Impact of Property Rights Reform to Support China’s Rural-Urban Integration

Household-Level Evidence from the Chengdu National Experiment

Klaus Deininger
Songqing Jin
Shouying Liu
Fang Xia
Abstract

As part of a national experiment in 2008, Chengdu prefecture implemented ambitious property rights reforms, including complete registration of all land together with measures to ease transferability and eliminate migration restrictions. A triple difference approach using the Statistics Bureau’s regular household panel suggests that the 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 toward agriculture and the old toward 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.

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Impact of Property Rights Reform to Support China’s Rural-Urban Integration:

Household-Level Evidence from the Chengdu National Experiment

Klaus Deininger†, Songqing Jin‡, Shouying Liu♯, Fang Xia♦

†World Bank, Washington DC
‡Michigan State University, East Lansing MI
♯Development Research Center of the State Council, Beijing
♦Central University of Finance and Economics, Beijing

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† Email: kdeininger@worldbank.org; jins@anr.msu.edu; liusy@drc.gov.cn; xia.fang.fx@gmail.com. We thank NBS, in particular Pingping Wang, Wei Wu, Yilin Feng, and Jianliang Di, as well as the Chengdu Statistical office, especially Taixiang Zhao, Xiaoying Gu, Yuan Lin, Yufang Chen, Quyan Chen, and Shiming Ren for access to data and support, Ting Shao for communication with NBS and the Chengdu Statistical office, and Yihao Li for research assistance. Funding support from the Knowledge for Change Program is gratefully acknowledged.
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1. Introduction

Although the rapid economic growth observed in China over the last decade is the result of many factors, a land tenure system that strictly separates rural from urban land and that allows expropriation of rural land and its conversion to urban land in a way that provides large margins to local governments has significantly contributed to the associated expansion of industrial activity. At the same time, this dualism between rural and urban land and the ability of local governments to generate enormous amounts of revenue by expropriating land cheaply and selling it to developers at prices that are orders of magnitude higher than what is being paid in compensation has also contributed to income inequality. Moreover, it led to inefficient land use, large ‘land banks’ by local governments, rural unrest, and – given China’s limited agricultural land endowment – concerns about negative impacts on food security. The latter may arise either directly – by irreversibly converting land from agricultural to non-agricultural uses – or indirectly by reducing investment and efficiency-enhancing land transfers by farmers who fear expropriation with limited compensation. Most experts agree that this situation is not sustainable and that, to change it, simultaneous action in a number of areas is needed (World Bank and DRC, 2014).

Cognizant of this challenge, a number of national experiments were conducted to explore the scope for alternative and potentially more sustainable arrangements. In this context, the city of Chengdu in Sichuan Province was selected by the central government as a “rural-urban integration reform experiment zone” in 2008. Efforts undertaken in the context of the experiment are of interest as they 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. They were expected to enhance tenure security and reduce transaction costs in land and labor markets so as to encourage land-related investment, enhance allocative efficiency, create jobs, and improve overall economic performance. But there was also concern that far-reaching reforms in this area would be costly to implement, and give rise to disputes or socially undesirable land transfers and migration.
As property rights and their links to rural-urban integration have recently been identified as key reform areas by China’s leadership, drawing the lessons from past reform experiments is important. Yet, beyond anecdotal accounts, few studies aim to assess either the magnitude of associated impacts or their incidence among different types of households. To provide a rigorous quantitative assessment, we use the fact that the experiment was implemented in Chengdu prefecture, with neighboring counties remaining unaffected. Panel data from NBS’ regular rural household survey for counties on both sides of the boundary allow us to assess reform impacts on household consumption and income, labor supply, incidence of land rental, crop choice, and productivity of agricultural land use. We use a triple difference strategy based on changes within the same household before and after the reform and inside vs. outside the boundary for identification, a choice justified by noting that sample counties on both sides of the border followed parallel trends before the intervention and we can control for a range of time variant public programs, in particular pension and medical schemes as well as agricultural subsidies that may have been implemented differently on both sides.

Results suggest that about 3-4 years after it was completed, the rural-urban integration reform experiment had led to significant consumption growth, estimated at 7.7 percent, especially for households with lower initial endowments of human and physical capital, and increments in net income of almost equal size. The magnitude of estimated annual consumption benefits is large, in excess of the cost of the entire intervention. A key reason for these shifts seems to be an increase in yields and profits from agriculture that coincides with increased diversification of output towards higher value crops: Agricultural yields increased by 55% and profits by 38%, due to more intensive input use, a shift in crop composition towards higher-value crops, and more active rental markets to transfer land from less to more productive users. This suggests removal of earlier threats of expropriation encouraged more effective use of highly productive peri-urban land to intensify agricultural production and, by doing so, increased job opportunities and resulted in changes of labor supply. Young individuals shifted from migration to agricultural activities while the old shifted from farming to off-farm activities.

