# Moving off the Farm

## Land Institutions to Facilitate Structural Transformation and Agricultural Productivity Growth in China

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## Abstract

Agriculture has made major contributions to China's economic growth and poverty reduction, but the literature has rarely focused on the institutional factors that might underpin such structural transformation and productivity. This paper aims to fill that gap. Drawing on an 8-year panel of 1,200 households in six key provinces, it explores the impact of government land reallocations and formal land-use certificates on agricultural productivity growth, as well as the likelihood of households to exit from agriculture or send family members to the non-farm sector. It finds that land tenure insecurity, measured by the history of past land reallocations, discourages households from quitting agriculture. The recognition of land rights through formal certificates encourages the temporary migration of rural labor. Both factors have a large impact on productivity (at about 30 percent each), mainly by encouraging market-based land transfers. A sustained increase in non-agricultural opportunities will likely reinforce the importance of secure land tenure, which is a precondition for successful structural transformation and continued economic attractiveness of rural areas.

# Moving off the farm: Land institutions to facilitate structural transformation and agricultural productivity growth in China

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## 1. Introduction

Agriculture has made enormous contributions to poverty reduction and overall development in China. However, in the presence of other impediments to the free movement of factors, growth of economic opportunities and demand for labor in the non-agricultural sector has given rise to significant inter-sectoral and inter-regional income disparities that have become of concern to policy-makers. The magnitudes involved can be appreciated by noting that, while agriculture's contribution to the economy declined from 40% in 1970 to less than 10% now, the share of labor employed in the sector in 2005, though down from 81% in 1970, still stood at 45%. This raises the question whether China can release labor from agriculture in a way that enhances productivity and brings about gradual increases in farm size and adoption of mechanized labor-saving methods of cultivation rather than relying on potentially distorting subsidies and at a pace that is fast enough to prevent further rapid widening of the gap between rural and urban incomes.

Institutional arrangements for the functioning of land and labor markets are a determinant of the ease with which this objective can be achieved. It is well known that restrictions on migrants' ability to gain urban residency permits (*hukou*) may impede migration so that returns to labor received by farmers remain well below the wages they could earn outside of agriculture. Land tenure arrangements are relevant in two respects. On the one hand, households who might be better off moving out of agriculture might fail to do so because of fear that, with continued threats of land reallocation without fair compensation at market value, leaving the land would imply a significant risk of losing rights to their land. On the other hand, in the absence of land certificates, the transaction cost associated with transferring land to those who can make more productive use of it may be too high, preventing many efficiency-enhancing transactions.

While policy makers are aware of these issues and have tried to address them through a number of measures, including the 2003 rural land contracting law (RLCL), evidence on the effectiveness of these provisions remains limited. Understanding of whether they had the desired impact and the magnitude of any effects on shifting labor out of agriculture to bring about rural structural transformation will be important in light of a number of recent concerns. These include, in addition to rising rural-urban inequality, the challenges posed by a gradual exhaustion of the pool of cheap labor in the country's interior, an aging rural population, and a need for continued agricultural productivity growth to overcome land and water scarcity.

To explore the impact of land-related institutions on temporary or permanent labor movements (via migration or off-farm employment) out of agriculture, we use a panel data set covering a period of almost 10 years (2000-2008). Methodologically, this allows us to use panel estimators to control for unobserved

time-invariant household characteristics which, if there are no structural differences between treated and control groups, can be interpreted as causal effects. Substantively, our data cover a period characterized by far-reaching economic and institutional changes in terms of off-farm labor market participation and agricultural productivity changes; real output per mu more than doubled from Y 2,550 to Y 5,588, despite declining staple crop prices. Some 15% of sample households exited agriculture and the mean share of household labor supplied to the non-agricultural sector increased from less than 50% to more than 60%.

Tenure insecurity, as measured by recent land reallocations, and transferability of land, as proxied by the share of households with certificates in a village, affect non-agricultural labor supply. Having experienced land reallocation discourages exit from agriculture but has no impact on labor supply to migration or the local non-farm sector. Coverage with land certificates, a variable rarely considered in past literature, is estimated to have potentially large effects on migration but not local off-farm work; compared to a village with no land documents, the average household in a village fully covered with certificates is estimated to supply about half a person-year more to non-farm labor markets via migration. Security against reallocation and the ease of transferring land are likely to play an important role as determinants of China's ability to transform its rural sector and improve allocative efficiency.

To the extent that they affect households' labor supply, we would expect these arrangements to also have an impact on agricultural productivity. Significant and quantitatively large productivity-effects are indeed confirmed by the data. Having been affected by reallocation after 2000 is estimated to reduce productivity by some 30% whereas possession of a land certificate in either period increases productivity by between 30% and 32%. These effects are not only quantitatively large but, in both cases, appear to be driven more by allocative efficiency than by investment-effects. As exogenous factors are likely to further increase the need and scope for efficiency-enhancing land transfers in the future, institutional measures to reduce the threat of land reallocation and increase coverage with certificates thus appear to have considerable potential to help China transform its rural sector and realize efficiency gains that could increase overall rural welfare and narrow or at least prevent widening of rural-urban income gaps.

The paper is structured as follows: Section two provides context by reviewing the role of agriculture in China's long-term development, recent institutional challenges in this respect, and legal initiatives taken to deal with them. Section three discusses the data used in more detail, reporting descriptive statistics on movement out of agriculture as well as agricultural productivity, in addition to introducing the conceptual framework for subsequent analysis. Section four presents econometric results to quantify impacts of institutional arrangements on partial or full movement out of agriculture and agricultural productivity. Section five concludes by drawing out implications for policy and possible future research.

## 2. Background and context

While agricultural growth in China has made unprecedented contributions to poverty reduction, institutional factors also pose enormous challenges to the smooth movement of labor out of the agricultural sector into higher-paying non-agricultural pursuits and to market-based land transfers to more productive farmers who can then expand the scale of their operations. Such transfers will become more important to prevent or limit widening of rural-urban income gaps in light of the challenges posed by rapid ageing of the rural population, a tighter overall labor supply, and environmental issues arising from scarcity of land and water resources. We review evidence of how reallocations and lack of documented property rights have in the past limited investment and farmers' movement out of agriculture, the legislative measures taken to address this, and ways in which institutional changes could affect outcome variables included in our data.

### 2.1 Agriculture in China's economic development: Past contributions and future challenges

Growth of the rural economy, driven by agriculture, and distributed equally as a consequence of egalitarian access to land, has been a key reason for rapid poverty reduction in China. In 1981, China was sixth-poorest country in the world,[1] with a poverty headcount of 84%. Growth in the primary sector, i.e. mainly in agriculture was four times more effective in reducing poverty than growth in secondary or tertiary sectors (Ravallion and Chen 2007); it helped to reduce the poverty headcount to 16% by 2005, well below the developing world average of 26% (Ravallion 2009).

While improved technology created the preconditions for rural growth, institutional changes that made property rights more secure and transferable, thereby facilitating a shift of labor out of agriculture, were key factors facilitating this transition. After an eventful history,[2] the first step was the 1978 Household Responsibility System (HRS) that made households residual claimants to output by contracting land from collectives to cultivators, initially for a period of 15 years. It set off unprecedented increases in productivity (Lin 1992, McMillan *et al.* 1989). However, the long-term effect was limited as many contracts remained verbal and failed to provide protection against administrative land reallocations (Rozelle *et al.* 2002). Land transfers were often still administered by village leaders in discretionary ways (Kung and Liu 1997),[3] creating conflicts of interest (Benjamin and Brandt 2002) and failing to capitalize on transfer opportunities created by rapid non-agricultural development. Agriculture was characterized by

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[1] Only Cambodia, Burkina Faso, Mali and Uganda had, in 1981, a higher headcount index than China (Ravallion 2009).

[2] Before the revolution, most farmers were poor tenants or owners of small plots. The communist government confiscated large landlords' holdings and distributed land rights to households on an egalitarian basis (Prosterman *et al.* 1990). In the 1950s, collectivization was adopted, with disastrous consequences for output and rural welfare (Lin and Yang 2000, Putterman and Skillman 1993, Yao 1999).

[3] Exchanges of land within the village had been prohibited before the 1986 Land Management Law legalized them. Transfers to outsiders remained illegal until allowed in 1998, although without clarifying specific modalities to be followed (Li 2003).

enormous improvements in total factor productivity (Jin *et al.* 2010) that relate to different phases of policy reform (Brummer *et al.* 2006).

Concentration of industry and rapid economic growth in the country's coastal region provided incentives for migration and temporary movement out of agriculture (Zhao 1999). As they responded to employment prospects and income differences (Lin *et al.* 2004), migrants contributed to rising rural incomes and well-being and success of coastal export industries (Liu *et al.* 1998, Zhai and Wang 2002).[4] The magnitudes are immense: The 2000 census counted 124.6 million internal migrants (Liang and Ma 2004) or about 17% of the labor force (Taylor *et al.* 2003), up from less than 5% in 1988 and some 10% in 1995 (Rozelle *et al.* 1999). Restrictions on migrants' ability to gain residency at the destination imply that virtually all migration is temporary (Fleisher and Yang 2003), prevent equalization of income levels (Whalley and Zhang 2007), and contribute to persistent cross-regional imbalances (Au and Henderson 2006).

