Agricultural Land Productivity	Thousand Yuan per mu	2.57	127.34	0.019	185.22
IGOV	Industrial Output Value	Thousand Yuan	18.448	859.415	8.56	871.415
P	Crop Price Index	Yuan	6.94	4.34	0.1	18.39
POP	Village Population	Headcount	1.811	1.181	217	9.487

Note: One mu is 0.166 acres

Consistent with what is recorded in the literature, our data show significant regional imbalances in industrial development. The minimum of industrial output value is 8,560 Yuan, and the maximum is 870 million Yuan. It is also interesting to note that the standard deviation is about 4.5 times the mean industrial output value. Villages with a large industrial sector are concentrated in the eastern coast, and those with a small industrial sector are spread in the far west. Similarly, labor use intensity, capital intensity, and land productivity all exhibit significant variations in our sample.

Results

Columns (1), (3) and (5) in Table 2 are the regression results of equation system (1-3). Because the quadratic term of industrial gross output value is insignificant in the labor and capital equations, we dropped that variable in those two equations but retain it in the land productivity equation. The results are reported in columns (2), (4), and (6).

Regression (2) shows that villages with higher industrial revenue tend to have a lower labor use intensity, and the effect is significant at the 1 % level. The size of that effect, however, is small; a 10% increase in a village's industrial revenue reduces agricultural labor use per mu only by 0.4%, ceteris paribus. It seems that agricultural

Table 2. The Impact of Rural Industrial Development on Agricultural Production

	Labor Intensity		Capital Intensity		Land Productivity	
	(1)	(2)	(3)	(4)	(5)	(6)
Industrial Output Value	-0.12	-0.04***	0.39*	0.42***	-0.75***	-0.72***
	(0.09)	(0.02)	(0.23)	(0.04)	(0.22)	(0.19)
Industrial Output Value Squared	0.004		0.001		0.07***	0.07***
	(0.004)		(0.011)		(0.01)	(0.01)
Crop Price Index	0.05	0.04	0.07	0.07	0.14*	0.14*
	(0.03)	(0.03)	(0.08)	(0.08)	(0.07)	(0.07)
Village Population	0.45***	0.45***	0.80***	0.80***	0.20	0.20
	(0.11)	(0.11)	(0.31)	(0.31)	(0.29)	(0.29)
R^2	0.06	0.06	0.21	0.21	0.46	0.46

Note: One, two, and three astericks indicate statistical significance at the 10, 5, and 1 % levels, respectively

labor in rural China has a very small response to price signals for their movement to the industrial sector for higher wages. But this result alone does not necessarily imply that agricultural land productivity will be compromised by the withdrawal of farm labor to nonfarm activities. In the presence of surplus labor, for example, the lost labor will not affect agricultural production.

Regression (4) shows that the presence of a strong rural industrial sector has a significant positive effect on the village's agricultural capital accumulation. A 10% increase in industrial revenue boosts per mu capital stock by 4.2%. Because village-level agricultural capital in our data is a mix of private capital, such as machinery and cattle, and collective goods, such as irrigation and electricity infrastructure, it is interesting to further investigate which type of investment has been more responsive to industrial development. We examine this problem in the next subsection.

Regression (6) indicates a U-shaped relationship between agricultural land productivity and industrial output value. That is, agricultural land productivity first decreases with the level of industrial development, then increases after a threshold. That threshold is estimated at 17,072 Yuan (2,630 US dollars for the year 2000). In light of industrial development's negative labor effect and positive capital effect, the U-shaped relationship indicates that the labor effect dominates the capital effect when industrial revenue is below the threshold, and the opposite is true when it is above the threshold. The implication is that labor drain does slightly dampen agricultural productivity. However, because about 99% of villages in our sample have an industrial output value exceeding 17,072 Yuan, industrial development's overall contribution to land productivity is strongly positive and mainly occasioned through stimulating capital investment.

The estimated coefficients on the control variables seem reasonable. Crop price's coefficient is significantly positive in the land productivity regression, indicating crop mix does account for a portion of the differences in per mu crop revenue. Population size is significantly positive in the labor and capital equations. It is not surprising that more populous villages have higher farm labor employment. The positive association between capital stock and population size is likely because larger villages tend to have more financial resources for such collective goods as irrigation and transportation infrastructure.

Differentiating Private and Public Investments

Although the results provided in Table 2 ascertain that rural industrial development has greatly stimulated agricultural capital investment, they fail to show whether the investment is made by individual households or by the village government. This is because the agricultural capital data in Table 2 are a mix of private capital, such as machinery and cattle, and collective capital, such as irrigation and electricity infrastructure. In China, the provision of most public goods is organized by the government; nongovernmental grassroots organizations are essentially nonexistent. As described above, China's Township and Village Enterprises (TVEs) are legally obliged to turn in a portion of their profits to local governments to support agricultural development. Thus it is important to examine whether such agriculture funds have been invested in infrastructure development to improve farm productivity. And understanding rural industry's influence on household investment will shed light on the New Economics of Labor Migration hypothesis that the nonfarm employment is a family strategy of breaking liquidation constraints for technology investment.

