# Household-level impacts of property rights reform in peri-urban China: Evidence from the Chengdu National Experiment

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*Selected Paper prepared for presentation at the 2015 Agricultural & Applied Economics Association and Western Agricultural Economics Association Annual Meeting, San Francisco, CA, July 26-28*

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***Abstract:*** As part of a national experiment, Chengdu prefecture implemented, in 2008, ambitious property rights reforms including complete registration of all land, easier transferability, and elimination of migration restrictions. A triple difference approach using the Statistics Bureau's regular household panel suggests reforms increased consumption and income, especially for less wealthy and less educated households, with estimated benefits well above the cost of implementation. Local labor supply increased with the young shifting towards agriculture and the old towards off-farm employment. Agricultural yields, intensity of input use, and diversity of output also increased. Improving property rights in peri-urban China appears to have increased investment and diversification.

## 1. Motivation and background

Between 2000 and 2010, urban land use in China expanded enormously at rates that are among the highest in East Asia. Institutional arrangements, in particular the fact that local governments are able to generate enormous revenue by expropriating land cheaply from farmers and selling it to developers at prices that are many orders of magnitude higher are one of the main factors underlying this phenomenon. The fact that land was often not used productively has been a source of bad loans, rural unrest and, in light of China's limited endowment of fertile agricultural land, is also viewed as affecting food security.

Cognizant of the challenges faced by this situation, a number of national experiments were conducted to explore the scope for alternative and potentially more sustainable arrangements. But to bring about change, simultaneous action in a number of areas is needed. Chengdu's 2008 effort at rural-urban integration is particularly relevant as it involved systematic verification of all types of land assets, relaxation of the restrictions imposed by the *hukou* system of urban residency permits, and measures to improve land market functioning. This would be expected to create jobs and enhance economic performance via higher investment due to higher tenure security and greater allocative efficiency, particularly for land and labor, due to market-based reallocation. At the same time, there is concern that far-reaching reforms in this area would be overly costly, give rise to disputes, or socially undesirable land transfers and migration. With concerns about land issues undermining the scope for future economic growth and property rights having been explicitly identified as a priority area for reform by China's leadership, assessing the impacts of past measures will be important to inform future policy and potentially design of specific experiments. Yet, beyond anecdotal accounts, there is no rigorous quantitative assessment to assess either the magnitude of associated impacts or their incidence among different types of households.

To provide such an assessment, we use the fact that the reform was only implemented in Chengdu prefecture, leaving neighboring counties unaffected. Panel data from NBS' regular rural household survey

for counties on both sides of the prefecture boundary to assess reform impacts on household consumption and income, labor supply, incidence of land rental, crop choice, and productivity of agricultural land use. This allows us to use a triple difference strategy focusing on changes within the same household before and after the reform and inside vs. outside the boundary for identification. We note that these counties followed similar trends pre-intervention and control for a range of time variant factors including public programs such as subsidy, pension, or medical schemes.

Results suggest that about 3-4 years after it was completed, property rights reforms had led to significant consumption growth, especially for households with lower initial endowments of education and assets. The magnitude of estimated annual consumption benefits is well in excess of the cost of the entire intervention. We also find gender- and age-differentiated effects on labor supply with the young supplying more hours to agriculture, the old increased off-farm labor supply, and some gender-specific differences. A key reason for this shift seems to be an increase in yields and profits from agriculture that goes together with an increased diversification of output towards higher value crops.

The paper is structured as follows. Section two provides context, discusses some of the salient features of the Chengdu experiment, and introduces analytical methodology and data sources. Section three presents descriptive statistics from the household survey as well the nature and cost of the land certification process in Chengdu. Section four discusses impacts on household welfare, individual labor supply, and agricultural productivity and crop composition. Section five concludes with implications for policy and future research.

## 2. Motivation and background

In line with the incentives provided by the current legal and institutional framework, rapid rural-urban land conversion poses considerable challenges for China's development. While piecemeal reform efforts have not yielded the desired results, Chengdu prefecture has followed a more integrated approach that could hold considerable lessons and we show how this can be evaluated using existing household level panel data and a regression discontinuity design.

### 2.1 The challenges of rural-urban land conversion in China

In the 2000-2010 period, the size of urban areas in China expanded enormously: use of satellite imagery to define 'urban' consistently across countries reveals that, with an average annual area expansion of 9.8% for Hangzhou 8.1% for Shanghai, 6.1% for Chongqing, 5.9% for Chengdu, 4.5% for the Pearl River Delta and 4.0%, for Beijing, most Chinese cities expanded at a rate well in excess of the East Asian average of 2.8% (World Bank 2014).[1]Most experts agree that such high rates of urban expansion are not conducive

[1] The average is for urban areas in East Asia with more than 5 million inhabitants in 2010 (World_Bank and DRC 2014).

to effective and sustainable land use. They can largely be attributed to structural factors, most importantly the fact that, as rural land is owned by village collectives and not tradable, conversion of land from agricultural to non-agricultural use is possible only via acquisition by local governments. Farmers receive compensation for agricultural land based on the value of land for agricultural production.[2] But land thus acquired can then be transferred by local government at prices often more than hundred times what was paid in compensation. Associated quantitates can be large and give rise to considerable distortions.[3]

Revenue from land acquisition has thus provided an enormous implicit subsidy to industry, in addition to becoming a mainstay of urban local government finance to provide infrastructure and services. The fact that land lease fees accounted for an average of 60% of local budgetary revenues in 2003/04 (Su *et al.* 2013), a figure that has risen further since.[4] Fiscal decentralization has made these effects more pronounced (Qun *et al.* 2015) as it reduced the revenue sources for local governments and led them become accustomed of taking advantage of the arbitrage possibilities generated by those discrepancies between urban land values and the cost of compensation for acquired land (Ding and Lichtenberg 2011). Indeed, after municipal governments established direct control of the supply of urban land, the market for residential land became less efficient (Peng and Thibodeau 2012).

This pattern of land development has several negative consequences. First, supplying land well below its real value leads to inefficient use of a valuable and finite resource; in fact a nation-wide survey in 2003 suggests 70% of land in China's Development zones was unused (Du and Peiser 2014). Second, expropriation without what is perceived to be fair compensation contributes to rural unrest (Nitikin *et al.* 2012).[5]Third, it undermines security of property rights and investment and, with land acquisitions focused on industrial uses to promote GDP growth, affects affordability of housing for most of the population. Price to rent ratios in major Chinese cities increased dramatically: in Beijing, real constant quality values for residential land increased by nearly 800% since 2003 with half of the increase having occurred during the 2008-10 period (Wu *et al.* 2012). Fourth, in light of the finite amount of land available, such use of land revenue to finance local governments is unsustainable and can precipitate major crises; in fact there is evidence of significant, though ultimately unsustainable, levels of collateralization of 'land banks',

[2] To avoid having to pay compensation for housing sites and relocate those whose villages are being incorporated into urban areas, local governments often left these intact. This has led to the spread of 'urban villages', i.e. unplanned and relatively run-down neighborhoods that often provide shelter for migrants tend exert negative externalities on prices for neighboring properties (Song and Zenou 2009).

[3] Urban housing becomes unaffordable for migrants, and informal markets or uncontrolled developments take over (140-150 mn migrants are estimated to live in some 50,000 urban villages). At the same time, rural residential land expands (empty villages) as it is non-tradable and migration remains temporary. In peri-urban areas fear of conversion may limit long-term investment and undermine agricultural productivity. In one town in Jiangxi province, it was estimated that about 33% more than required was converted, imposing not only large losses on farmers but leading to a significant reduction in social welfare (Tan *et al.* 2011).

[4] Total construction land in 2005 was estimated at about 17 million ha, about 64% of which in rural areas. A number of innovative, though not entirely legal models whereby villages brought this land directly to the market and reaping large profits from doing so (Su *et al.* 2013).

[5] It is estimated that, during the 1987-2001 period alone, 40-50 million farmers lost half or more of their land to expropriation and that only about half of them obtained an urban residence permit (*hukou*) providing access to social services and education for their children (Tao and Xu 2007).

accumulation of bad debts and 'land hoarding' by local governments (Du and Peiser 2014).[6]Finally, high rates of conversion of what is often prime agricultural land will lead to often irreversible reductions of the country's agricultural production potential, with potential implications for food security.

With land acquisition having become a focal point for legal disputes and rural unrest(Whiting 2011), efforts to find solutions focused on two aspects. First, there have been calls to increase compensation paid to farmers and to make auctions rather than negotiation mandatory for any land allocation to industrial use. But determining an 'appropriate' level of compensation in a very dynamic land market is difficult. More importantly, local governments will still compete to attract industrial investment; in fact, auctions are shown to be easily manipulated, so that even their systematic use did not stop corruption (Cai *et al.* 2013). While these problems would be eliminated if direct rural-urban land transfers were allowed, few rural residents would be willing to give up their land unless an equivalent social safety net and source of income in old age will be available to them (Ong 2014). Also, exclusively transferring the gains in land value that can be realized by changing from rural to urban land use to private individuals seems not only unfair but would also leave local governments without the means to provide infrastructure or social services. A tax on land or capital gains could help to do so but is not viable without institutional preconditions, in particular a proper cadastral database, being in place (Nitikin *et al.* 2012).