At the household level, the difficulty of getting a residence permit and the implied high risk of moving out of agriculture and abandoning land use in favor of off-farm ventures is a key reason why returns to agricultural labor remain persistently below what can be obtained from non-agricultural work or self-employment (Cook 1999). It contributed to factor market imperfections (Wang *et al.* 2007), made in many situations decisions on consumption and production non-separable (Bowlus and Sicular 2003), limited income diversification, and led to continued use of land as a key safety net and source of old-age support with few substitutes (Zhang 2010). While high incidence of migration by the poor (de Brauw *et al.* 2002) could in principle reduce poverty in sending communities (Zhao 2002), actual impacts are less clear (Du *et al.* 2005). Still, similar to other countries' experience, migration is often complemented by local off-farm employment and part-time farming (Brosig *et al.* 2009) or complete exit from agriculture.

To develop institutional arrangements that can help improve functioning of factor markets, especially those for land, the government conducted a range of land tenure experiments (Kung 2006), building on the results to put in place legal measures to strengthen tenure security. Key among these are the 1998 Land Management Law (Chen and Davis 1998) and then the 2003 Rural Land Contracting Law. The latter puts focus on three areas, namely (i) a more stringent definition of land rights as property rights rather than just private contracts; (ii) a ban on big reallocations and setting of clear conditions for small readjustments;[5] and (iii) a commitment to issuance of land documents. However, while studies have explored determinants and impacts of land takings and the amount of compensation paid (Deininger and

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[4] As interregional linkages and spillovers from the export- and foreign investment-driven boom in coastal areas remain limited (Fu 2004), migration is the only opportunity for many rural residents to benefit from the country's economic boom.
[5] In the course of "big" reallocation, all farmland in the village was given back to the collective and, after subtracting proportional shares for land needed for other purposes, reallocated in equal sizes among villagers. "Small" readjustments, by contrast, merely transfer land from households who experienced changes in family composition but left the rest unaffected. The RLCL completely bans big reallocations while more clearly defining 'small' readjustment and requires that it be approved by two thirds of the village.

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Jin 2008), the effect of institutional arrangements on labor supply has not been explored in depth. Study of this issue will be critical not only because of its direct bearing on rural-urban inequality but also as exogenous factors that create opportunities for factor markets to enhance allocative efficiency are likely to become more pronounced in the near future. For example, China may be entering a period of labor shortage (Cai and Wang 2010) where near-unlimited supply of cheap migrant labor from the country's interior can no longer be taken for granted (Zhang *et al.* 2010). Other countries' experience suggests that the institutional arrangements to promote structural change may persist and have long-term consequences, reinforcing the importance of carefully studying this issue.[6]

## 2.2 The role of land institutions in fostering structural transformation and off-farm development

The literature holds that secure property rights to land can facilitate structural transformation in two ways (Besley and Ghatak 2010). Increased tenure security and the associated reduction of expropriation risk will increase investment incentives. Formal documentation of rights, e.g. through certificates, makes it easier to unambiguously identify legitimate owners and thereby reduces the transaction cost of market-based land transfers. If other conditions -such as differences in productivity between producers because of availability of other sources of employment or a sufficiently liquid land sales market- are in place, this can facilitate either efficiency-enhancing land transfers to more productive users or use of land as collateral in credit markets (Deininger and Feder 2009). Adapting these principles to Chinese conditions, where use of rural land as collateral is not permitted, reallocations could threaten those moving out of agriculture, and coverage with certificates is uneven, allows us to derive testable hypotheses.

Regarding land reallocation, in China the risk of dispossession for a resident cultivator who uses the land for agricultural purposes is low. This is one of the reasons why many studies find higher tenure security, defined as reduced probability of administrative reallocation, to have limited investment impact (Jacoby *et al.* 2002, Li *et al.* 1998). At the same time, the danger that renting out of land by somebody exiting agriculture could be perceived as a signal that the land is no longer required and could be transferred by administrative reallocation has long been identified as a potential challenge (Brandt *et al.* 2004, Yang 1997). Reallocation may thus discourage exit from the sector at the margin, consistent with findings that, where factor markets function reasonably well, such intervention significantly reduces technical efficiency (Zhang *et al.* 2011).

Regarding transferability, measures to facilitate market-based land transfers, e.g. by increasing coverage with land certificates and outlawing reallocation have a potential to make a very positive contribution to the economy (Carter and Yao 2002). Indeed, China witnessed rapid emergence of land rental markets which

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[6] Data spanning several decades up to a century from the US show that (i) there is a close correspondence between the non-agricultural wage rate and average farm size as a determinant of the potential income that can be achieved from agriculture (Gardner 2002); and (ii) exist from the agricultural sector is affected by expected returns to agricultural cultivation (Barkley 1990).

had hardly existed as late as by the mid-1990s (Deininger and Jin 2005). In a situation where land loss by cultivators is unlikely and use of rural land as collateral not allowed, certificates or transferability could affect outcomes through two channels. A first one is to make contract enforcement easier, thus facilitating land transactions with individuals who are not close kin so that use of informal mechanisms for contract enforcement is not an option. A second one is to reduce the fear of land loss even if land is transferred for longer periods, thus allowing use of long-term contracts that can make a more substantive contribution to structural transformation, e.g. by allowing tenants to make long-term plans and investment.[7] Both of these can allow land users who might temporarily or permanently move out of the sector to earn higher and less risky returns from their land, thereby facilitating operation of factor markets and, if some of the proceeds are invested locally, creating the basis for a more vibrant rural economy.

A number of recent studies provide partial empirical support for these arguments. In a 2006 representative sample, land rental facilitated a major shift from agriculture towards migration (from 57% to 17%). On rented plots, net revenue was some 60% higher than what the landlord been obtained by under self-cultivation, and proceeds made landlords and tenants better off (Jin and Deininger 2009). A productivity-enhancing role of land markets is also inferred from the fact that, in a more limited sample from Southern China, productivity on leased plots is consistently highest (Feng *et al.* 2010). For agricultural land, rental rights together with higher tenure security have been found to increase the probability of migration while higher levels of tenure security alone may reduce migration levels on agricultural land but increase it on forest land where differences in labor-land complementarities are less pronounced (Mullan *et al.* 2011).[8]

While this points towards positive impacts of factor market operation, there is evidence that, even after reforms, institutional barriers to achieving fully efficient outcomes remain. Household perceptions and observed behavior -such as *a priori* limitation of the set of possible transaction partners- point towards remaining barriers to land market operation (Jin and Deininger 2009). Those predicted to be constrained in the off-farm labor market benefit more from exogenous increases in labor demand brought about by the sloping land conversion program, a key intervention increasing labor demand (Groom *et al.* 2010).

A key question is thus whether, even with current restrictions on migration, remaining imperfections in rental markets impose constraints on farmers' ability to supply labor to the non-agricultural economy. As evidence on this is scant and public opinion on the merits of key institutional arrangements, e.g. the ban on land reallocation, continues to be strongly polarized (Wang *et al.* 2011). To be credible and policy relevant, such analysis of the impact of land institutions will have to avoid pitfalls such as (i) mistakenly

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[7] Of course, easier transferability will allow benefitting from an investment even if the land is no longer used. This may be the reason why some studies find that investment made in and/or after 1998, was 9.8% higher for households that have land use certificates (Zhu and Riedinger 2011).
[8] Higher tenure security alone, without a commensurate increase in transfer rights, reduces the probability of migration whereas increasing both rental rights and tenure security makes migration more likely but an increase in tenure security alone. The opposite is true for forest land where the differences in labor land complementarities are less pronounced.

interpreting inter-regional variation as a causal effect as may be the case with simple cross sectional analysis; (ii) neglecting exit from agriculture by restricting the sample to agricultural producers present in both periods; and (iii) looking at migration behavior without drawing out productivity implications.

## 3. Data and descriptive evidence

Descriptive data on changes in overall income levels and sources, occupational status, and agricultural productivity from our 6-province panel highlight the dynamic nature of China's rural sector and the geographically differentiated pattern of productivity and income growth as well as occupational diversification. They provide the basis for a discussion of the empirical strategy exploring determinants of part-time and full time movement out of agriculture as well as agricultural productivity.

### 3.1 Sample composition and key definitions

Our data are from a two-period household survey conducted in China's six major agricultural provinces in 2000 and 2008.[9] In each province, counties are stratified into five sub-groups by gross value of industrial output to represent varying income levels. Per province, one county and two villages were randomly selected from each sub-group and 20 households interviewed in each selected village. This yields a total sample (in 2000) of 1200 households (6 provinces x 5 counties x 2 villages x 20 households). In 2008, two earthquake-damaged villages in Sichuan could not be interviewed, reducing the sample to 1160 households. Of these, 88 had moved to urban areas (of which 74 could be traced) while 53 dropped out and were replaced, leaving us with 1093 households for which information in 2000 as well as 2008 is available.[10] The household survey includes detailed information on agricultural outputs and inputs, endowments with key factors of production, off-farm activities, whether or not and when households received land use certificates, and whether or not and when households experienced land reallocations.