Table 3 presents the results from a four-equation system where aggregate capital equation (2) is replaced with two equations, one of private capital and another public capital. Columns (1), (3), (5) and (7) include as an independent variable the squared term of industrial output value. Since the squared term of industrial output value turned out non-significant in regressions (1), (3) and (5), we dropped it from those three equations but retain it in the land productivity equation. The results are reported in columns (2), (4), (6) and (8).

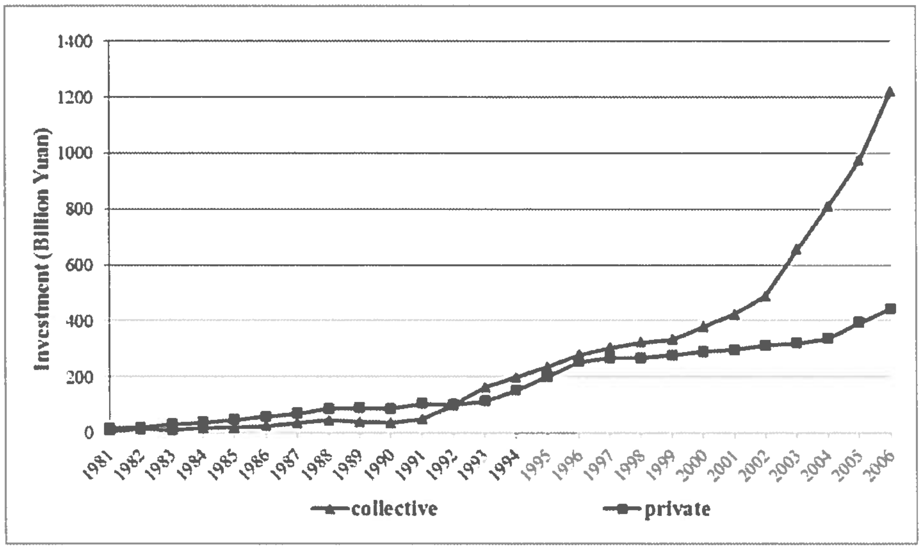
Table 3. Differenciating Public and Private Investments

	Labor Intensity		Private Capital Intensity		Public Capital Intensity		Land Productivity	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Industrial Output	-0.12	-0.04***	0.23	0.06	0.40	0.42***	-0.75***	-0.72***
Value	(0.09)	(0.02)	(0.34)	(0.07)	(0.27)	(0.05)	(0.22)	(0.20)
Industrial Output Value	0.004		-0.01		0.001		0.07***	0.07***
Squared	(0.004)		(0.02)		(0.013)		(0.01)	(0.01)
Crop Price Index	0.05	0.04	0.09	0.09	0.07	0.08	0.14*	0.14*
	(0.03)	(0.03)	(0.11)	(0.11)	(0.09)	(0.09)	(0.07)	(0.07)
Village Population	0.45***	0.45***	-0.37	-0.37	0.86**	0.86**	0.20	0.20
	(0.11)	(0.11)	(0.46)	(0.46)	(0.36)	(0.36)	(0.29)	(0.29)
R^2	0.06	0.06	0.01	0.01	0.16	0.16	0.46	0.46

Note: One, two, and three astericks indicate statistical significance at the 10, 5, and 1 % levels, respectively

Industrial revenue's effect on private capital is statistically insignificant, and its magnitude is very small. The effect on collective capital however is positive and strongly significant; the size estimate is exactly equal to that in the aggregate capital equation in Table 2. Therefore, rural industrial development has contributed to agricultural capital accumulation by way of financing public infrastructural investment, rather than through stimulating private investment on individual farms. The paucity of private investment in the face of increased nonfarm income is consistent with the findings of De Brauw and Giles (2006) that most rural Chinese households have not invested nonfarm income into productive assets. Because households are likely to invest nonfarm income in new farming technologies only if such investment is profitable (Taylor and Wyatt, 1996), this result is not surprising in light of the dearth of profitable investment opportunity facing China's small landholders. Rural industry's stimulating effect on public investment is consistent with Byrd and Lin's (1990) account that China's village and township governments are heavily dependent on rural enterprises for generating extra-budgetary revenue to support agricultural development.