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

Between 2000 and 2010, rural-urban land conversion in China expanded at rates that are among the highest in East Asia. As such changes are not easily reversed, this poses vast challenges for China’s development for decades to come. While piecemeal efforts to change this pattern had proved largely ineffective, the
rural-urban integration reforms undertaken in Chengdu prefecture followed a more integrated approach that could hold broader lessons. We describe the nature of the reforms and our analytical approach to evaluating their impact.

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). At the same time, and despite numerous measures to the contrary, rural-urban income inequality widened. While clear causality is difficult to establish, most experts agree that high rates of land conversion make a key contribution to this and, in addition, give rise to factor market distortions and often inefficient and unsustainable land use. This 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. While farmers receive compensation for their agricultural land based on the value of land for agricultural production, land acquired in this way can be transferred by local government at prices a hundred times or more what was paid in compensation.

The scope for realizing such windfall gains made land acquisition a preferred means for funding local governments, with far-reaching implications for overall land supply, land prices, and the operation of land and other factor markets. 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 as fiscal decentralization reduced alternative revenue sources for local governments (Qun et al. 2015). Revenue generated in this way provides a huge implicit subsidy to industrialization (Ding and Lichtenberg 2011), with negative impacts on availability of land for residential and housing purposes (Peng and Thibodeau 2012).

This pattern of land development, which would be difficult to maintain without complementary restrictions in labor markets that in and of themselves may lead to considerable efficiency losses (Au and Henderson 2006b), has several consequences. First, as local governments compete to attract industry, prices for industrial land in China have remained very low (World Bank and DRC, 2014). Supplying land to industry below its real value led to inefficient use of a valuable resource; in fact a nation-wide survey in 2003

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1 The average is for urban areas in East Asia with more than 5 million inhabitants in 2010 (World Bank and DRC 2014).
2 Farmers’ residential land is often not expropriated, something that led to the spread of ‘urban villages’, i.e. unplanned neighborhoods that tend to provide shelter for migrants tend exert negative externalities on prices for neighboring properties (Song and Zenou 2009). It is estimated that 140-150 mn migrants are estimated to live in some 50,000 urban villages (Tan et al. 2011).
3 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).
suggests that 70% of land in China’s Development zones was unused (Du and Peiser 2014). Meanwhile, residential land prices in Chinese cities increased dramatically, affecting affordability of housing for most of the population: in Beijing, real constant quality values for residential land rose by nearly 800% since 2003 with half of the increase having occurred during the 2008-10 period (Wu et al. 2012). Second, expropriations without what is perceived to be fair compensation contribute to conflict between farmers and government (Nitikin et al. 2012). They also undermine security of property rights, investment, land market functioning, and thus the efficiency of land use. Third, use of one-off land transfer revenue to finance recurrent local government expenditure is not viable in the long term and, in light of China’s limited endowment with fertile land, will affect long-term food security. Local governments’ high levels of collateralization of ‘land banks’, accumulation of bad debts, and ‘land hoarding’ all can lead to serious problems in the financial sector (Du and Peiser 2014).

As land acquisition has increasingly become a focal point for legal disputes and rural unrest (Whiting 2011), efforts to find solutions focused on two areas. First, there have been calls to increase compensation paid to farmers and to make auctions rather than negotiation mandatory for all cases where land is made available for industry use. But determining an ‘appropriate’ level of compensation in a dynamic market is difficult. More importantly, local governments compete fiercely for industrial investment and auctions have been shown to be easily manipulated so that even their systematic use will not stop corruption (Cai et al. 2013). Although direct rural-urban land transfers could eliminate these problems, few rural residents would be willing to give up their land unless an equivalent social safety net and source of income in old age was available (Ong 2014). Failure to capture the gains in land value from changing from rural to urban land use in a more sustainable way also undermines local governments’ ability to provide social services. A tax on land or capital gains could help to do so but can only be implemented if institutional preconditions are met, in particular if a proper cadastral database is in place (Nitikin et al. 2012).

This suggests that viable reforms would need to pursue a multi-pronged approach, including (i) registration of all rural land; (ii) a possibility for migrants to get an urban hukou that provides access to social services, especially if they give up part or all of 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 (iv) 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). Several experiments were undertaken to explore available options. These include integration of construction and collective land markets in Shenzen, land security development in Chongqing, urban fringe redevelopment in Beijing, land readjustment in

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4 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).