We categorize households into non-, full-time-, or part time-farmers. Non-farmers are those who report neither agricultural output nor using any inputs for agricultural activity. Part time-farmers have at least one individual whose main activity is not farming but who instead works outside the home county as a migrant or in local off-farm activities within the home county. In addition to the number of days spent in farming, the survey also includes information on the number of labor days supplied to the non-farm sector by migrants or those engaging in local off-farm activity.[11] Overall economic development during the period is evidenced by considerable shifts in occupational status; in 2000, 21% of the 1093 sampled households engaged in farming only, 73% were part-time farmers, and 6% relied only on off-farm

[9] Note that the second round of the survey was undertaken when the impact of the 2008 global financial crisis was most acute. If, as the literature suggests, the agricultural sector provided an employment buffer during the crisis, this will have to be factored in when interpreting results.
[10] Excluding earthquake-damaged households, attrition, including replacements, is thus 5.78% (53 replaced +14 untraceable /1160 households).
[11] Although this variable could, in principle, measure the extent of off-farm participation at the household level better than just the number of individuals, this variable is likely to be measured with high levels of error for migrants where information was not provided by the concerned person directly. We therefore choose the number of individuals participating in off-farm markets as our main measure but report both.

occupations. In the meantime, 5% more part-time farmers became non-farmers than full-time farmers, and 64% of the full-time farmers either devoted some labor (52%) or all labor (12%) to off-farm employment.

By 2008, the share of non-farmers (19%) had marginally eclipsed that of full-time farmers (17%) and the share of part-time farmers was reduced from 73% to 64% (table 1). This very aggregate picture show significant variation across provinces with the biggest increase in off-farm households (non-farmers) observed for Zhejiang (from 10% to 34%), followed by Hubei (7% to 21%) and Hebei (6% to 16%). Even in Liaoning, some 11% of the sample engaged in off-farm activities by 2008. In Hebei, Liaoning and Hubei, both full-time and part-time farmers abandoned agricultural production, leading to increases in the share of non-farmers from 6.0%, 3.2% and 7.3% to 16.0%, 10.8 and 20.9% respectively. In Shaanxi, the share of full-time farmers remained constant at 17% and all of the increase in the share of non-farmers (from 2.7% to 12.4%) came through a shift out of part-time farming. In Zhejiang, more than one third of previously rural households have shifted out of farming completely while the share of part-time farmers has remained more or less constant. Differences across types in terms of demographics, labor supply and its distribution, and aggregate agricultural productivity, provide interesting insights.

In addition to the types of data routinely included in multi-purpose household surveys and detailed information on agricultural production, our data also provides evidence on institutional arrangements that affect land tenure security, in particular the coverage with certificates and levels of land reallocations of different types (large and small) at different points in time.[12] Assets include agricultural equipment, fixed business equipment, durable goods and residential structures.

### 3.2 Descriptive statistics

While there is a universal decrease in household size, the variable dropped most markedly for full time farmers, from 3.55 to 2.75 persons, along with an increase in the dependency ratio from 36% in 2000 -an already very high level- to 50%, compared to some 20% for the rest of the sample, in 2008. In line with this, income for this group was, with Y 6,223 in 2008, much lower than income by part-time (Y 21,845) and non-farmers (Y 22,737) during the period.[13] Education levels increased to 10.5 years and 10.2 years in 2008 for part-time and non-farmers, respectively, but only 7.3 years for full-time farmers. While income increased more than 60% in real terms between 2000 and 2008, inequality in per capita income narrowed slightly, with the Gini decreasing from 0.53 to 0.50, possibly due to a marked increase in subsidies (Huang *et al.* 2011). Gaps in asset levels were more pronounced and with the Gini for total asset

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[12] There are two caveats worth noting. First, a total of 129 households reported to have a certificate without being able to recall the exact time when it was received. All of the regressions below are based on the assumption that this group received documents before 2000 although results are robust to various alternative assumptions or dropping this group altogether. Second, as households who exited agricultural production did not report whether or not they had land certificates, we are forced to use village averages for the share of households with certificates instead.

[13] Note that, possibly a result of subsidies having increased significantly over the period, the rate of income growth experienced by full-time farmers was slightly higher than that for non- or part-time farmers.

endowments rising from 0.64 to 0.72 between 2000 and 2008, asset inequality increased markedly: While full-time farmers increased their asset endowment from Y 16,863 to Y 53,445, part-time farmers did so from Y 33,432 to Y 84,355 and non-farmers from Y 75,880 to Y 226,816.

Differences in demographic structure gave rise to marked variations in labor supply and sources and income levels across household types. Part time farmers increased labor supply from 578 to 738 days in total (or 182 to 241 days per adult), compared to an increase from 413 to 545 days (168 to 205 days per person) for non-farm and a change from 288 to 273 (125 to 158 days per person) for full-time farmers. With the exception of full-time farmers, the composition of labor supply changed markedly as well; although their total number of labor days in agriculture increased slightly (from 240 to 262), part time farmers reduced the share of time spent on agriculture from 41% to 36%, while expanding labor in migration from 21% to 31% and reducing local off-farm work from 38% to 33%. Non-farm households expanded supply of labor to migration from 23% to 60% while reducing labor in local off-farm activity from 78% to 40%. Shifts in labor supply are mirrored by corresponding changes of income composition.

The data also point towards improved functioning of factor markets, especially those for land. While the amount of owned land decreased 9.1 mu to 6.9 mu for full-time and from 7.7 mu to 7.0 mu for part time farmers, cultivated land area decreased much less (from 9.7 mu to 8.8 mu) for full-time farmers and increased (from 8.2 mu to 8.9) for part time farmers, presumably as a result of better functioning of land rental markets. At the same time, land ownership by non-farmers increased, from 3 to 4.35 mu. The most likely reason is that the 2003 RLCL policy of stopping land redistribution was more strictly adhered to. More importantly, and in contrast to what would be expected in environments with missing markets where land reallocation might be the only mechanism to restore balance, our data suggest that having had a high level of land reallocation in the past will increase the expectation of future redistributions. A review of institutional variables, in particular the incidence of land reallocations and land certificates by province, can provide insights on this (table 2).[14] Two findings emerge. First, land reallocation overall was infrequent; 70% of producers were never affected by such an event. Second, while the rate of reallocations decreased from 17% to 10%, marked differences emerge across provinces; while Hebei shows the most marked drop from 23% to 2% and redistributions more or less halved in Shaanxi (18% to 8%) and Zhejiang (21% to 14%), they decreased less or stay constant in others, such as Hubei (15% to 11%), Sichuan (8% to 7%), and Liaoning (15%).[15] Details on the type of reallocation are available only

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[14] The share of households with land use certificates must be undervalued as 129 households did not report the exact years when the certificates were issued, in which sense we only know they had certificates in year 2008 but we have no idea whether they had or not in year 2000. If these households were assumed to have received certificates in year 2000, the percentage would be 52% in total, 67% in Hebei, 53% in Shaanxi, 51% in Liaoning, 61% in Zhejiang, 53% in Sichuan, and 27% in Hubei.

[15] This is consistent with evidence of high levels of continued reallocation in many provinces that seems to be rooted in a continued gap between equity and efficiency with the policy of no redistribution (or full compensation for land taken from migrants) being supported by more educated, male-headed, and agriculture-dependent households (Wang *et al.* 2011).

from village-level data which confirm a consistent trend towards reducing the number of reallocations across provinces. Between 2000 and 2008, no reallocations were carried out in Sichuan and Hebei and Zhejiang eliminated minor reallocations. In Hubei numbers are trivial (both 0.09) despite the existence of major and minor reallocations. On the other hand, while major reallocations were more limited in Shaanxi (0.29) and Liaoning (0.11), the share of minor reallocations increased. To interpret these figures recall that many villages did have a reallocation around 1998 in the context of renewal of land use contracts that had expired after the first 15-year period following the HRS.

Table 2 illustrates that, although one third of households still lack a land use certificate, issuance of certificates has progressed more uniformly, in contrast to variable levels of compliance with policies to stop land reallocations. Between 32 and 52% of households had certificates before 2000 and lagging provinces, in particular Hubei and Liaoning where levels of issuance in 2000 had been remained very low caught up rapidly by providing certificates to 39% and 19% of producers, respectively, after 2000. To the extent that having certificates enhances transferability more than tenure security, we would expect it to facilitate out-migration and operation of land rental markets.

In line with aggregate data, descriptive statistics in table 3 point towards large increases in real output per area and profit (including returns to family labor) over the period. The fact that cultivated area remained almost constant despite a decline in owned area to 83% of the 2000 value points towards increased rental market activity. Profit per mu increased by a factor of 2.3 and labor and capital intensity, defined as the amount of agricultural assets per mu, increased by 13% and 85%, respectively. Resource endowments varied widely across regions. In 2008, average owned and cultivated are 10 and 15 mu, respectively, in Liaoning as compared to 4 and 7 mu in Zhejiang. Relative factor intensities varied as expected, with labor intensity higher in land-scarce provinces such as Sichuan (82 days/mu in 2000 and 114 days/mu in 2008) compared to 'land abundant' ones such as Liaoning (24 and 32 days/mu, respectively) although alternative employment opportunities also appear to play a role, as illustrated by the decrease of labor intensity (from 32 to 28 days/mu) in Zhejiang. The total amount of agricultural assets, which increased by 70% overall, more than doubled in Shaanxi while declining slightly in Zhejiang. The data also indicate considerable increase in major purchased inputs of crop production. Expenditure on fertilizer and other inputs (including pesticides, machinery, fuel and electricity) almost doubled over the eight year period (from 70 to 143 Yuan per mu for fertilizer and from 70 to 120 for other inputs) while spending on seeds increased by more than 50% (from 21 to 33 Yuan per mu), with regional variations. In Hebei, Shaanxi, Sichuan and Hubei values of these inputs in 2008 were more than 1.5 times of the values in 2000, the increases were less than 50% for all inputs in Zhejiang and for seeds and others in Liaoning.