Most observers agree that viable reform would need to include a number of elements, namely (i) registration of all rural land; (ii) a possibility for migrants to get an urban *hukou* that provides access to social services, possibly on the condition that they give their rural land rights; (iii) allowing rural collectives or individuals to enter into direct land transactions at freely negotiated prices, subject to compliance with planning standards; and (vi) taxation of land so as to generate the revenue to support urban welfare packages while also contributing to more efficient land use (Tao and Xu 2007). Experiments, including integration of state construction and collective land markets in Shenzhen, land security development in Chongqing, urban fringe redevelopment in Beijing, land readjustment in Meitan, and rural-urban integration in Chengdu aimed to put in place a more comprehensive package of reforms(World_Bank and DRC 2014). Systematic evaluation of the impact on household welfare will be essential to draw lessons on the potential nature and direction of future policy and reforms.

### 2.2 The Chengdu experiment

Chengdu prefecture includes 20 counties/districts with a total area of 12,000 $km^2$ and a population of 11 million, of which 5 million are rural residents. In 2008, it was named as pilot area for the comprehensive

[6]A combination of legal and institutional issues (including cadres' incentives), restrictions imposed by the *hukou* system, and limited tolerance for informal developments have been identified as some of the root causes for land having emerged as a key policy issue (Wong 2014) and where local governments essentially see land as state owned and rely on land transfers or real estate development as indispensable source of revenue and security for financing by local governments creates serious dangers (Pan *et al.* 2015).

reform under a Commission for Balanced Urban-Rural Growth (CBRUG). Three key changes were introduced(Li 2012). First, a participatory effort to title all land -including agricultural, construction, forest, and waste land- and to establish a registration system was implemented under the authority of administrative villages. The purpose was to establish clear and secure property rights as a basis for long-term contracts for agricultural or construction land.[7] Second, the Chengdu Rural Property Rights Exchange was established as a platform for transactions of all types of rural property rights, including construction land quotas for these to become more market oriented and transparent and to allow farmers and collectives to take the initiative in auctioning construction land quotas through competitive bidding and the role of Government to shift to that of a regulator and supervisor. Introduction of tradable development rights allows voluntary market-driven access to land for non-agricultural purposes in ways that can benefit local communities.[8] Third, to encourage migration, *hukou* restrictions were eliminated and regulations to allow easier transfers of rural construction land were passed. At least in principle, this would allow migrants to use the land in their place of origin to finance start-up of small enterprises in urban areas, and not to worry about losing their land while they are away from home for a longer period of time.

The experiment attracted considerable attention by policy makers, scholars and the media. Case studies are suggestive of positive reform effects in terms of (i) higher levels of investment in high-value perennials and vegetables due to a reduced threat of expropriations and reallocations and confidence in the stability of land ownership triggered by award of formal documents;[9] (ii) increased volume of land transactions for agricultural and construction land that are likely to enhance efficiency and an incipient markets for secondary transactions and land conversion;[10] and (iii) job creation in agriculture and other industries and higher wages or incomes as gains from reforms are shared more broadly throughout the local economy. But, although potentially very valuable, such anecdotal evidence if often based on a non-representative sample, lacks a clear counterfactual, and does not allow quantification of benefits in a way that can be compared to the cost of the intervention. To provide these and, in doing so, draw out the implications of the experiment in a more systematic manner, more systematic survey evidence is needed.

[7] Titles to homesteads were given on occupied land, although household plot size frequently exceeded the legal standard and the area documented on past certificates. Together with close consultation within the village, this helped to minimize disputes over homestead land. Use rights to other collectively owned construction land, such as rural enterprises, public interest, and land for other purposes, were documented as well.

[8] A fund to strengthen protection of farmland, replenished from fees from transfers of land use rights and charges on newly developed construction land, is used to cover farmers' contribution to old-age pension insurance and to provide subsidies for land protection. The mean quota price is reported to be around Y 300,000 per mu (up from Y 170,000 3 years ago) and many rural communities seem to use these resources to construct central housing with better access to services.

[9] This allows households to participate in rental without sending a signal that they do not need the land and make them subject to reallocation.

[10] Market-based practices for transferring collectively owned construction land for urban business purposes have also entered a pilot stage. In 2008, Jingjiang District listed the use rights to two parcels of collectively owned construction land for public bidding. Villages entrusted the development and management rights of the collective construction land to a platform company which consolidated the land, carried out its primary development, and listed it for bidding. 40-year use rights to the collective construction land were sold at RMB 800,000 per mu with proceeds distributed among villagers. Many similar cases followed (World_Bank and DRC 2014).

### 2.3 Analytical approach and data sources

To assess household-level effects of Chengdu's property rights reform on household welfare, time use, inputs into and productivity of agricultural production, we use a modified regression discontinuity design and distinguish between counties that are located just inside the border who were affected by the reform and those just outside the border who therefore were not. We use panel data from the National Bureau of Statistics' regular household survey in 7 counties adjacent to the border of Chengdu prefecture (3 counties inside and 4 outside of the boundary),[11]as illustrated in figure 1.

Ideally, we would have liked a sample to include data from the same households before and after the reform to control for time-invariant unobserved characteristics. While NBS' 2011 change of sample households makes this impossible, access to two panel data sets, each with multiple observations per household before and after the reform, still allows us to control for time-invariant household characteristics.[12] This implies that we can use a triple-difference approach that focuses on changes between the first and second panel period for the same households between treated and non-treated households in pre- and post-reform periods.

Given the involvement of supervisors resident in the sample villages and the use of very detailed logbooks to record consumption on a daily basis (Chen and Ravallion 1996), NBS data on consumption are generally considered to be of exceptionally high quality (Jalan and Ravallion 1999). Beyond information on consumption, the survey includes (less precise) information on income and individual members' supply of labor to farm or off-farm activities, migration, income from different sources, and an account of agricultural output and inputs. We also have data on key village characteristics including GPS coordinates of facilities, total population, land area used in agriculture, and access to public services such as education and health which we can use to control for time-varying effects at village level.

With 9-13 villages per county and 10 households per village, the pre-reform sample comprises 310 and 470 households inside and outside Chengdu, respectively.[13] The post-reform sample similarly includes 280 and 390 households inside and outside the prefecture boundary. After dropping some 5% of sample households who did not engage in productive activities or participate in the labor market due to old age or disability, we end up with a sample of 285pre- and 259 post-reform households inside Chengdu and 453 and 382 households in neighboring counties (Meishan and Ziyang) in the pre-and post-reform sample, respectively.

[11] The NBS sample is drawn from a fixed set of counties. We compare outcomes of NBS households in counties from both sides of the Chengdu prefecture border with three counties in Chengdu and four counties in Meishan and Ziyang.
[12] We use the years of 2005 and 2006 for the pre-reform and of 2011 and 2012 for the post-reform period. To avoid contamination as land reform was planned and implemented mainly between 2007 and 2009 and maintain a balanced sample from before and after reform implementation.
[13] The number of selected villages was 9 for Jintang of Chengdu, 10 for Shuangliu of Chengdu, 12 for Qionglai of Chengdu, 13 for Dongpo of Meishan, 12 for Renshou of Meishan, 10 for Lezhi of Ziyang, and 12 for Jianyang of Ziyang.

Using a triple-difference approach, reform effects are identified based on difference between (i) years one and two within the same household; (ii) pre- and post-reform periods; and (iii) treated and non-treated households. The basic equation of interest can be written as

$$Y_{ijt} = \alpha + \beta_1 R_{ijt} + \beta_2 C_{ij} R_{ijt} + \beta_3 T_{ijt} + \beta_4 C_{ij} T_{ijt} + \beta_5 R_{ijt} T_{ijt} + \beta_6 C_{ij} R_{ijjt} T_{ijt} + \beta_7 X_{ijt} + \beta_8 V_{ijt} + \delta_{ij} + \varepsilon_{ijt} \quad (1)$$

where $Y_{ijt}$ is the outcome of interest for household $I$ in village $j$ in year $t$;[14] $X_{ijt}$ is a vector of time-varying household characteristics including the number of children, adults and old people, highest education, the head's gender and age, and the amount of crop subsidies received; $V_{ijt}$ is a vector of time-varying village characteristics including total population, land area used for agriculture, distances to educational, health, and administrative institutions; $\delta_{ij}$ is a household fixed effect, $\varepsilon_{ijt}$ is an error term; $R_{ijt}$ is a binary indicator taking a value of 1 if the observation is post-reform (2011/12) and 0 otherwise; $C_{ij}$ is an indicator that is 1 for households within Chengdu prefecture and 0 otherwise; $T_{ijt}$ is an indicator variable for the second year of each panel; and $\beta$ is a vector of parameters to be estimated with our main interest in $\beta_6$, the estimated mean impact of the reform.