It is well known that the launching of the Household Responsibility System in the early 1980s has greatly improved the productivity of Chinese farms by decentralizing production decisions from collective farms to individual households (Lin, 1992). Figure 2 shows that in the 1980s private investment dominated collective investment, both in absolute value and growth rate. But in the 1990s collective investment exceeded and continued growing faster than private investment. These trends reflect, as our results suggest, the fall of investment opportunity on Chinese farms and the rise of the government's role in promoting productivity growth. Although it is good news that the public sector is striving to improve rural infrastructure, the paucity of investment opportunity for Chinese farmers will likely depress their entrepreneurship in the long run.



Source: National Bureau of Statistics of China (2008).

Figure 2. Growth of Public (Collective) and Private Investments in Agricultural Capital

Robustness to Outliers

Recall from Table 1 that the maximum industrial revenue in our village sample is 871 million Yuan. Villages with such a large industrial sector may well have been urbanized, and nonfarm income may account for the majority of household income. Therefore, farming decisions in such industrialized villages may differ significantly from those in the rest of the country. Farmers in such villages, for example, may leave their farmland idle or lease it out, devoting themselves to nonfarm employment and businesses. It is important, therefore, to examine the robustness of the results obtained above when excluding the outlier villages from our sample.

Table 4 presents the results of the regression system in Table 3's columns (2), (4), (6), and (8), with the subsample of villages whose industrial output value is less than 500 million Yuan (79 million dollars). Excluding the outlier villages seems to have not affected our conclusions. The elasticities of farm labor and private capital with respect to industrial output value have remained largely unchanged. Parameter estimates changed slightly in the land productivity regression, with the minimum of the U-shape curve now being 21,271 Yuan, as opposed to 17,072 in the full sample. The elasticity of collective capital intensity increased from 0.42 to 0.55, indicating a stronger association between industrial development and agricultural infrastructure capital after excluding the highly industrialized villages from the sample. This is reasonable because the incentives to invest in agriculture weaken when per capita income reaches a high level.

Table 4. Analysis of Robustness to Outliers

	Labor Intensity	Private Capital Intensity	Public Capital Intensity	Land Productivity
Industrial Output Value	-0.04**	0.09	0.55***	-0.75***
	(0.02)	(0.07)	(0.06)	(0.30)
Industrial Output Value Squared				0.07***
				(0.02)
Crop Price Index	0.04	0.11	0.08	0.17**
	(0.03)	(0.13)	(0.10)	(0.08)
Village Population	0.45***	-0.39	0.81**	0.19
	(0.12)	(0.46)	(0.35)	(0.28)
R^2	0.06	0.01	0.21	0.38

Note: One, two, and three astericks indicate statistical significance at the 10, 5, and 1% levels, respectively

Conclusions

Rural industrial development has profound implications for agriculture. Although industry's ability to absorb surplus farm labor and alleviate poverty in rural areas is well recognized, the implications of developing industry in rural areas, as opposed to in cities, are greatly understudied. We have, in this paper, examined the influences China's rural industrial development has had on agricultural development. Our analysis focuses on intra-village movements of labor and capital between agriculture and industry, shedding light on the mechanisms by which the two sectors influence one another.

Our results show that rural industrial development has a strongly positive impact on agricultural productivity. Although labor's withdrawal from farms to factories does slightly dampen farm output value, this loss is negligible in comparison with the benefits rural enterprises bring to agriculture by way of facilitating capital accumulation. Furthermore, we have found that the development of rural industry is specifically conducive to public infrastructure capital investment, but not to private investments such as machinery and livestock power. These results point to two unique advantages of industrial development in rural areas. One is that rural enterprises tend to hire local people, allowing an efficient use of labor in peak seasons. Another is rural industry can generate tax revenue for local governments to undertake large projects benefitting the community.

Our analysis reveals that, across China, public investment plays a more important role in productivity growth than does private investment. While it is good news to see local governments have invested tax revenue to improve agricultural productivity, it is unclear how efficient they are using such resources. The paucity of private investment in the face of improved household income reflects limited opportunities for Chinese farms to grow. Land reform and increased research and extension efforts are needed to encourage entrepreneurial undertakings that are necessary for sustained productivity growth.

References

Barrett, C. (1996, December). "On Price Risk and the Inverse Farm Size—Productivity Relationship." *Journal of Development Economics* 51(2), 193-215.

Benjamin, D. (1992, March). "Household Composition, Labor Markets, and Labor Demand: Testing for Separation in Agricultural Household Models." Econometrica 60(2), 287-322.

Benjamin, D, L. Brandt, and J. Giles. (2005, July). "The Evolution of Income Inequality in Rural China." *Economic Development and Cultural Change* 53 (4), 769-824.

Byrd, W.A., and Q. Lin. (1990). *China's Rural Industry: Structure, Development, and Reform.* New York: Oxford University Press.