### 3.3 Conceptual framework and estimation strategy

Our empirical analysis focuses on determinants of households' moving off the farm and of agricultural productivity. To identify determinants of the first set of outcomes, we use a reduced form equation

$$L_{it} = \beta_0 + \beta_1 S_{it} + \beta_2 X_{it} + \beta_3 T_{it} + \beta_4 P_i + \varepsilon_{it} \ (1)$$

where $L_{it}$ represents either (i) an indicator variable that is one if the household derives all its income from non-farm activities and zero otherwise; (ii) the number of individuals in the household who derive their main income from off-farm activities; or (iii) the number of labor days supplied to off-farm labor markets. $S_{it}$ is a vector of institutional variables including the share of households in the village who received land certificates and whether or not a household experienced land reallocations. $X_{it}$ is a vector including household demographics, asset value, and land endowment. $T_{it}$ and $P_i$ are year and province dummies.

A drawback of the linear model for discrete responses is that partial effects are constant throughout the range of dependent variables and that negative fitted values and inconsistent conditional variance. In the case of farm exit, where the independent variable is binary, a probit model can be used to avoid this shortcoming. By the same token, we use the Poisson model for the number of household members participating in off-farm labor markets which is a count variable. A tobit model is used to deal with the fact that the optimum amount of days supplied by a household to the off-farm labor market may be zero.

In panel data settings, the independence between covariates and the unobserved heterogeneity is a strong assumption. Compared to probit and tobit models, the fixed-effect Poisson estimation is well-defined (Hausman *et al.* 1984, Wooldridge 1999). However, it does not allow an observation to contribute to the estimation if its outcomes are zeros in all periods, which will reduce our sample size by 8.8%, 39.9% and 27.1% in terms of total number of individuals engaging in off-farm employment, migrants, and local off-farm participants, respectively. We follow recent studies and include average levels of time-varying variables (Egger *et al.* 2011, Lewis *et al.* 2011, Ricker-Gilbert *et al.* 2011), thus relaxing the independence assumption by modeling the distribution of the unobserved effect conditional on exogenous variables (Mundlak 1978, Chamberlain 1984). The GEE and the pooled tobit (Wooldridge 2006) allow us to enhance efficiency without sacrificing consistency. Based on our discussion, we expect reallocations to reduce exit from agriculture and certificates to enhance temporary labor supply to non-agriculture.

To assess whether institutional arrangements can, either directly or indirectly, affect productivity, we start with a Cobb-Douglas production function

$$Q_{ijt} = \exp(\alpha_i + \alpha_j + \delta \ S_{it}) A_{ijt}^{\theta_1} L_{ijt}^{\theta_2} K_{ijt}^{\theta_3} I_{ijt}^{\theta_4} \ (2)$$

where $Q_{ijt}$ is the value of crops produced by household i in province j in year t; $A_{ijt}, L_{ijt}, K_{ijt}$, and $I_{ijt}$ are cultivated area, labor for production, value of agricultural assets, and a vector of inputs including seeds, chemical fertilizer, and others (the sum of organic manure, pesticides, and agricultural machinery);

$\theta_1$, $\theta_2$, $\theta_3$ and $\theta_4$ are technical coefficients to be estimated; $\alpha_i$ and $\alpha_j$ are time invariant household and village characteristics; $S_{it}$ is again is the vector of institution variables including whether a household had a land use certificate or experienced a land reallocation. Taking logarithms on both sides yields

$$q_{ijt} = \alpha_i + \alpha_j + \delta \; S_{it} + \theta_1 a_{ijt} + \theta_2 l_{ijt} + \theta_3 k_{ijt} + \theta_4 i_{ijt} + \varepsilon_{ijt} \; (3)$$

where $q_{jit}$, $a_{ijt}$, $l_{ijt}$, $k_{ijt}$ and $i_{ijt}$ are logarithms of $Q_{ijt}$, $A_{ijt}$, $L_{ijt}$, $K_{ijt}$ and $I_{ijt}$. To eliminate unobservable time invariant characteristics, we take first differences to obtain

$$\Delta q_{ij} = \delta \; \Delta S_i + \theta_1 \Delta a_{ij} + \theta_2 \Delta l_{ij} + \theta_3 \Delta k_{ij} + \theta_4 \Delta i_{ij} + \Delta \varepsilon_{ij} \; (4)$$

In addition to technical coefficients θ regarding the impact of inputs, δ is the vector of key parameters of interest capturing the impact of having received land certificates or been affected by land reallocation in 2000-2008. Based on the literature discussed earlier, we expect certificates to affect productivity positively while land reallocations are likely to have a negative impact. To interpret the coefficients on these coefficients as indicators of impact and thus attribute productivity changes to institutional changes is that both initial conditions and pre-intervention trends do not differ significantly between those who did and did not receive certificates or were affected by redistribution and we include relevant tests below.

## 4. Econometric results

Econometric analysis allows us to assess the relevance of institutional variables and the magnitude of their impact on relevant outcomes. Having been affected by reallocation reduces the propensity of exiting agriculture by a modest amount but leaves the amount of time supplied to the non-agricultural sector (migration or local) on a part-time basis unaffected. Coverage with certificates, on the other hand, reduces the likelihood of migration, but not of taking up local off-farm work. While some of these findings mirror qualitative results in other studies, the ability to explore productivity impacts of institutional arrangements sets ours apart. Doing so suggests that in both cases effects are large with absence of reallocation and presence of certificates increasing productivity by almost a third each, largely via allocative efficiency rather than land-attached investment. As development is likely to prompt further exogenous changes that provide opportunities for decentralized and market-based responses by local producers, attention to the institutional arrangements identified here may help to realize even greater productivity gains in the future.

### 4.1 Non-agricultural labor supply and exit from the sector

Coefficients in table 4 are average partial effects for the probability of exiting agriculture, the number of individuals participating in non-agricultural activities (both migration and local off-farm employment), and the number of days supplied to the different types of non-agricultural labor markets. We use the share

of certificates at the village level because this is likely to determine demand for land transactions and as information on possession of certificates in 2008 was not collected for those who had exited agriculture.

Regarding a permanent movement of labor from the sector, whether for local employment or migration, households who had been affected by land reallocations are less likely to exit the agricultural sector. The estimated marginal effect is about 5%, i.e. households who experienced reallocation after 2000 are 5% less likely to exit agriculture than those who did not, suggesting that legal restrictions on reallocation may be less than perfectly enforced.[16] To our knowledge, this is the first time that risk of reallocation has been shown to affect movement out of agriculture and it will be of interest to explore associated productivity effects. Part-time labor supply to non-agricultural labor markets is estimated to be unaffected by reallocation as, with one exception (number of individuals in local markets), all coefficients are negative but insignificantly different from zero. Reallocations thus appear to affect farmers' decisions on staying in agricultural production rather than the extent to which they engage in off-farm activities. Also, the share of certificates at village level, as a proxy for the transaction cost of land transfers, appears to not affect exist decisions and few of the other coefficients are of high significance.

A second finding of interest is that availability of certificates significantly contributes to participation in off-farm labor markets, an effect driven entirely by the impact of certificates on encouraging migration. This is in line with the notion that, engaging in local off-farm employment is unlikely to significantly affect landlords' ability to monitor or enforce contracts but that absence for more extended periods of time will imply that there are benefits from more formal means of contracting. The size of estimated coefficients is large, compared to a village with no land certificates, issuance of land use certificates to every household in the village would be predicted to result in a 63% increase in the number of individuals supplying labor to non-agricultural labor markets or an increase of households' labor supply to such markets by 86 days. Specifically, it would increase the number of migrants by 36% and the working days they work by 99. The size of this effect is particularly remarkable given that data collection for the second round happened at the height of the financial crisis. Concerning other variables, higher levels of education emerge as being positively correlated with higher levels of off-farm participation. On average each additional year of education translated to 3% increase in the number of individuals supplying labor to the non-farm sector (or a 2% increase in migrants) as well as 9 total off-farm labor (and 7 migration) days.