We take first differences to remove time-invariant household characteristics to yield

$$\Delta Y_{ijt} = \beta_3 + \beta_4 C_{ij} + \beta_5 R_{ijt} + \beta_6 C_{ij} R_{ijt} + \beta_7 \Delta X_{ijt} + \beta_8 \Delta V_{ijt} + \Delta \varepsilon_{ijt} \quad (2),$$

the main estimating equation. To explore if effects vary with households' endowment of human capital and physical assets, we augment this equation by adding interaction terms between initial endowment and reform-related indicator variables. We estimate:

$$\Delta Y_{ijt} = \gamma_1 + \gamma_2 C_{ij} + \gamma_3 R_{ijt} + \gamma_4 E_{ijt-1} + \gamma_5 C_{ij} R_{ijt} + \gamma_6 E_{ijt-1} R_{ijt} + \gamma_7 C_{ij} E_{ijt-1} + \gamma_8 C_{ij} E_{ijt-1} R_{ijt} + \gamma_9 \Delta X_{ijt} + \gamma_{10} \Delta V_{ijt} + \Delta \varepsilon_{ijt} \quad (3)$$

where $E_{ijt\text{-}1}$ denotes either an indicator variable that is one if the highest level of education for a family in the initial period is above the compulsory level of junior high school, or the standardized value of physical assets and the $\gamma$s are parameters to be estimated and the main parameters of interest are the mean reform effect, $\gamma_5$, and its variation with pre-existing endowments, $\gamma_8$.

An econometric challenge to our identification is that the relatively limited number of clusters in our sample may lead to downward-bias of the variance matrix. To address this, we follow the literature (Cameron and Miller 2015) and report p-values from wild cluster bootstrap consistently for coefficients of interest ($\beta_6$ and $\gamma_8$) and take this into account in interpreting results.

[14] In some of our regressions, outcomes are at the individual rather than the household level. We do not include another subscript to avoid clutter.

The validity of our identification strategy hinges on two assumptions. First, we need to control for other observables, including interventions that may have been implemented differentially across treatment and control areas to avoid mistakenly attributing changes in outcome variables to property rights reform rather than other factors. Second, we need to ascertain there are no pre-existing time varying unobservables between treatment and control.

Regarding the first issue, key interventions in place during the period of concern are agricultural subsidies (Huang *et al.* 2011; Meng 2012). While these are funded centrally, disbursements may vary by prefecture and we include information on the amounts received by the household, in addition for a wide range of household-level observables, in our regressions.

Second, treatment and control areas may already have followed different growth trajectories before reforms. The standard way to check whether may have been the case is to test for 'parallel trends'. As discussed in more detail below, we cannot reject the hypothesis of no significant difference in pre-reform trends for overall household welfare and the share of income derived from agriculture non-farm employment, migration, and local wages and, with one exception, individuals' time use, and agricultural yields and profits. Significant pre-reform trends between households within and outside Chengdu prefecture exist, however, with respect to use of agricultural inputs and crop choice. They point towards marked declines in agricultural assets (-18% in Chengdu vs. +35% in villages outside the prefecture boundary) and use of agricultural inputs such as fertilizer (-60% vs. -4%) and pesticides (-24% vs. +9%). Output shares of wheat and other grains increased and those form oil crops decreased in Chengdu while the opposite was observed in neighboring villages.

## 3. Descriptive statistics and nature of reforms

While descriptive analysis points towards differences in terms of income, time use, and agricultural yields between counties inside and outside Chengdu, there are no statistically significant differences in pre-reform trends except agricultural production which declined more rapidly within as compared to outside Chengdu. Reform was implemented swiftly, with strong participation, few disputes, and at reasonable cost. Coverage was almost complete, allowing issuance of long-term or permanent contracts for most of the land.

### 3.1 Descriptive statistics

Table 1 reports descriptive statistics on household characteristics, welfare, agricultural production, and time use for the pre- and post-reform periods inside and outside of Chengdu as well as estimated pre-reform trends and a test of their significance. We note that households in the treatment and control are comparable with respect to basic characteristics: they comprise 3-4 adults, had a head born in the late

1950s, education between junior high and high school, some 8% of female heads. At the same time, three sets of differences emerge. First, households in Chengdu had higher levels of assets, income, and consumption (Y16,063 to Y40,025, Y4,928 to Y8,549, and Y3,150 to Y6,078, respectively, between pre- and post-reform period) than those outside (Y11,564 to Y29,752, Y3,770 to Y8,069, and Y2,668 to Y4,997). They also allocated labor differently across sectors, presumably due to proximity to urban income earning opportunities: with a time commitment of 43% and 50% in 2005/06, farming was the most important activity for households inside and outside Chengdu, followed by migration (18% and 23%, respectively, and local off-farm employment (14% and 10%). But the last column indicates that pre-reform trends are not significantly different between the two, supporting our identification strategy.

Second, with respect to agricultural production, households in Chengdu prefecture cultivated smaller areas (3.45 vs. 4.79 mu for those outside in 2005/06) but spent more on inputs than those outside (474 vs. 297 Y/mu) and obtained higher levels of yield (1,880 vs. 1,254 Y/mu) and net revenues (1,406 vs. 957 Y/mu). At the same time, pre-reform trends suggest a strongly declining trend in most of these variables inside as compared to outside Chengdu. Finally, a glance at the changes between pre-and post-reform period for those in the treatment and control suggests that reform may indeed have had a positive impact in a number of dimensions. But proper econometric analysis that controls for other factors is needed to see whether such cursory evidence is substantiated by the data.

### 3.2 Nature and cost of the certification process

To quantify costs of the reform, we use data from a village-level survey administered by DRC in May 2014to villages on either side of comparable stretches of the administrative border of Chengdu prefecture that includes the three Chengdu counties in the NBS sample used for our analysis (Deininger *et al.* 2015).

A detailed description of the size of different types of land and characteristics of the certification process for each of them is provided in table 2. The average village has an area of about 6,000 mu (4 $km^2$) of which some 62% were arable land, 28% forest, and close to 5% construction and residential land. Certificates for collective construction land were issued to the village whereas those for contracted arable and forest land and residential land and actual structures were awarded to households.

Regarding reform implementation, we note that in more than 85% of cases, rules were made at the village level, by either the assembly (48%), economic organizations (23%), representatives (14%) or leaders (1%). Organization came more often from above (47% of township or above; 26% village leaders), and actual measurement was done by village representatives in 55% of cases.

In about 55% of villages, land registration gave rise to disputes, with an average of 14.9 disputes per village. Conflict was most pervasive for arable and forest land (which attracted conflict in 50% and 35%

of villages with 9.4 and 8.8 disputes, respectively) and least frequent with regard to collective and construction land (18.7% and 22.6% of villages with a mean of some 6 disputes). Even where conflict emerged, most of the cases encountered were resolved by village institutions: in villages with conflict, a total of 1.2 cases required intervention by institutions above the village.

After certification, contracts with a length exceeding 30 years were issued for all construction land and more than 95% of all other land use types. Permanent land use contracts were given in close to 72% of cases overall, from 85% of residential and construction land to 80% of collective land, and some 50% and 48% of arable and forest land. Survey data point toward a total cash cost for the program of about Y 8.7 per mu of which close to half (38%) was contributed by the village and the remainder from outside. Villagers contributed close to 2,000 man-days of labor (about 3 days per household) and, with somewhat more than 10 person-months of labor by outsiders, contributions from above the village remained limited.

## 4. Econometric results

The reform is estimated to have led to a significant increase of 6.5 percent in per capita consumption that was most pronounced for less educated and less wealthy households, and an increment in net income of almost equal size. Average annual benefits were thus higher than cover program cost. It contributed to job creation, increasing total labor supply, with a shift from migration to agricultural activities by the young and from farming to off-farm activities by the old. It also triggered an increase of agricultural yields by 50% and of profits by 34%, triggered by a shift in crop composition towards higher-value crops, more active rental markets to transfer land from less to more productive users, more intensive input use.