Carter, M. (1984, March). "Identification of the Inverse Relationship between Farm Size and Productivity: An Empirical Analysis of Peasant Agricultural Production." *Oxford Economic Papers* 36(1),131-145.

China's Ministry of Agriculture. (2008). *Chinese Agricultural Statistics Yearbook 2008.* Beijing: China Statistics Press.

De Brauw, A., and J. Giles. (2008). "Migrant Labor Markets and the Welfare of Rural Households in the Developing World: Evidence from China." Policy Research Working Paper No.4585, The World Bank, Washington, DC.

Démurger S., M. Fournier, and W. Yang. (2010, September). "Rural Households' Decisions towards Income Diversification: Evidence from a Township in Northern China." *China Economic Review* 21(S1), S32-S44.

Freedman, D.A. (2005). *Statistical Models: Theory and Practice*. New York: Cambridge University Press.

Gregory, P. (1986). *The Myth of Market Failure: Employment and the Labor Market in Mexico*. Baltimore: The Johns Hopkins University Press.

He, K. (2006). *China's Township and Village Enterprises*. Beijing: Foreign Language Press.

Jacoby, H. (1993, October). "Shadow Wages and Peasant Family Labor Supply: An Econometric Application to the Peruvian Sierra." *Review of Economic Studies* 60(4), 903-921.

Kevane, M. (1994, June). "Village Labour Markets in Sheikan District, Sudan." *World Development* 22(6), 839-857.

Lanjouw, J.O., and P. Lanjouw. (2001, October). "The Rural Non-farm Sector: Issues and Evidence from Developing Countries." *Agricultural Economics* 26(1), 1-23.

Lewis, W. A. (1954, May). "Economic Development with Unlimited Supplies of Labor." *The Manchester School* 22(2), 139-191.

Li, Y. (2010). "An Overview of Township and Village Enterprises in China during 1949-2009." *Proceedings of the 2nd International Conference on Corporate Governance*. Available at http://www.une.edu.au/business-school/research/corp-gov-conf/papers/li-tves.pdf [Retrieved January 2013]

Lin, J. Y. (1992, March). "Rural Reforms and Agricultural Growth in China." *The American Economic Review* 82(1), 34-51.

National Bureau of Statistics of China. (2003). *China Agricultural Statistics 2003*. Beijing, China: National Bureau of Statistics Press.

National Bureau of Statistics of China. (2008). *China Statistics Yearbook 2008*. Beijing, China: National Bureau of Statistics Press.

Mundlak, Y. (1992, August). "Agricultural Productivity and Economics Policies: Concepts and Measurements." Working Paper No. 75: 13-47. OECD Development Center, Paris, France.

Pitt, M. M., and M. R. Rosenzweig. (1986). "Agricultural Prices, Food Consumption and the Health and Productivity of Farmers." In I. Singh, L. Squire, and J. Strauss (eds.), *Agricultural Household Models: Extensions, Applications and Policy*. Baltimore: John Hopkins Press.

Ranis, G., and J. Fei. (1961, September). "A Theory of Economic Development." *The American Economic Review* 51(4), 533-565.

Rozelle, S., J. E. Taylor, and A. De Brauw. (1999, May). "Migration, Remittances, and Agricultural Productivity in China." *The American Economic Review* 89(2), 287-91.

Singh, I., L. Squire, and J. Strauss. (1986). *Agricultural Household Models: Extensions, Applications and Policy.* Baltimore: Johns Hopkins University Press.

Stark, O., and D. Bloom. (1985, May). "The New Economics of Labor Migration." *The American Economic Review* 75(2), 173-78.

Taylor, J. E. (1992, April). "Remittances and Inequality Reconsidered- Direct, Indirect, and Intertemporal Effects." *Journal of Policy Modeling* 14(2), 187-208.

Taylor, J. E. and T. J. Wyatt. (1996, August). "The Shadow Value of Migration Remittances, Income and Inequity in a Household-farm Economy." *Journal of Development Studies* 32(6), 899-912.

The Central People's Government of the People's Republic of China. (1996). "The Law of the PRC on Township and Village Enterprises." Available at http://www.hbnw.gov.cn/other/zcfg/zcfg/xzqy01.htm. [Retrieved February, 2013]

Udry, C. (1998). "Efficiency and Market Structure: Testing for Profit Maximization in African Agriculture". Available at: http://www.econ.yale.edu/~cru2//pdf/separate.pdf. [Retrieved February, 2013]

Wang, T. (1990). "Regional Imbalances." In W. A. Byrd and Q. Lin (eds.), *China's Rural Industry: Structure, Development, and Reform*. Oxford: Oxford University Press.

Xue, L. (2006). "The Evolution of TVEs in China." *Journal of Small Business and Enterprise Development* 3(2), 235-241.