In addition to the institutional variables of primary interest, we note that off-farm participation increases significantly over time and in endowments with physical and human capital as well as lower dependency rates. The positive and highly significant time dummy captures a secular increase in the propensity of

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[16] This result is in line with descriptive evidence suggesting that households who had experienced land reallocation in the past had a significantly higher subjective probability of losing land through reallocation in the future. They were more likely to expect a reallocation in the future and expected it to happen much sooner than those who had not suffered from a reallocation.

exiting agriculture; the probability of exiting agricultural production in 2008 is estimated to be higher by an average of 13% as compared to in 2000. The positive coefficients on the size of population 14-60 years of age across all measures of off-farm participation point to the importance of the labor endowment for off-farm labor supply. At the mean, having one more adult in the household increased the number of individuals with off-farm pursuits by 48% and the number of labor days by 122. While the number of individuals in local off-farm work increased by 20%, that of migrants rose by 30% with increases of 56 and 57 labor days, respectively. Higher numbers of dependents, however, reduce the propensity to migrate but increase the likelihood of engaging in local off-farm labor markets, an effect that is even stronger for over 60 year olds. Although this may be partly due to the timing of the survey, it may also indicate that the latter can support farming in some periods but not take full management responsibility.

The fact that assets are predicted to reduce the likelihood of migration while increasing the propensity to engage in off-farm employment is in line with the notion that lack of assets or local demand for labor is a key reason for households to migrate rather than participate in local off-farm employment. From a policy perspective, this reinforces the importance of policies favoring local asset accumulation.[17] The increases in real asset values reported in table 3 (Y 46,324 for the entire sample, from Y 20,278 in Hebei to 146,153 in Zhejiang) would, according to the estimates, have led to a decrease in the number of individuals migrating by 4.6 percentage points on average, ranging from 2.0 in Hebei to 14.6 in Zhejiang. The significant positive coefficient on the 2008 year dummy for migration points towards an increase in off-farm participation over time. The lack of a corresponding trend in local non-agricultural employment may indicate that the contribution to local economic growth rather than just out-migration is not yet assured. Differences in signs and magnitudes of the coefficients on province dummies also point towards marked inter-regional variation in the extent of changes in non-agricultural labor market participation over time; moves into off-farm occupations are more likely in Zhejiang whereas local off-farm employment is less likely in Shaanxi, Liaoning, Sichuan and Hubei.

**4.2 Determinants of agricultural productivity**

If certificates and reallocations systematically affect households' participation in non-agricultural labor markets, one would expect them to also have an impact on the productivity of land use. In line with earlier discussion, three possible mechanisms are possible. First, greater transferability may allow productive farmers to lease in land and increase the size of their operation. Second access to non-agricultural income could, either directly or indirectly alleviate liquidity constraints that might have led to lower levels of productivity. Finally, increased tenure security and possibly long-term contracts could

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[17] The fact that remittances from migration were found to have increased spending on housing and consumer durables but not productive investment (de Brauw and Rozelle 2008) may point towards a need of exploring this issue more carefully.

prompt those involved to make longer-term investments which may not necessarily be observable in the survey (e.g. if those remaining in agriculture invest to improve their agricultural skills to be able to farm greater land sizes more efficiently). Results from estimating a production function on the panel of 863 full- or part-time farmers in table 5 provide a direct test of this and allow us to explore the plausibility of different channels through which such effects could materialize.

As household fixed effects control for unobserved time-invariant characteristics only, effects estimated in this way can be interpreted as causal impact of institutional change in the 2000-08 period only if, before the intervention, those who were and were not affected by the change were on similar growth trajectories. While testing this 'parallel trends' assumption requires panel data, we use the fact that individual-level job histories for the last decade and beyond were obtained from a subset of the households in the 2000 survey to obtain information on changes in households' overall level of labor force participation, the share of households participating in full and part time agriculture, and the share of total labor time spent in migration and outside of agriculture. Appendix table 1 which presents levels and changes in these variables for the groups of interest does not allow us to reject the hypothesis of no significant difference in pre-intervention trends for any of the variables. To explore this further, we also check equality in key variables pertaining to household characteristics, labor supply, and endowments with productive factors such as land and assets. Appendix table 2 points towards significant differences in few of these variables only for households affected by reallocations who were more educated and affluent than those who were not. Under the assumption that education and wealth allow more rapid adoption of technical change, this should bias coefficients in the productivity regression downwards so that our estimate will be a lower bound of redistribution-induced productivity effects.

We find evidence of a negative and significant impact of reallocations conducted after 2000 but not ones before this date.[18] The point estimate of 0.30 in both specifications suggests that, by reducing productivity by almost a third, redistributions could have had large productivity-effects. Further research is needed to determine whether this occurs because operators without comparative advantage in farming to stay in agriculture as they fear to lose to reallocation or whether it prevents efficiency-enhancing investments by tenants who are able to obtain land only for a short duration of time.

While qualitative effects of reallocation on various determinants of productivity have been found -though not always quantified- before, our regressions also point towards possession of certificates having clear and quantitatively large productivity-effects. The magnitude of the coefficients, 0.32 for certificates that had been held before 2000 and 0.30 for those received between 2000 and 2008, suggests that households

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[18] Although this could be interpreted as suggesting only a short-lived impact of reallocations, a more plausible interpretation for the lack of pre-2000 reallocations is that that many villages had some form of redistribution when original land use contracts expired in the 1990s.

with a certificate are about one third more productive than those without a certificate.[19] If this effect were to come via higher levels of investment, we would expect it to increase in the length for which the certificate has been held. Results for the relevant test, reported in the bottom panel, do not allow us to reject equality of the relevant coefficients between households that received them earlier and later, implying that, rather than through investment, a large part of the effects measured here may be driven by differences in unobserved farmer ability and allocative efficiency.

Coefficients on other factors such as land, fertilizer, and other purchased inputs are highly significant and with the large point estimate of the coefficient on land reinforcing the relevance of this factor. The insignificant coefficient of labor, while consistent with findings from other studies (Benjamin *et al.* 2005) is surprising in view of recent concerns about emerging labor shortages in China's export sector but may be explained by the notion that it is the old who take care of agricultural cultivation in many contexts, especially if there is significant out-migration (Chang *et al.* 2011).

## 5. Conclusion and policy implications

The fact that productivity growth in non-agriculture has consistently been higher than in the agricultural sector implies a secular movement of labor out of agriculture with economic development. The nature and speed of this process, and the implications for household welfare as well as policies to address rural-urban income gaps, will depend on the policy and institutional environment. The issue is acute in China given the spatial concentration of industry, the small size of average agricultural land endowments, large numbers of farmers and the generational dynamics created by rapid ageing of rural populations. All of these suggest an enormous potential for market-based transfers to improve allocative efficiency and rural economic development in the near future. Better appreciation of how institutional factors affect the direction and pace of rural structural transformation and productivity will be critical to understand the underlying dynamics and help design policies that can avoid rising rural-urban inequality without having to resort to very costly and potentially distorting transfer payments. However, even though China is at a critical point in terms of policy design, empirical studies in this area are lacking.

To help close this gap, we use recent panel data to study the impact of two key institutional factors -land reallocation through non-market mechanisms and availability of land use certificates- on rural structural transformation and agricultural productivity. Based on the notion of tenure security and transferability as main ways through which land tenure affects behavior, we hypothesize that reallocations may impede a smooth exit from agriculture whereas certificates could make it easier to transfer land and leave the current residence to join the non-agricultural labor force on a temporary basis. While the impacts of

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[19] Note that, because the regression includes only those who reported agricultural production in both periods, we are able to use the possession of land certificate at the household level as the relevant variable.

institutional arrangements on labor market participation have been explored by previous studies, we are able to go beyond the existing literature by quantifying productivity implications.

Three empirical results stand out. First, experience of reallocations after 2000 reduces incentives for permanently exiting agriculture (but not temporary non-agricultural labor supply). With 5%, the size of the estimated effect remains modest. Second, certificates seem to affect participation in non-agricultural labor markets almost entirely through their impact on enhancing temporary migration. In this case, the estimated coefficients are large; having certificates for all households in village would increase an average household's supply of labor to the off-farm sector by half a person. Third, although we find little evidence of investment impacts from higher levels of tenure security, it appears that institutional variables affect allocative efficiency. Having been affected by reallocation after 2000 is estimated to have reduced productivity by about 30%. Receipt of a land use certificate during this period had a quantitatively large impact on productivity of about the same magnitude.

There are two areas for follow-up research. First, it will be of interest to explore channels for institutional arrangements to affect outcomes in more detail, complementing the reduced form approach taken here although data requirements of this are likely to be large. Second, land and labor are undeniably linked and it is generally believed that labor market distortions have a much more significant impact on economic outcomes than those in land markets. Some of the recent land reform pilots also involved loosening of residency requirements and would thus allow study of the interaction between the two markets. In light of the magnitude of productivity-effects from land market restrictions only estimated here, such analysis would appear both timely and policy relevant.