### 4.1 Welfare impacts of property rights reform

Estimates of reform-induced impacts on consumption and income as well as the contribution of different income sources are reported in table 3. Here and in subsequent tables, estimated mean impacts are in panel A while impacts that are allowed to vary by initial level of education and physical assets are in panels B and C, respectively. Columns 1 and 2 of table 3 panel A point towards a reform-induced increase in households' per capita consumption of 6.5 percentage points, an estimate that is robust to clustering. Per capita income is estimated to have increased by 5.1 percentage points although the point estimate is less robust. This implies estimated annual reform benefits of Y100 per mu,[15] well above the Y8.7 per mu it cost to implement the reform (see table 2). In other words, estimated income gains even in one year are more than sufficient to pay for the cost of the program. Panels B and C highlight that the impact of Chengdu's land reforms on per capita consumption was pro-poor: while income for households where the head's education was below junior high is estimated to have increased by 13 points, those with more than

[15] With a mean cultivated area of 4 mu, the estimated benefit per mu in terms of consumption net and income is 6,078*0.065/4 and 8,549*0.051/4, respectively.

compulsory education are estimated to not have benefited. Similarly, the z-score for assets interacted with the Chengdu dummy is negative and significant, suggesting that reform benefited those with less initial assets but not those with initial wealth above the mean.

In addition to income levels, exploring reform impacts on income composition (col. 4-6) provides pointers on factors that may underpin such shifts. Panel A suggests that the reform led to a significant increase in the overall share of income from farming (by 4.5 percentage points) and a decrease in the income share of local wages (by some 2.3 percentage points). Again, bootstrapped p-values suggest these effects are robust to clustering. By comparison, estimated impacts on the share of income from off-farm income or migration are insignificant. Size and significance of such impacts differed by initial levels of education and assets (panels B and C): in general reforms led to higher income shares from farming by those with lower initial education or assets -by 7.2 (4.6) points- but no changes by those with higher initial education or asset levels.

**4.2 Impacts on time use**

If, for example by promoting land-related investment and transfers from less to more efficient producers via rental markets, reforms increased productivity and wages or induced shifts in the relative productivity of different activities, we would expect to see corresponding shifts in overall labor supply or the amount of time allocated to different sectors. As we have information on individuals' time use, analyzing this aspect also allows us to obtain estimates of reform impacts that are gender- and age-differentiated, in line with evidence suggesting that such effects could be important(Wang 2014).

Results for total household-level labor supply by individuals of working age overall (col. 1) and by age for own farming, off-farm employment, and migration (col. 2-7) in table 4 highlight a number of points.[16] First, reforms led to an increase in overall labor supply that was particularly pronounced for males, pointing to expansion of labor market opportunities. Second, disaggregating this effect by sector, gender, and age group suggests that members of the young generation (16-40 years old) significantly increased labor supply to the agricultural sector. For males this was a net increase that was combined with a much smaller reduction in off-farm work whereas females shifted time from migration towards agriculture and to a lesser extent off-farm work. For the old generation (aged 41-60 and 41-55 years for males and females, respectively), we note an increase in net labor supply to off-farm work by males and a reallocation of labor time from agriculture towards off-farm work and migration for females. Most estimated effects are robust to clustering.

[16]The age brackets of 16-60 years (or 55 for females) are in line with the age for participation in formal labor markets.

Disaggregating these by gender (see the two bottom panels of table 4) highlights that reforms led to an increase in farming and reduction in off-farm employment but did not change the amount of time spent in migration by young males. By contrast, young females significantly reduced the amount of time spent on migration while increasing labor supply to both farming and off-farm employment. For the old, a slightly different pattern is observed with reforms leading to significantly increased supply of labor to off-farm but not to farming or migration whereas old females compensated for a reduction of labor time in farming with an increase in off-farm and migration labor.

**4.3Agricultural productivity and crop composition**

A plausible explanation for the estimated increases in income shares from and labor supplied to farming would be that reform led to increased yields or profits in this sector, e.g. by encouraging investment or land transfers to more productive farmers. Tables 5 and 6 present results with respect to reform effects on these variables as well as land market activity, input use, and composition of output from agricultural production to assess if this possibility is backed by evidence. Cols. 1 and 2 of table 5panel A point towards reform-induced increases of revenues from agricultural production by more than 50% or a corresponding increase in profits of 34%. Panel B suggests that reform did not advantage better educated households although panel C implies that reform-induced increases in yield (but not profits) for those with higher levels of assets were significantly above the overall average.

While the survey collected information on renting in only, reforms are estimated to have increased activity in land rental by 5.7 percentage points, beyond a secular increase of land rental activity of 2.3 percentage points (col. 3). This is in line with the notion that more secure tenure makes it easier to transfer land without having to fear it will be expropriated (Deininger and Jin 2005) so that reforms contributed to structural transformation (Deininger *et al.* 2014). Panel C suggests that reform effects on rental markets were even more pronounced for those with higher levels of initial assets panel B suggests no variation by education.

Although significantly different pre-reform trends for use of most purchased inputs as well as composition of output between households inside and outside Chengdu suggest that some ‘catching up’ may be involved, results in table 5point towards a marked reform-induced substitution of purchased inputs for labor. As fertilizer and pesticides provide benefits beyond the current production cycle (Jacoby *et al.* 2002), this is consistent with the reform having removed investment disincentives, providing greater incentives to apply purchased inputs and adjust to rising wages (Ge and Yang 2014) so as to increase efficiency. Per-mu intensities of fertilizer, pesticides, and seeds are estimated to have increased by 103%, 67%, and 43%, respectively, compared to a reform-induced reduction of hired labor intensity of

28%.[17]Results in panel C suggest that, with the exception of seeds, changes in the intensity of input use were more pronounced for those with higher levels of assets.

In terms of the composition of agricultural output (table 6), reforms seem to have accelerated the trend of shifting area out of rice (-1.1%) and wheat (-1.4%) towards oil crops (+1.4%) which may partly be due to subsidies. With point estimates of -3.3% for wheat, -2.5% for rice, and +2.2% for oil crops, the estimated magnitude of reform-induced effects exceeds that of secular trends. We note that this was almost entirely compensated for by reform-induced increases in the area devoted to vegetables (+3.4%), oil crops (+2.2%), and corn (+2.0%). Panel B suggests that reform led more educated households to plant more rice and less vegetables than those with basic education only, possibly explaining the patterns of input use observed earlier. Panel C implies that after reform, those with more assets devote more land to high-value vegetables (a one standard deviation estimated to be associated with a 1% increase in vegetable area), an effect that could be due to the more capital-intensive or risky nature of this crop.

## 5. Conclusion and policy implications

Our analysis suggests that Chengdu's far-reaching property rights reforms were carried out swiftly and effectively, with three main effects. First, reforms contributed to increased consumption and income, in particular for less educated and affluent households, with estimated benefits exceeding the cost of reform implementation. Second, they increased overall labor supply and contributed to a shift of labor by young males and females to the agricultural sector which, for females coincided with a significant reduction of time spent migrating. Finally, reforms increased agricultural yields and profits through greater rental market activity that transferred land to more productive producers; substitution of purchased inputs for labor; and a shift out of grains towards vegetables, corn, and oilseeds that offer higher profitability.

All of these findings are consistent with the notion that, before the reform, tenure insecurity had undermined not only investment but also the functioning of land and labor markets, preventing high-value peri-urban land form being most effectively used and thus imposing considerable social losses. As China's leadership considers if and how to build on what has been achieved, the pilot results point to important substantive lessons in terms of the key elements of reform implementation. They also suggest that careful design and an emphasis on input evaluation right from the start could greatly help to systematically appreciate the lessons from such efforts as well as ways in which they could be integrated into broader policy.

[17]Reform-induced increases in supply of (young) own labor noted above are consistent with this reduced reliance on hired labor.