**Table 1: Descriptive statistics by type of employment**

| | Total | | Full time farmers | | Part time farmers | | Non-farmers | |
|---|---|---|---|---|---|---|---|---|
| | **2000** | **2008** | **2000** | **2008** | **2000** | **2008** | **2000** | **2008** |
| **Household demographics** | | | | | | | | |
| Head's age | 45.06 | 52.58 | 46.99 | 57.79 | 44.38 | 51.39 | 46.83 | 51.82 |
| Male head | 0.97 | 0.95 | 0.97 | 0.92 | 0.97 | 0.96 | 0.98 | 0.91 |
| Household size | 4.06 | 3.74 | 3.55 | 2.75 | 4.23 | 4.06 | 3.70 | 3.58 |
| Population <14 years | 0.72 | 0.42 | 0.75 | 0.30 | 0.71 | 0.49 | 0.75 | 0.30 |
| Population 14-60 years | 3.00 | 2.83 | 2.30 | 1.53 | 3.24 | 3.18 | 2.53 | 2.84 |
| Population >60 years | 0.34 | 0.49 | 0.50 | 0.92 | 0.28 | 0.39 | 0.42 | 0.44 |
| Dependency ratio | 0.26 | 0.26 | 35.69 | 50.11 | 22.30 | 20.17 | 36.44 | 25.49 |
| Head's education (year) | 6.61 | 6.54 | 5.77 | 5.46 | 6.82 | 6.75 | 7.00 | 6.86 |
| Highest education (year) | 9.60 | 9.89 | 7.52 | 7.26 | 10.19 | 10.52 | 9.47 | 10.19 |
| **Labor supply & income sources** | | | | | | | | |
| Total labor supply (days) | 508 | 622 | 288 | 273 | 578 | 738 | 413 | 545 |
| Days worked per adult | 170 | 224 | 125 | 158 | 182 | 241 | 168 | 205 |
| from agriculture (%) | 51.1 | 40.2 | 100.0 | 100.0 | 41.4 | 35.5 | 0.0 | 0.0 |
| from migration (%) | 16.5 | 30.4 | 0.0 | 0.0 | 20.8 | 31.3 | 22.5 | 60.0 |
| from local off-farm (%) | 32.4 | 29.4 | 0.0 | 0.0 | 37.8 | 33.2 | 77.5 | 40.0 |
| Income per adult eq. | 2518 | 5670 | 892 | 3015 | 2854 | 6123 | 4047 | 6595 |
| Gini of income per adult eq. | 0.53 | 0.50 | 0.45 | 0.55 | 0.48 | 0.43 | 0.56 | 0.56 |
| Total income (yuan) | 8940 | 19295 | 2498 | 6223 | 10356 | 21845 | 13929 | 22737 |
| from agriculture (%) | 46.8 | 37.5 | 100.0 | 100.0 | 35.6 | 31.3 | 0.0 | 0.0 |
| from migration (%) | 19.1 | 34.1 | 0.0 | 0.0 | 24.4 | 36.2 | 17.0 | 62.4 |
| from local off-farm (%) | 34.1 | 28.4 | 0.0 | 0.0 | 40.0 | 32.5 | 83.0 | 37.6 |
| Income per day worked (yuan) | 25.00 | 43.49 | 14.95 | 47.61 | 25.73 | 37.01 | 57.43 | 65.47 |
| Number of off-farm individuals | 1.36 | 1.62 | 0.00 | 0.00 | 1.72 | 1.81 | 1.59 | 2.49 |
| Share of off-farm individuals | 0.43 | 0.52 | 0.00 | 0.00 | 0.51 | 0.52 | 1.00 | 1.00 |
| Number of migrants | 0.44 | 0.84 | 0.00 | 0.00 | 0.56 | 0.81 | 0.38 | 1.70 |
| Share of migrants | 0.14 | 0.27 | 0.00 | 0.00 | 0.17 | 0.23 | 0.24 | 0.68 |
| Number of local off-farm individuals | 0.92 | 0.78 | 0.00 | 0.00 | 1.16 | 0.99 | 1.22 | 0.79 |
| Share of local off-farm individuals | 0.29 | 0.25 | 0.00 | 0.00 | 0.34 | 0.28 | 0.77 | 0.32 |
| **Productive activity** | | | | | | | | |
| Owned land area (mu) | 7.70 | 6.52 | 9.07 | 6.94 | 7.69 | 7.01 | 3.00 | 4.35 |
| Gini of owned land area | 0.46 | 0.43 | 0.48 | 0.46 | 0.44 | 0.42 | 0.44 | 0.43 |
| Cultivated land area (mu) | 8.05 | 7.23 | 9.68 | 8.83 | 8.23 | 8.87 | 0.00 | 0.00 |
| Gini of asset | 0.64 | 0.72 | 0.59 | 0.68 | 0.62 | 0.62 | 0.72 | 0.80 |
| Assets (yuan) | 32,491 | 105,310 | 16,863 | 53,445 | 33,432 | 84,355 | 75,880 | 226,816 |
| of which agricultural (%) | 9.02 | 5.47 | 13.71 | 9.12 | 8.36 | 5.90 | 0.70 | 0.35 |
| **Geographical distribution** | | | | | | | | |
| Hebei (%) | 16.6 | 16.6 | 22.7 | 21.6 | 71.3 | 62.4 | 6.1 | 16.0 |
| Shaanxi (%) | 17.0 | 17.0 | 16.7 | 16.7 | 80.7 | 71.0 | 2.7 | 12.4 |
| Liaoning (%) | 16.9 | 16.9 | 32.4 | 29.7 | 64.3 | 59.5 | 3.2 | 10.8 |
| Zhejiang (%) | 17.9 | 17.9 | 10.2 | 11.8 | 79.6 | 54.1 | 10.2 | 34.2 |
| Sichuan (%) | 14.1 | 14.1 | 28.6 | 17.5 | 66.2 | 67.5 | 5.2 | 14.9 |
| Hubei (%) | 17.5 | 17.5 | 15.7 | 7.9 | 77.0 | 71.2 | 7.3 | 20.9 |
| No. of observations | 1093 | 1093 | 226 | 190 | 803 | 701 | 64 | 202 |

*Source:* Own computation from 2000/2010 panel household survey.
*Note:* Monetary values for 2008 are deflated by CPIs from NBSC.

**Table 2: Incidence of land reallocations institutional preconditions for tenure security and land market development**

| | Total | Hebei | Shaanxi | Liaoning | Zhejiang | Sichuan | Hubei |
|---|---|---|---|---|---|---|---|
| **Land reallocations (household level)** | | | | | | | |
| Never had reallocation (%) | 70.17 | 74.03 | 68.82 | 67.57 | 60.71 | 84.42 | 68.59 |
| Reallocation before 2000 (%) | 17.02 | 23.20 | 18.28 | 15.14 | 20.92 | 7.79 | 15.18 |
| Reallocation after 2000 (%) | 9.61 | 2.21 | 7.53 | 14.59 | 14.29 | 7.14 | 10.99 |
| Realloc. in both periods (%) | 3.20 | 0.55 | 5.38 | 2.70 | 4.08 | 0.65 | 5.24 |
| **Land reallocations (village level)** | | | | | | | |
| Share with major reallocations before 2000 | 0.58 | 1.00 | 0.21 | 1.00 | 0.90 | 0.12 | 0.19 |
| Share with minor reallocations before 2000 | 0.67 | 0.39 | 0.90 | 0.61 | 0.80 | 0.62 | 0.70 |
| Share with major reallocations after 2000 | 0.14 | 0.00 | 0.29 | 0.11 | 0.30 | 0.00 | 0.09 |
| Share with minor reallocations after 2000 | 0.20 | 0.28 | 0.38 | 0.40 | 0.00 | 0.00 | 0.09 |
| **Land use certificates** | | | | | | | |
| No land certificate (%) | 31.93 | 30.94 | 39.78 | 29.73 | 28.57 | 27.92 | 34.03 |
| Certificate before 2000 (%) | 31.75 | 45.30 | 29.57 | 43.78 | 35.71 | 26.62 | 9.42 |
| Certificate after 2000 (%) | 16.10 | 2.21 | 6.99 | 18.92 | 10.20 | 18.83 | 39.27 |
| Certificate, date unknown (%) | 20.22 | 21.55 | 23.66 | 7.57 | 25.51 | 26.62 | 17.28 |
| No. of observations | 1,093 | 181 | 186 | 185 | 196 | 154 | 191 |

*Source:* Own computation from 2000/2010 panel household survey.