**Figure 1: Location of treatment and control counties**

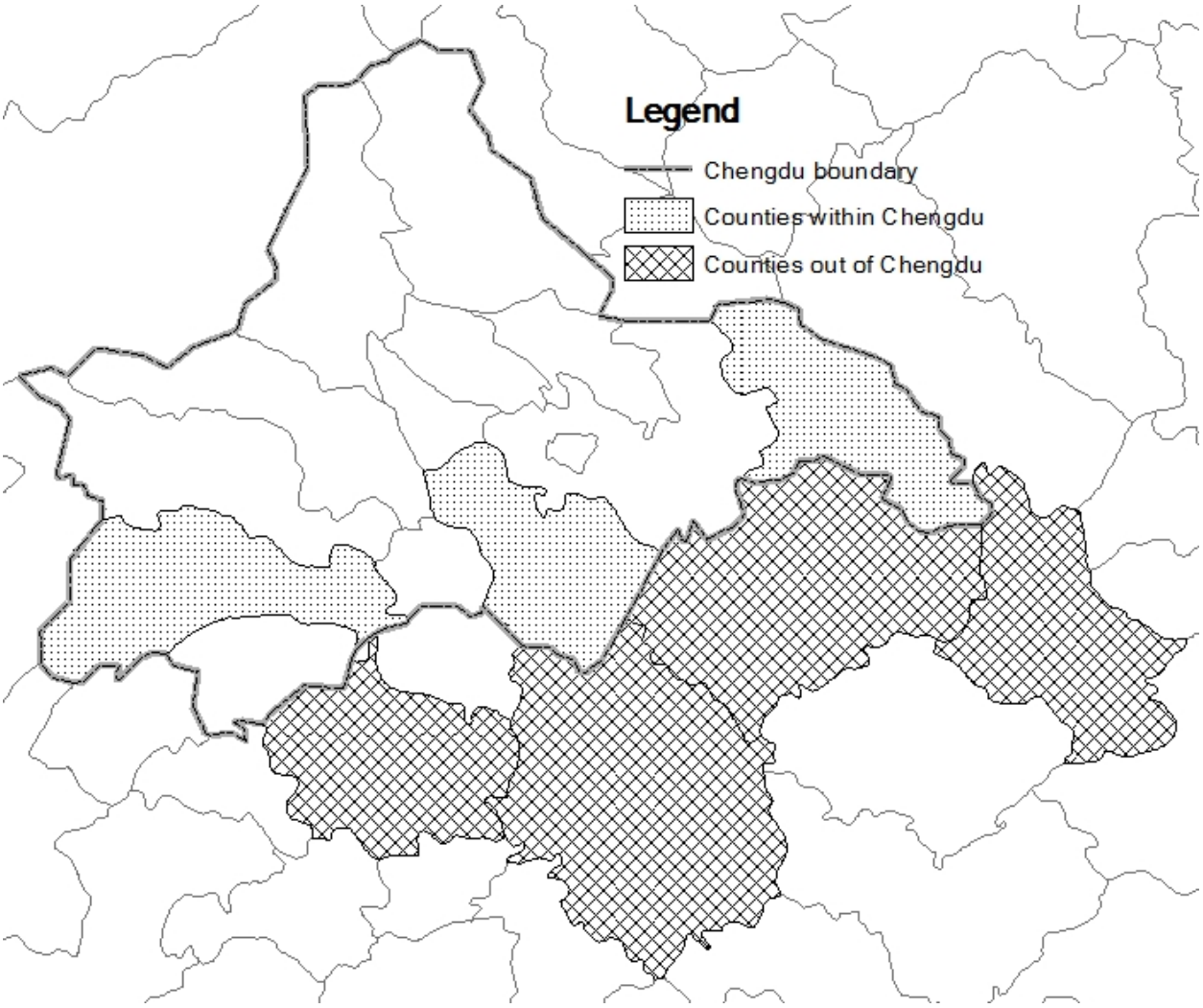

**Table 1: Descriptive statistics for household outcomes**

| | Before | | After | | Before Trend | | |
|---|---|---|---|---|---|---|---|
| | **Outside** | **Inside** | **Outside** | **Inside** | **Outside** | **Inside** | **Sig.** |
| **Household characteristics** | | | | | | | |
| Household size | 3.73 | 3.48 | 3.69 | 3.46 | -0.011 | -0.007 | |
| Household size adult equivalent | 3.20 | 3.05 | 2.98 | 2.84 | -0.008 | 0.026 | |
| Highest education (level 3 = jun. high) | 3.26 | 3.34 | 3.21 | 3.26 | 0.009 | 0.004 | |
| Female head | 0.08 | 0.07 | 0.08 | 0.08 | -0.002 | 0.007 | |
| Head's age | 48.06 | 45.88 | 54.13 | 53.13 | 1.124 | 1.119 | |
| **Income and expenditure** | | | | | | | |
| Consumption per capita | 2,668 | 3,150 | 4,997 | 6,078 | -0.025 | -0.052 | |
| Net income per capita | 3,770 | 4,928 | 8,069 | 8,549 | -0.008 | -0.029 | |
| Share of income from crop agric. | 0.35 | 0.32 | 0.28 | 0.24 | -0.005 | -0.023 | |
| Share of income from other agric. | 0.34 | 0.30 | 0.24 | 0.16 | -0.054 | -0.060 | |
| Share of inc. from local wages | 0.07 | 0.08 | 0.09 | 0.17 | 0.008 | 0.019 | |
| Share of inc. from loc nfrm self emp. | 0.05 | 0.08 | 0.05 | 0.07 | 0.001 | 0.014 | |
| Share of inc. from migration | 0.16 | 0.20 | 0.25 | 0.23 | 0.048 | 0.042 | |
| Share of inc. from other | 0.03 | 0.03 | 0.10 | 0.13 | 0.002 | 0.009 | |
| Renting in any land | 0.08 | 0.00 | 0.04 | 0.04 | -0.022 | -0.007 | |
| Total assets per capita | 11,564 | 16,063 | 29,752 | 40,025 | 0.070 | 0.031 | |
| **Time use** | | | | | | | |
| Share of household time in farming | 0.50 | 0.43 | 0.40 | 0.30 | -0.018 | -0.027 | |
| Share of household time in local off-farm | 0.10 | 0.14 | 0.11 | 0.21 | 0.003 | 0.017 | |
| Share of household time in migration | 0.23 | 0.18 | 0.25 | 0.16 | 0.026 | 0.028 | |
| Months worked prime age adults | 24.63 | 22.85 | 22.14 | 17.84 | 0.005 | 0.540 | |
| Months worked prime age males | 13.54 | 12.65 | 13.10 | 11.27 | 0.100 | 0.121 | |
| *Males 16-40 years old* | | | | | | | |
| Months for farming | 3.57 | 3.43 | 1.15 | 1.78 | -0.412 | -0.412 | |
| Months for local off-farm | 1.27 | 1.95 | 1.44 | 2.57 | -0.096 | 0.472 | * |
| Months for migration | 6.31 | 4.49 | 7.92 | 3.91 | 0.234 | 0.197 | |
| *Males 41-60 years old* | | | | | | | |
| Months for farming | 7.57 | 5.57 | 4.83 | 2.53 | -0.246 | -0.504 | |
| Months for local off-farm | 1.34 | 2.15 | 2.45 | 4.23 | 0.215 | 0.006 | |
| Months for migration | 1.05 | 1.55 | 2.15 | 2.39 | 0.300 | 0.482 | |
| Months worked prime age females | 12.63 | 11.09 | 11.55 | 8.59 | 0.064 | 0.443 | |
| *Females 16-40 years old* | | | | | | | |
| Months for farming | 5.51 | 5.13 | 3.09 | 3.58 | -0.324 | -0.444 | |
| Months for local off-farm | 0.96 | 1.79 | 0.87 | 1.40 | -0.041 | 0.015 | |
| Months for migration | 4.46 | 2.69 | 6.07 | 2.34 | 0.362 | 0.588 | |
| *Females 41-55 years old* | | | | | | | |
| Months for farming | 8.06 | 7.35 | 6.72 | 4.73 | -0.023 | -0.301 | |
| Months for local off-farm | 1.13 | 1.02 | 0.82 | 1.73 | 0.003 | 0.093 | |
| Months for migration | 0.48 | 0.26 | 1.28 | 0.84 | 0.174 | 0.208 | |
| **Agricultural production** | | | | | | | |
| Cultivated area (mu) | 4.79 | 3.45 | 5.18 | 3.99 | 0.201 | 0.111 | |
| Area share of wheat | 0.45 | 0.39 | 0.40 | 0.32 | -0.001 | 0.025 | *** |
| Area share of rice | 0.10 | 0.07 | 0.05 | 0.03 | 0.015 | 0.020 | |
| Area share of corn | 0.14 | 0.21 | 0.14 | 0.16 | 0.011 | 0.001 | * |
| Area share of other grain | 0.10 | 0.06 | 0.12 | 0.06 | -0.010 | 0.011 | *** |
| Area share of vegetable | 0.10 | 0.14 | 0.13 | 0.21 | -0.024 | -0.031 | |
| Area share of oil crops | 0.12 | 0.13 | 0.16 | 0.21 | 0.010 | -0.027 | *** |
| Yield (yuan/mu) | 1,254 | 1,880 | 1,471 | 1,578 | -0.021 | -0.111 | * |
| Expenses on hired labor (yuan/mu) | 15.54 | 21.43 | 14.32 | 18.09 | 0.026 | 0.293 | * |
| Expenses on seed (yuan/mu) | 29.64 | 41.02 | 51.64 | 44.93 | -0.235 | -0.223 | |
| Expenses on fertilizer (yuan/mu) | 161.52 | 201.67 | 209.29 | 164.89 | -0.042 | -0.604 | *** |
| Expenses on pesticide (yuan/mu) | 38.71 | 60.53 | 57.89 | 84.54 | 0.091 | -0.242 | *** |
| Net revenue (yuan/mu) | 957 | 1,406 | 1,091 | 1,168 | 0.142 | 0.079 | |
| Subsidy for grain per mu (yuan/mu) | 12.84 | 21.01 | 55.05 | 56.07 | -0.162 | 0.110 | ** |
| Subsidy for machine (yuan/mu) | 0.00 | 0.00 | 0.03 | 0.00 | 0.000 | 0.000 | |
| Subsidy for seed (yuan/mu) | 0.24 | 0.00 | 2.77 | 5.34 | -0.038 | 0.000 | |
| Subsidy for other inputs (yuan/mu) | 0.00 | 0.00 | 27.62 | 6.59 | 0.000 | 0.000 | |
| Number of observations | 906 | 570 | 764 | 518 | 453 | 285 | |

*Note*: Monetary values are deflated to 2005 by CPI for rural Sichuan. As explained in the text, the 'Sig' column denotes the significance in pre-reform trends between households inside and outside the prefecture boundary. *** p<0.01, ** p<0.05, * p<0.1.