**Table 3: Descriptive statistics for agricultural production**

| | Total | Hebei | Shaanxi | Liaoning | Zhejiang | Sichuan | Hubei |
|---|---|---|---|---|---|---|---|
| | | | | **2000** | | | |
| Output (yuan) | 2550.05 | 3658.54 | 2366.68 | 3269.12 | 2142.68 | 1781.75 | 1848.72 |
| Yield (yuan/mu) | 368.97 | 373.03 | 352.663 | 287.50 | 409.17 | 430.13 | 386.45 |
| Profit & return to labor (Y/mu) | 196.44 | 197.64 | 206.69 | 101.60 | 211.21 | 275.75 | 208.61 |
| Owned land area (mu) | 8.47 | 13.69 | 7.94 | 11.73 | 5.24 | 4.76 | 6.11 |
| Cultivated land area (mu) | 9.12 | 14.77 | 8.09 | 12.62 | 6.85 | 4.88 | 6.25 |
| Total labor (manday/mu) | 47.03 | 28.81 | 48.07 | 24.07 | 32.44 | 81.94 | 71.68 |
| Family labor (manday/mu) | 46.77 | 28.77 | 47.75 | 23.58 | 32.02 | 81.87 | 71.51 |
| Hired labor (manday/mu) | 0.26 | 0.03 | 0.32 | 0.48 | 0.42 | 0.07 | 0.17 |
| Seed exp. (yuan/mu) | 20.70 | 13.42 | 16.70 | 33.80 | 18.79 | 17.69 | 21.94 |
| Fertilizer exp. (yuan/mu) | 77.29 | 75.01 | 66.26 | 59.61 | 78.36 | 94.43 | 95.41 |
| Other expenditure (yuan/mu) | 69.57 | 86.36 | 59.08 | 83.68 | 88.17 | 41.11 | 57.46 |
| Head's age | 45.02 | 45.00 | 45.39 | 45.58 | 47.62 | 42.43 | 44.05 |
| Male head | 0.98 | 0.98 | 0.94 | 0.99 | 0.98 | 0.97 | 0.99 |
| Household size | 4.13 | 4.12 | 4.35 | 3.64 | 4.14 | 4.27 | 4.30 |
| Population 14-60 years | 3.09 | 3.14 | 3.16 | 2.76 | 3.34 | 3.05 | 3.19 |
| Highest education (year) | 9.58 | 9.03 | 10.08 | 10.23 | 10.26 | 8.10 | 9.60 |
| Agricultural assets (yuan) | 1,084 | 2,043 | 796 | 1,419 | 618 | 760 | 737 |
| Non-agricultural assets (yuan) | 25,119 | 24,812 | 14,400 | 27,010 | 52,977 | 9,534 | 25,002 |
| Household w certificate (%) | 33.60 | 47.26 | 31.65 | 45.40 | 34.96 | 29.92 | 10.96 |
| Household date unknown (%) | 14.95 | 17.81 | 16.46 | 3.68 | 21.95 | 25.20 | 8.22 |
| Experienced reallocations (%) | 19.58 | 23.97 | 22.15 | 19.02 | 25.20 | 8.66 | 17.81 |
| | | | | **2008** | | | |
| Output (yuan) | 5588.29 | 8115.37 | 4427.23 | 8501.52 | 5061.67 | 3168.09 | 3614.18 |
| Yield (yuan/mu) | 775.04 | 828.79 | 688.02 | 787.32 | 1030.54 | 661.58 | 685.17 |
| Profit & return to labor (Y/mu) | 456.27 | 502.10 | 403.30 | 485.15 | 694.48 | 334.95 | 340.36 |
| Owned land area (mu) | 7.06 | 10.86 | 5.81 | 10.21 | 3.98 | 4.94 | 5.51 |
| Cultivated land area (mu) | 8.98 | 12.59 | 6.44 | 14.78 | 7.05 | 5.20 | 6.60 |
| Total labor (manday/mu) | 53.19 | 33.13 | 62.01 | 32.16 | 28.12 | 113.54 | 55.84 |
| Family labor (manday/mu) | 52.73 | 32.79 | 61.81 | 31.94 | 26.90 | 112.59 | 55.72 |
| Hired labor (manday/mu) | 0.47 | 0.34 | 0.19 | 0.22 | 1.22 | 0.95 | 0.12 |
| Seed exp. (yuan/mu) | 33.28 | 31.74 | 25.48 | 43.16 | 19.84 | 33.58 | 43.27 |
| Fertilizer exp. (yuan/mu) | 142.93 | 137.34 | 141.35 | 122.87 | 115.49 | 175.78 | 167.15 |
| Other expenditure (yuan/mu) | 120.41 | 145.34 | 107.73 | 124.58 | 120.37 | 96.52 | 125.33 |
| Head's age | 52.59 | 51.97 | 52.92 | 53.65 | 55.26 | 49.69 | 51.94 |
| Male head | 0.95 | 0.96 | 0.92 | 0.98 | 0.98 | 0.94 | 0.95 |
| Household size | 3.79 | 3.66 | 3.98 | 3.34 | 3.77 | 3.98 | 4.07 |
| Population 14-60 years | 2.84 | 2.80 | 3.01 | 2.46 | 2.83 | 2.91 | 3.03 |
| Highest education (year) | 9.84 | 9.21 | 10.22 | 10.01 | 10.24 | 9.00 | 10.29 |
| Agricultural assets (yuan) | 1,845 | 2,815 | 2,122 | 2,704 | 598 | 998 | 1,401 |
| Non-agricultural assets (yuan) | 70,683 | 44,319 | 40,718 | 58,072 | 199,150 | 39,138 | 62,763 |
| Household w certificate (%) | 66.86 | 67.81 | 56.33 | 69.94 | 69.92 | 72.44 | 66.44 |
| Experienced reallocations (%) | 12.98 | 2.74 | 13.92 | 19.02 | 14.63 | 8.66 | 17.81 |
| No. of observations | 863 | 146 | 158 | 163 | 123 | 127 | 146 |

*Source:* Own computation from 2000/2010 panel household survey.
*Note:* Monetary values for 2008 are deflated by CPIs from NBSC.

**Table 4: Regressions for households moving off the farm and the labor supplied to off-farm activities**

| | Exit from agriculture | No. of individuals employed in | | | Days worked in | | |
|---|---|---|---|---|---|---|---|
| | | off farm | ..migrating | …local | off farm | ..migrating | …local |
| Own land area per capita | -0.002 | 0.002 | -0.013 | 0.020 | 2.000 | -3.578 | 3.896 |
| | (0.014) | (0.018) | (0.012) | (0.018) | (4.034) | (3.378) | (3.466) |
| Head's age | -0.002 | -0.019** | -0.011 | -0.008 | -3.871** | -1.549 | -2.601 |
| | (0.002) | (0.007) | (0.007) | (0.008) | (1.817) | (1.806) | (1.495) |
| Male head | 0.026 | 0.066 | 0.163 | -0.210 | -34.696 | -6.035 | -50.548 |
| | (0.067) | (0.174) | (0.157) | (0.135) | (52.024) | (41.018) | (36.102) |
| Highest education | -0.003 | 0.030*** | 0.023*** | 0.008 | 9.168*** | 7.192*** | 3.774** |
| | (0.003) | (0.009) | (0.008) | (0.008) | (2.486) | (2.046) | (1.925) |
| Population <14 years | -0.030** | -0.057 | -0.109*** | 0.066** | 6.005 | -31.676*** | 25.687*** |
| | (0.013) | (0.037) | (0.036) | (0.033) | (11.129) | (8.896) | (8.849) |
| Population 14-60 years | -0.003 | 0.481*** | 0.304*** | 0.199*** | 122.050*** | 57.006*** | 55.826*** |
| | (0.010) | (0.032) | (0.032) | (0.029) | (9.581) | (7.301) | (7.930) |
| Population >60 years | -0.005 | 0.113* | 0.055 | 0.071 | 43.073** | 7.100 | 32.510** |
| | (0.022) | (0.063) | (0.052) | (0.055) | (17.187) | (12.407) | (14.420) |
| Value of assets ('000 yuan) | 0.000 | -0.000 | -0.001*** | 0.000*** | -0.037 | -0.214*** | 0.063* |
| | (0.000) | (0.000) | (0.000) | (0.000) | (0.037) | (0.065) | (0.035) |
| Share of certificates | -0.011 | 0.631*** | 0.356** | 0.143 | 85.768* | 98.967*** | -7.897 |
| (village level) | (0.053) | (0.151) | (0.139) | (0.158) | (45.823) | (36.925) | (41.625) |
| Land reallocation | -0.049** | -0.026 | -0.061 | 0.016 | -14.385 | -2.641 | -8.932 |
| | (0.019) | (0.075) | (0.062) | (0.067) | (21.040) | (17.183) | (17.034) |
| Year 2008 | 0.132*** | 0.295*** | 0.449*** | -0.106 | 126.195*** | 82.731*** | 23.120 |
| | (0.035) | (0.082) | (0.101) | (0.076) | (19.737) | (19.290) | (16.285) |
| Shaanxi | -0.033 | -0.031 | 0.626*** | -0.419*** | 10.926 | 119.372*** | -119.33*** |
| | (0.021) | (0.077) | (0.134) | (0.048) | (20.883) | (17.705) | (18.919) |
| Liaoning | -0.040* | -0.128 | 0.168 | -0.192*** | 27.900 | 31.446 | -12.861 |
| | (0.021) | (0.082) | (0.111) | (0.060) | (22.829) | (19.215) | (19.493) |
| Zhejiang | 0.027 | 0.336*** | 0.481*** | 0.060 | 115.238*** | 75.447*** | 37.937* |
| | (0.032) | (0.091) | (0.138) | (0.068) | (23.416) | (19.781) | (19.694) |
| Sichuan | -0.026 | -0.205*** | 0.489*** | -0.454*** | -8.917 | 107.934*** | -116.80*** |
| | (0.024) | (0.077) | (0.135) | (0.048) | (22.337) | (18.434) | (20.905) |
| Hubei | 0.039 | 0.258*** | 0.652*** | -0.193*** | 86.594*** | 120.930*** | -38.292* |
| | (0.031) | (0.089) | (0.142) | (0.062) | (22.198) | (18.872) | (20.172) |
| Observations | 2,186 | 2,186 | 2,186 | 2,186 | | | |
| Wald chi$^2$ | 227.31 | 1373.52 | 809.35 | 522.17 | | | |
| Pseudo R$^2$ | | | | | 0.037 | 0.039 | |
| R$^2$ | 0.128 | 0.405 | 0.306 | 0.203 | 0.339 | 0.218 | 0.204 |

*Note:* R$^2$ is calculated based on the correlation coefficient between predicted and observed values (see Egger *et al.* 2011).