**Table 2: Key characteristics of land certification**

| | Total | Collect | Contract | Forest | Constr. | Housing | Houses |
|---|---|---|---|---|---|---|---|
| **Main characteristics** | | | | | | | |
| Total area | 12,821 | 6,151 | 3,929 | 1,799 | 316 | 309 | 331 |
| Titling complete | 0.945 | 0.987 | 0.987 | 0.956 | 0.870 | 0.941 | 0.922 |
| …if yes, months taken | 4.669 | 3.828 | 4.007 | 5.992 | 4.606 | 4.573 | 5.649 |
| No. of certificates issued | 3,596 | 91 | 932 | 747 | 523 | 897 | 873 |
| Area titled (mu) | 10,662 | 5,284 | 3,737 | 1,465 | 185 | 260 | 206 |
| Total labor from village (md) | 2,408 | | | | | | |
| Total labor from outside (md) | 271 | | | | | | |
| Total cost (Y/mu) | 8.69 | | | | | | |
| Share of cost borne by village | 0.380 | | | | | | |
| **Organization and implementation** | | | | | | | |
| Rules made by village leaders | 0.003 | 0.007 | 0.007 | 0.000 | 0.000 | 0.000 | 0.000 |
| Rules made by village representatives | 0.138 | 0.154 | 0.146 | 0.127 | 0.147 | 0.126 | 0.141 |
| Rules made by village assembly | 0.484 | 0.456 | 0.503 | 0.500 | 0.402 | 0.495 | 0.477 |
| Rules made by village econ. organizations | 0.233 | 0.235 | 0.232 | 0.246 | 0.265 | 0.216 | 0.228 |
| Rules made by township or above | 0.143 | 0.148 | 0.113 | 0.127 | 0.186 | 0.162 | 0.154 |
| Organization done by village leaders | 0.264 | 0.237 | 0.276 | 0.222 | 0.165 | 0.261 | 0.285 |
| Organization done by village representatives | 0.059 | 0.059 | 0.053 | 0.089 | 0.064 | 0.061 | 0.053 |
| Organization done by village assembly | 0.121 | 0.112 | 0.138 | 0.111 | 0.119 | 0.130 | 0.132 |
| Organization done by village econ. organizations | 0.083 | 0.059 | 0.099 | 0.096 | 0.064 | 0.096 | 0.093 |
| Organization done by township or above | 0.472 | 0.533 | 0.434 | 0.481 | 0.587 | 0.452 | 0.437 |
| Actual measurement done by village leaders | 0.085 | 0.086 | 0.093 | 0.059 | 0.111 | 0.078 | 0.080 |
| Actual measurement by village representatives | 0.554 | 0.517 | 0.583 | 0.615 | 0.407 | 0.609 | 0.567 |
| Actual measurement done by village assembly | 0.042 | 0.033 | 0.040 | 0.022 | 0.056 | 0.026 | 0.053 |
| Actual measurement by village econ. organizations | 0.227 | 0.192 | 0.252 | 0.267 | 0.241 | 0.209 | 0.247 |
| Actual measurement done by township or above | 0.093 | 0.172 | 0.033 | 0.037 | 0.185 | 0.078 | 0.053 |
| **Disputes** | | | | | | | |
| Any disputes encountered | 0.549 | 0.187 | 0.497 | 0.348 | 0.226 | 0.250 | 0.300 |
| … if yes, no. of disputes | 14.850 | 6.429 | 10.987 | 9.745 | 6.292 | 9.759 | 8.111 |
| … disputes could not be resolved by village leaders | 1.248 | 0.074 | 0.724 | 0.894 | 0.042 | 1.690 | 0.933 |
| **Results** | | | | | | | |
| Contract now longer than 30 years | 0.987 | 0.993 | 0.980 | 0.977 | 1.000 | 0.983 | 0.993 |
| Contract now permanent | 0.717 | 0.792 | 0.497 | 0.481 | 0.848 | 0.861 | 0.860 |

*Source:* Own computation from 2014 Chengdu village survey for three counties inside Chengdu.

**Table 3: Estimated impact of property rights intervention on overall welfare**

| | Total | | Income from | | | |
|---|---|---|---|---|---|---|
| | **Cons..** | **Income** | **Farming** | **Local wage** | **Off farm** | **Migration** |
| **Panel A** | | | | | | |
| Chengdu | -0.029*** | -0.072*** | -0.023*** | 0.014*** | 0.016*** | -0.008*** |
| | (0.003) | (0.008) | (0.001) | (0.001) | (0.001) | (0.001) |
| Post reform | 0.130*** | -0.002 | 0.000 | -0.003 | -0.007* | -0.031** |
| | (0.010) | (0.029) | (0.001) | (0.003) | (0.002) | (0.007) |
| Chengdu*post | 0.065*** | 0.051* | 0.045*** | -0.023** | -0.005 | -0.005 |
| | (0.006) | (0.017) | (0.003) | (0.004) | (0.003) | (0.006) |
| Bootstrapped p-value | 0.000 | 0.252 | 0.000 | 0.000 | 0.404 | 0.649 |
| Observations | 1,379 | 1,379 | 1,379 | 1,379 | 1,379 | 1,379 |
| R-squared | 0.122 | 0.101 | 0.035 | 0.025 | 0.019 | 0.061 |
| **Panel B** | | | | | | |
| Chengdu | -0.062** | -0.051*** | -0.040*** | 0.024*** | 0.017** | -0.020*** |
| | (0.012) | (0.005) | (0.002) | (0.001) | (0.003) | (0.003) |
| Post reform | 0.099*** | -0.023 | -0.000 | -0.002 | -0.007* | -0.024** |
| | (0.012) | (0.032) | (0.001) | (0.003) | (0.003) | (0.008) |
| > Junior high educ. | -0.024** | -0.030* | 0.018*** | -0.010** | -0.001 | 0.016** |
| | (0.005) | (0.010) | (0.003) | (0.002) | (0.001) | (0.004) |
| Chengdu*post | 0.131*** | 0.039 | 0.072*** | -0.049*** | -0.008 | 0.011 |
| | (0.013) | (0.023) | (0.004) | (0.005) | (0.004) | (0.010) |
| > Junior high educ.*post | 0.097*** | 0.072** | -0.001 | 0.000 | 0.003 | -0.023*** |
| | (0.010) | (0.015) | (0.002) | (0.001) | (0.002) | (0.002) |
| Chengdu*> junior high educ. | 0.086** | -0.047* | 0.037*** | -0.021*** | -0.002 | 0.025*** |
| | (0.024) | (0.017) | (0.001) | (0.002) | (0.006) | (0.004) |
| Chengdu*> junior high | -0.197** | 0.012 | -0.069*** | 0.073*** | 0.008 | -0.036** |
| educ.*post | (0.035) | (0.020) | (0.004) | (0.003) | (0.007) | (0.011) |
| Bootstrapped p-value | 0.156 | 0.761 | 0.000 | 0.156 | 0.529 | 0.150 |
| Observations | 1,379 | 1,379 | 1,379 | 1,379 | 1,379 | 1,379 |
| R-squared | 0.125 | 0.103 | 0.043 | 0.032 | 0.020 | 0.064 |
| **Panel C** | | | | | | |
| Chengdu | -0.030*** | -0.072*** | -0.023*** | 0.014*** | 0.016*** | -0.008** |
| | (0.002) | (0.008) | (0.002) | (0.001) | (0.001) | (0.001) |
| Post reform | 0.130*** | -0.002 | 0.001 | -0.003 | -0.007* | -0.031** |
| | (0.009) | (0.029) | (0.001) | (0.003) | (0.002) | (0.007) |
| Z assets | -0.047*** | -0.043*** | 0.014*** | 0.004** | -0.004** | -0.008** |
| | (0.005) | (0.002) | (0.001) | (0.001) | (0.001) | (0.002) |
| Chengdu*post | 0.066*** | 0.051* | 0.046*** | -0.023** | -0.005 | -0.005 |
| | (0.006) | (0.018) | (0.003) | (0.004) | (0.003) | (0.006) |
| Z assets*post | 0.028*** | 0.040*** | -0.013*** | -0.012*** | 0.001 | 0.003 |
| | (0.004) | (0.003) | (0.001) | (0.001) | (0.001) | (0.002) |
| Chengdu*z assets | 0.052*** | 0.032** | 0.007** | -0.005** | 0.001 | -0.013*** |
| | (0.009) | (0.006) | (0.002) | (0.001) | (0.001) | (0.002) |
| Chengdu*z assets*post | -0.075*** | -0.041** | -0.013** | 0.029*** | 0.004 | 0.005 |
| | (0.009) | (0.012) | (0.003) | (0.004) | (0.002) | (0.005) |
| Bootstrapped p-value | 0.156 | 0.110 | 0.108 | 0.000 | 0.264 | 0.537 |
| Observations | 1,379 | 1,379 | 1,379 | 1,379 | 1,379 | 1,379 |
| R-squared | 0.127 | 0.103 | 0.042 | 0.029 | 0.020 | 0.066 |

Robust standard errors in brackets are clustered by treatment status. *** p<0.01, ** p<0.05, * p<0.1.