**Table 5: Determinants of agricultural productivity**

| | Output (log) | |
|---|---|---|
| Cultivated land area (log) | 0.708*** | 0.679*** |
| | (0.118) | (0.115) |
| Total labor (log) | -0.043 | |
| | (0.047) | |
| Family labor (log) | | -0.028 |
| | | (0.046) |
| Hired labor (log) | | 0.013 |
| | | (0.099) |
| Highest education (log) | 0.043 | 0.015 |
| | (0.130) | (0.129) |
| Value of agricultural assets (log) | 0.025 | 0.022 |
| | (0.020) | (0.020) |
| Expenditure on seeds (log) | 0.038 | 0.036 |
| | (0.041) | (0.041) |
| Expenditure on fertilizer (log) | 0.158** | 0.144** |
| | (0.061) | (0.061) |
| Other expenditure (log) | 0.157*** | 0.158*** |
| | (0.050) | (0.048) |
| Land certificates before 2000 ($\delta_1$) | 0.315*** | 0.333*** |
| | (0.103) | (0.102) |
| Land certificates after 2000 ($\delta_2$) | 0.295** | 0.272* |
| | (0.148) | (0.139) |
| Land reallocations before 2000 ($\delta_3$) | -0.052 | -0.021 |
| | (0.105) | (0.110) |
| Land reallocations after 2000 ($\delta_4$) | -0.304** | -0.298** |
| | (0.127) | (0.128) |
| Shaanxi | -0.297** | -0.296* |
| | (0.143) | (0.151) |
| Liaoning | -0.100 | -0.101 |
| | (0.159) | (0.171) |
| Zhejiang | -0.421*** | -0.465*** |
| | (0.160) | (0.164) |
| Sichuan | -0.789*** | -0.841*** |
| | (0.144) | (0.148) |
| Hubei | -0.250 | -0.232 |
| | (0.164) | (0.169) |
| Constant | 0.637*** | 0.635*** |
| | (0.116) | (0.118) |
| Observation | 863 | 863 |
| $R^2$ | 0.378 | 0.386 |
| **Tests:** | | |
| $\delta_1 = \delta_2$ | 0.02 | 0.18 |
| $\delta_3 + \delta_4 = 0$ | 3.83* | 3.03* |

**Appendix table 1: Test for parallel trends between 1990/95 and 2000**

| | Total | Received certificates in 2000-08 | | | Affected by reallocations 2000-08 | | |
|---|---|---|---|---|---|---|---|
| | | No | Yes | t-test | No | Yes | t-test |
| **Levels in 2000** | | | | | | | |
| No. of working individuals | 3.78 | 3.81 | 3.65 | | 3.79 | 3.72 | |
| Share in agric. full time | 0.48 | 0.47 | 0.51 | | 0.48 | 0.42 | |
| Share in agric. part time | 0.28 | 0.28 | 0.28 | | 0.28 | 0.29 | |
| Share of migrants | 0.14 | 0.14 | 0.14 | | 0.13 | 0.17 | |
| Share outside of agriculture | 0.25 | 0.25 | 0.21 | | 0.24 | 0.29 | |
| **Changes between 1990 and 2000** | | | | | | | |
| No. of working individuals | 0.90 | 0.94 | 0.74 | | 0.89 | 0.97 | |
| Share in agric. full time | -0.23 | -0.24 | -0.20 | | -0.24 | -0.19 | |
| Share in agric. part time | 0.09 | 0.10 | 0.06 | | 0.10 | 0.03 | |
| Share of migrants | 0.10 | 0.10 | 0.11 | | 0.09 | 0.11 | |
| Share outside of agriculture | 0.14 | 0.14 | 0.14 | | 0.14 | 0.15 | |
| **Growth rates between 1990 and 2000** | | | | | | | |
| No. of working individuals | 0.03 | 0.03 | 0.02 | | 0.03 | 0.03 | |
| Share in agric. full time | -0.21 | -0.24 | -0.10 | | -0.22 | -0.20 | |
| Share in agric. part time | 0.66 | 0.66 | 0.64 | | 0.68 | 0.50 | |
| Share of migrants | 0.83 | 0.84 | 0.77 | | 0.83 | 0.77 | |
| Share outside of agriculture | 0.95 | 0.94 | 1.00 | | 0.96 | 0.84 | |
| **Changes between 1995 and 2000** | | | | | | | |
| No. of working individuals | 0.49 | 0.51 | 0.40 | | 0.47 | 0.61 | |
| Share in agric. full time | -0.14 | -0.15 | -0.12 | | -0.15 | -0.13 | |
| Share in agric. part time | 0.06 | 0.05 | 0.07 | | 0.06 | 0.03 | |
| Share of migrants | 0.06 | 0.06 | 0.07 | | 0.06 | 0.07 | |
| Share outside of agriculture | 0.09 | 0.10 | 0.05 | | 0.09 | 0.10 | |
| **Growth rates between 1995 and 2000** | | | | | | | |
| No. of working individuals | 0.03 | 0.03 | 0.03 | | 0.03 | 0.04 | |
| Share in agric. full time | -0.38 | -0.42 | -0.18 | | -0.35 | -0.54 | |
| Share in agric. part time | 0.83 | 0.81 | 0.88 | | 0.86 | 0.57 | |
| Share of migrants | 1.13 | 1.14 | 1.08 | | 1.15 | 1.02 | |
| Share outside of agriculture | 1.31 | 1.35 | 1.12 | | 1.31 | 1.29 | |
| No. of observations | 517 | 431 | 86 | | 450 | 67 | |

*Source:* Own computation from 2000/2010 panel household survey.

**Appendix table 2: Comparison of initial conditions for households receiving certificates/affected by redistribution in 2000-08**

| | Total | Received certificates in 2000-08 | | | Affected by reallocations 2000-08 | | |
|---|---|---|---|---|---|---|---|
| | | No | Yes | t-test | No | Yes | t-test |
| **Household demographics** | | | | | | | |
| Male head | 0.98 | 0.97 | 0.99 | | 0.97 | 0.99 | |
| Household size | 4.12 | 4.12 | 4.13 | | 4.11 | 4.21 | |
| Population <14 years | 0.71 | 0.70 | 0.73 | | 0.71 | 0.69 | |
| Population 14-60 years | 3.09 | 3.11 | 3.04 | | 3.08 | 3.21 | |
| Population >60 years | 0.33 | 0.32 | 0.35 | | 0.33 | 0.31 | |
| Dependency ratio | 0.24 | 0.24 | 0.26 | | 0.25 | 0.22 | |
| Highest education (year) | 9.58 | 9.52 | 9.89 | | 9.47 | 10.35 | ** |
| **Labor supply & income sources** | | | | | | | |
| Total labor supply (days) | 526 | 530 | 506 | | 523 | 545 | |
| Days worked per adult | 170 | 171 | 169 | | 171 | 168 | |
| ... in agriculture (%) | 56.2 | 56.1 | 56.4 | | 56.7 | 52.6 | |
| ... in migration (%) | 16.4 | 16.2 | 17.2 | | 16.0 | 18.6 | |
| ... in local off-farm (%) | 27.5 | 27.7 | 26.4 | | 27.3 | 28.8 | |
| Income per adult eq. | 2,080 | 2,078 | 2,091 | | 2,006 | 2,578 | *** |
| Total income (yuan) | 7,581 | 7,606 | 7,471 | | 7,263 | 9,714 | *** |
| … from agriculture (%) | 51.4 | 52.2 | 47.8 | | 51.6 | 50.4 | |
| … from migration (%) | 19.4 | 18.8 | 21.7 | | 19.1 | 20.9 | |
| … from local off-farm (%) | 29.2 | 28.9 | 30.5 | | 29.3 | 28.7 | |
| Number of off-farm individuals | 1.34 | 1.34 | 1.32 | | 1.32 | 1.44 | |
| Share of off-farm individuals | 0.39 | 0.39 | 0.39 | | 0.38 | 0.41 | |
| Number of migrants | 0.46 | 0.45 | 0.49 | | 0.44 | 0.54 | |
| Share of migrants | 0.12 | 0.12 | 0.13 | | 0.12 | 0.13 | |
| Number of individuals in local off-farm | 0.88 | 0.90 | 0.82 | | 0.88 | 0.90 | |
| Share of individuals in local off-farm | 0.27 | 0.27 | 0.26 | | 0.26 | 0.28 | |
| **Endowments and productive activity** | | | | | | | |
| Owned land area (mu) | 8.46 | 8.63 | 7.71 | | 8.51 | 8.13 | |
| Cultivated land area (mu) | 9.12 | 9.34 | 8.13 | | 9.22 | 8.43 | |
| Assets (yuan) | 26,203 | 26,823 | 23,435 | | 24,536 | 37,379 | *** |
| … of which agricultural (%) | 0.10 | 0.10 | 0.09 | | 0.10 | 0.09 | |
| No. of observations | 863 | 705 | 158 | | 751 | 112 | |

*Source:* Own computation from 2000/2010 panel household survey.

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