*Note:* Household characteristics include number of children, number of adults, number of old people, family's highest education, female household head, head's age, and the amount of subsidies received. Village characteristics include total population, land area for agriculture, and indicator variables for remote village, suburban village, distance to county capital longer than 20 km, distance to primary school shorter than 2 km, distance to secondary school shorter than 2 km, and distance to medical station shorter than 2 km.

**Table 4: Estimated impact of property rights intervention on time use**

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | | **Entire sample** | | | | | |
| | **Total** | **Young people (16-40)** | | | **Old people (40-60/55)** | | |
| | | **Farming** | **Off farm** | **Migration** | **Farming** | **Off farm** | **Migration** |
| **Panel A** | | | | | | | |
| Chengdu | 0.395** | 0.083 | 0.565*** | -0.044 | -0.270*** | -0.008 | 0.129 |
| | (0.079) | (0.069) | (0.058) | (0.032) | (0.038) | (0.067) | (0.106) |
| Post reform | 0.858 | 0.577 | -0.006 | 0.308 | 1.104* | 0.250 | -0.942** |
| | (0.464) | (0.522) | (0.133) | (0.308) | (0.440) | (0.182) | (0.196) |
| Chengdu*post | 0.191 | 1.037*** | -0.477** | -0.471** | -0.079 | 0.386** | 0.361 |
| | (0.100) | (0.031) | (0.106) | (0.128) | (0.234) | (0.103) | (0.155) |
| Bootstrapped p-value | 0.000 | 0.136 | 0.112 | 0.272 | 0.799 | 0.110 | 0.122 |
| Observations | 1,283 | 974 | 974 | 974 | 812 | 812 | 812 |
| R-squared | 0.330 | 0.227 | 0.042 | 0.077 | 0.302 | 0.081 | 0.084 |
| **Panel B** | | | | **Males only** | | | |
| | **Total** | **Young people (16-40)** | | | **Old people (40-60)** | | |
| | | **Farming** | **Off farm** | **Migration** | **Farming** | **Off farm** | **Migration** |
| Chengdu | 0.226* | -0.077 | 0.676*** | -0.211* | -0.241** | -0.154** | 0.202 |
| | (0.076) | (0.041) | (0.105) | (0.074) | (0.074) | (0.037) | (0.116) |
| Post reform | 0.191 | 0.403 | -0.036 | 0.162 | 0.356* | 0.004 | -0.368* |
| | (0.155) | (0.334) | (0.118) | (0.222) | (0.131) | (0.127) | (0.135) |
| Chengdu*post | 0.324*** | 0.620*** | -0.388** | 0.023 | 0.173 | 0.491*** | 0.069 |
| | (0.044) | (0.101) | (0.085) | (0.141) | (0.158) | (0.081) | (0.156) |
| Bootstrapped p-value | 0.000 | 0.146 | 0.000 | 0.855 | 0.410 | 0.388 | 0.753 |
| Observations | 1,242 | 748 | 748 | 748 | 765 | 765 | 765 |
| R-squared | 0.262 | 0.068 | 0.027 | 0.065 | 0.037 | 0.058 | 0.070 |
| **Panel C** | | | | **Females only** | | | |
| | **Total** | **Young people (16-40)** | | | **Old people (40-55)** | | |
| | | **Farming** | **Off farm** | **Migration** | **Farming** | **Off farm** | **Migration** |
| Chengdu | 0.124** | 0.031 | -0.110 | 0.182* | -0.208*** | 0.143*** | 0.043 |
| | (0.032) | (0.080) | (0.054) | (0.058) | (0.034) | (0.024) | (0.054) |
| Post reform | 0.820 | 0.311 | 0.089 | 0.563** | 0.680 | 0.227 | -0.420 |
| | (0.428) | (0.460) | (0.053) | (0.126) | (0.436) | (0.189) | (0.245) |
| Chengdu*post | -0.216* | 0.473** | 0.159** | -0.707*** | -0.399*** | 0.187*** | 0.193** |
| | (0.089) | (0.083) | (0.035) | (0.107) | (0.024) | (0.017) | (0.059) |
| Bootstrapped p-value | 0.402 | 0.132 | 0.000 | 0.266 | 0.102 | 0.102 | 0.374 |
| Observations | 1,101 | 688 | 688 | 688 | 527 | 527 | 527 |
| R-squared | 0.301 | 0.113 | 0.057 | 0.066 | 0.077 | 0.066 | 0.022 |

Robust standard errors in brackets are clustered by treatment status. *** p<0.01, ** p<0.05, * p<0.1.

*Note:* Household characteristics include number of children, number of adults, number of old people, family's highest education, female household head, head's age, the amount of subsidies received, average level of education for the group and gender composition of the group. Village characteristics include total population, land area for agriculture, and indicator variables for remote village, suburban village, distance to county capital longer than 20 km, distance to primary school shorter than 2 km, distance to secondary school shorter than 2 km, and distance to medical station shorter than 2 km.

**Table 5: Estimated impact of property rights intervention on agricultural productivity**

| | Yield | Profit | Rent in | Purchased input use | | | |
|---|---|---|---|---|---|---|---|
| | | | | Labor | Seed | Fertilizer | Pesticide |
| **Panel A** | | | | | | | |
| Chengdu | -0.091* | -0.021 | 0.020** | 0.319*** | -0.058** | -0.592*** | -0.375*** |
| | (0.031) | (0.063) | (0.004) | (0.047) | (0.010) | (0.022) | (0.016) |
| Post reform | -0.039 | -0.207 | 0.023** | 0.089 | -0.063* | -0.147** | -0.232*** |
| | (0.054) | (0.111) | (0.007) | (0.081) | (0.027) | (0.027) | (0.021) |
| Chengdu*post | 0.503*** | 0.339* | 0.057*** | -0.277*** | 0.439*** | 1.039*** | 0.673*** |
| | (0.078) | (0.144) | (0.005) | (0.047) | (0.008) | (0.022) | (0.029) |
| Bootstrapped p-value | 0.114 | 0.252 | 0.150 | 0.306 | 0.000 | 0.156 | 0.156 |
| Observations | 1,379 | 1,379 | 1,379 | 1,379 | 1,379 | 1,379 | 1,379 |
| R-squared | 0.131 | 0.072 | 0.027 | 0.020 | 0.027 | 0.050 | 0.037 |
| **Panel B** | | | | | | | |
| Chengdu | -0.068 | 0.028 | 0.012 | 0.218** | -0.150*** | -0.483*** | -0.423*** |
| | (0.037) | (0.067) | (0.007) | (0.046) | (0.010) | (0.024) | (0.009) |
| Post reform | -0.026 | -0.247 | 0.006 | 0.150 | -0.034 | 0.019 | -0.162*** |
| | (0.067) | (0.121) | (0.008) | (0.082) | (0.033) | (0.025) | (0.019) |
| > Junior high educ. | 0.101** | 0.077 | -0.043*** | 0.064** | -0.110*** | 0.612*** | 0.117** |
| | (0.018) | (0.039) | (0.004) | (0.018) | (0.007) | (0.003) | (0.023) |
| Chengdu*post | 0.526** | 0.393* | 0.051*** | -0.291** | 0.399*** | 0.961*** | 0.736*** |
| | (0.093) | (0.162) | (0.008) | (0.054) | (0.023) | (0.030) | (0.022) |
| > Junior high educ.*post | -0.049 | 0.122* | 0.063*** | -0.194*** | -0.081* | -0.560*** | -0.251*** |
| | (0.041) | (0.048) | (0.005) | (0.032) | (0.027) | (0.013) | (0.026) |
| Chengdu*> junior high educ. | -0.083*** | -0.146** | 0.031* | 0.245*** | 0.266*** | -0.410*** | 0.095 |
| | (0.012) | (0.034) | (0.012) | (0.029) | (0.039) | (0.022) | (0.052) |
| Chengdu*> junior high | -0.068 | -0.198* | 0.013 | 0.142* | 0.179** | 0.324*** | -0.127** |
| educ.*post | (0.047) | (0.069) | (0.016) | (0.045) | (0.049) | (0.032) | (0.037) |
| Bootstrapped p-value | 0.220 | 0.270 | 0.639 | 0.114 | 0.108 | 0.000 | 0.306 |
| Observations | 1,379 | 1,379 | 1,379 | 1,379 | 1,379 | 1,379 | 1,379 |
| R-squared | 0.134 | 0.075 | 0.031 | 0.023 | 0.029 | 0.063 | 0.040 |
| **Panel C** | | | | | | | |
| Chengdu | -0.089* | -0.027 | 0.021** | 0.327*** | -0.067** | -0.584*** | -0.367*** |
| | (0.031) | (0.063) | (0.004) | (0.043) | (0.017) | (0.018) | (0.015) |
| Post reform | -0.037 | -0.204 | 0.023** | 0.087 | -0.062* | -0.149*** | -0.232*** |
| | (0.054) | (0.109) | (0.007) | (0.080) | (0.026) | (0.025) | (0.020) |
| Z assets | 0.067*** | 0.048** | 0.018*** | 0.028 | -0.134*** | 0.051** | -0.008 |
| | (0.006) | (0.009) | (0.001) | (0.016) | (0.009) | (0.010) | (0.007) |
| Chengdu*post | 0.506*** | 0.348* | 0.056*** | -0.287*** | 0.450*** | 1.028*** | 0.672*** |
| | (0.078) | (0.143) | (0.005) | (0.042) | (0.005) | (0.024) | (0.027) |
| Z assets*post | -0.110*** | -0.005 | -0.028*** | -0.022 | 0.136*** | -0.122*** | -0.145*** |
| | (0.006) | (0.007) | (0.000) | (0.015) | (0.004) | (0.012) | (0.004) |
| Chengdu*z assets | -0.002 | 0.284*** | -0.020** | -0.336*** | 0.392*** | -0.382*** | -0.193*** |
| | (0.003) | (0.014) | (0.005) | (0.021) | (0.015) | (0.013) | (0.015) |
| Chengdu*z assets*post | 0.312*** | -0.040 | 0.029*** | 0.262*** | -0.420*** | 0.257*** | 0.537*** |
| | (0.012) | (0.023) | (0.003) | (0.013) | (0.029) | (0.038) | (0.023) |
| Bootstrapped p-value | 0.156 | 0.114 | 0.156 | 0.156 | 0.000 | 0.150 | 0.150 |
| Observations | 1,379 | 1,379 | 1,379 | 1,379 | 1,379 | 1,379 | 1,379 |
| R-squared | 0.158 | 0.099 | 0.029 | 0.026 | 0.035 | 0.065 | 0.051 |

Robust standard errors in brackets are clustered by treatment status. *** p<0.01, ** p<0.05, * p<0.1.

*Note:* Household characteristics include number of children, number of adults, number of old people, family's highest education, female household head, head's age, and the amount of subsidies received. Village characteristics include total population, land area for agriculture, and indicator variables for remote village, suburban village, distance to county capital longer than 20 km, distance to primary school shorter than 2 km, distance to secondary school shorter than 2 km, and distance to medical station shorter than 2 km.

**Table 6: Estimated impact of property rights intervention on crop choice**

| | Share of area planted with | | | | | |
|---|---|---|---|---|---|---|
| | **Wheat** | **Rice** | **Corn** | **Oth. grain** | **Vegetable** | **Oil crops** |
| **Panel A** | | | | | | |
| Chengdu | 0.026*** | 0.005 | -0.009** | 0.017** | -0.011* | -0.034*** |
| | (0.004) | (0.003) | (0.003) | (0.004) | (0.004) | (0.001) |
| Post reform | -0.011* | -0.014*** | -0.010 | 0.009 | 0.013 | 0.014** |
| | (0.004) | (0.001) | (0.005) | (0.007) | (0.008) | (0.004) |
| Chengdu*post | -0.033** | -0.025** | 0.020*** | -0.023** | 0.034*** | 0.022** |
| | (0.006) | (0.005) | (0.003) | (0.006) | (0.006) | (0.006) |
| Bootstrapped p-value | 0.000 | 0.000 | 0.130 | 0.098 | 0.098 | 0.106 |
| Observations | 1,369 | 1,369 | 1,369 | 1,369 | 1,369 | 1,369 |
| R-squared | 0.089 | 0.064 | 0.026 | 0.051 | 0.045 | 0.045 |
| **Panel B** | | | | | | |
| Chengdu | 0.022*** | 0.005* | -0.005 | 0.018*** | -0.023** | -0.020*** |
| | (0.003) | (0.002) | (0.003) | (0.003) | (0.004) | (0.002) |
| Post reform | -0.006 | -0.012*** | -0.008 | 0.011 | 0.010 | 0.007 |
| | (0.003) | (0.001) | (0.005) | (0.007) | (0.006) | (0.003) |
| > Junior high educ. | 0.006** | -0.002 | 0.006** | -0.004 | -0.008* | 0.008** |
| | (0.002) | (0.002) | (0.001) | (0.003) | (0.002) | (0.001) |
| Chengdu*post | -0.044*** | -0.032*** | 0.015** | -0.027** | 0.068*** | 0.014 |
| | (0.007) | (0.005) | (0.004) | (0.006) | (0.005) | (0.009) |
| > Junior high educ.*post | -0.013** | -0.005* | -0.008** | -0.006** | 0.004 | 0.026*** |
| | (0.003) | (0.002) | (0.002) | (0.002) | (0.003) | (0.001) |
| Chengdu*> junior high educ. | 0.009* | 0.002 | -0.012*** | -0.000 | 0.031** | -0.038*** |
| | (0.004) | (0.004) | (0.002) | (0.006) | (0.006) | (0.006) |
| Chengdu*> junior high educ.*post | 0.040*** | 0.021*** | 0.013* | 0.013 | -0.100*** | 0.014 |
| | (0.005) | (0.001) | (0.004) | (0.006) | (0.004) | (0.006) |
| Bootstrapped p-value | 0.228 | 0.000 | 0.282 | 0.204 | 0.000 | 0.410 |
| Observations | 1,369 | 1,369 | 1,369 | 1,369 | 1,369 | 1,369 |
| R-squared | 0.095 | 0.067 | 0.026 | 0.052 | 0.054 | 0.050 |
| **Panel C** | | | | | | |
| Chengdu | 0.026*** | 0.006 | -0.009** | 0.017** | -0.011* | -0.034*** |
| | (0.004) | (0.003) | (0.003) | (0.004) | (0.004) | (0.001) |
| Post reform | -0.011* | -0.014*** | -0.011 | 0.009 | 0.013 | 0.014** |
| | (0.004) | (0.001) | (0.005) | (0.007) | (0.008) | (0.004) |
| Z assets | 0.009*** | -0.000 | -0.007*** | 0.001 | -0.004*** | -0.000 |
| | (0.001) | (0.001) | (0.001) | (0.001) | (0.001) | (0.002) |
| Chengdu*post | -0.033** | -0.024** | 0.019*** | -0.023** | 0.036*** | 0.021** |
| | (0.006) | (0.005) | (0.003) | (0.006) | (0.006) | (0.007) |
| Z assets*post | -0.006** | 0.003** | 0.011*** | -0.005** | -0.003 | -0.001 |
| | (0.002) | (0.001) | (0.000) | (0.001) | (0.001) | (0.002) |
| Chengdu*z assets | -0.006* | -0.003 | 0.010*** | -0.005* | 0.014*** | -0.010*** |
| | (0.002) | (0.002) | (0.001) | (0.002) | (0.002) | (0.001) |
| Chengdu*z assets*post | -0.004 | 0.028*** | -0.033*** | 0.000 | 0.010** | 0.000 |
| | (0.006) | (0.002) | (0.003) | (0.005) | (0.003) | (0.008) |
| Bootstrapped p-value | 0.589 | 0.511 | 0.382 | 0.855 | 0.098 | 0.969 |
| Observations | 1,369 | 1,369 | 1,369 | 1,369 | 1,369 | 1,369 |
| R-squared | 0.092 | 0.072 | 0.030 | 0.052 | 0.047 | 0.046 |

Robust standard errors in brackets are clustered by treatment status. *** p<0.01, ** p<0.05, * p<0.1.

*Note:* Household characteristics include number of children, number of adults, number of old people, family's highest education, female household head, head's age, and the amount of subsidies received. Village characteristics include total population, land area for agriculture, and indicator variables for remote village, suburban village, distance to county capital longer than 20 km, distance to primary school shorter than 2 km, distance to secondary school shorter than 2 km, and distance to medical station shorter than 2 km.

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