5 Land thus emerged as a key policy issue (Wong 2014) with multiple institutional challenges (Pan et al. 2015).
Meitan, and the rural-urban integration in Chengdu to be studied here (World_Bank and DRC 2014). While some appear to have had positive effects, a more systematic evaluation of their impact on household welfare could help distill lessons to inform the potential nature and direction of future policy reforms in this area.

2.2 The Chengdu experiment

Chengdu prefecture includes 20 counties/districts with a total area of 12,000 km² and a population of 11 million, of which 5 million are rural residents. In 2008, it was named as pilot area for the comprehensive 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 wasteland – 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. 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 to allow more market-oriented and transparent mechanisms for price discovery. It also aimed 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. 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 migration without the fear of losing an essential social safety net, or the sale of part of a migrant’s land in her place of origin to finance start-up of small enterprises in urban areas.

The experiment attracted interest from policy makers, scholars and the media. Case studies suggest 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; (ii) increased volume of land transactions for agricultural and construction land that are likely to enhance efficiency and incipient markets for secondary transactions and land conversion; 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

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6 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.

7 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.

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

2.3 Analytical approach and data sources

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 the boundary), as illustrated in figure 1 to assess household-level effects of Chengdu’s property rights reform on household welfare, time use, inputs into and productivity of agricultural production. A modified regression discontinuity design whereby reform effects are identified by comparing between counties located just inside the prefecture border who were affected by the reform and otherwise comparable ones just outside the border who were not is applied. Ideally, we would have liked a sample to include data from the same households before and after the reform. The fact that NBS changed its panel of households in 2011 makes this impossible. The ability to use 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. 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 detailed logbooks to record consumption on a daily basis (Chen and Ravallion 1996), NBS data on consumption are considered of exceptionally high quality (Jalan and Ravallion 1999). Beyond information on consumption, the survey includes (less precise) data on income and individual members’ labor supply 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 total working age population, agricultural land, and distance to public health and education facilities to control for village level time-varying effects.

With 9-13 villages per county and a sample size of 10 households per village, the pre-reform sample comprises a total of 310 and 470 households inside and outside Chengdu, respectively. The post-reform sample similarly includes 280 and 390 households inside and outside the prefecture boundary. After dropping some 5% of sample households who neither engaged in productive activities nor participated in labor markets due to old age or disability, we end up with a sample of 285 pre- and 259 post-reform households.

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9 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.
10 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.
11 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.
households inside Chengdu and 453 and 382 households in neighboring counties (Meishan and Ziyang) in the pre-and post-reform sample, respectively.

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

\[ Y_{ijt} = \alpha + \beta_1 R_{ijt} + \beta_2 C_{ij} T_{ij} + \beta_3 T_{ijt} + \beta_4 C_{ij} T_{ijy} + \beta_5 R_{ijt} T_{ijt} + \beta_6 C_{ij} R_{ijt} T_{ijt} + \beta_7 X_{ijt} + \beta_8 V_{ijt} + \delta_{ij} + \varepsilon_{ijt} \tag{1} \]

where \( Y_{ij} \) is the outcome of interest for household \( I \) in village \( j \) in year \( t \); \( X_{ijt} \) 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 from pension and medical schemes as well as crop subsidies received; \( V_{ijt} \) is a vector of time-varying village characteristics including total working age 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; \( R_{ij} \) 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.

Our main interest is in \( \beta_6 \), the estimated mean impact of the reform.

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

\[ \Delta Y_{ijt} = \beta_3 + \beta_4 C_{ij} + \beta_5 R_{ijt} + \beta_6 C_{ij} R_{ijt} + \beta_7 \Delta X_{ijt} + \beta_8 \Delta V_{ijt} + \Delta \varepsilon_{ijt} \tag{2} \]

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:

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

where \( E_{ijt-1} \) 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, \( \gamma_s \), and its variation with pre-existing endowments, \( \gamma_s \).

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

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12 In some of our regressions, outcomes are at the individual rather than the household level. We do not include another subscript to avoid clutter.
Miller 2015) and report p-values from wild cluster bootstrap consistently for coefficients of interest (β6 and γ8) and take this into account consistently in interpreting results. From a substantive perspective, the validity of our identification strategy hinges on two assumptions. First, we need to ascertain there are no pre-existing time varying unobservables between treatment and control. Second, there is 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.

3. Descriptive statistics and the nature of the reforms

While households inside and outside Chengdu differed from each other in terms of income, time use, and agricultural yields between, 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 Chengdu (col. 1-4), estimated pre-reform trends (cols. 5 and 6), and a test of the significance of differences in such trends between households inside and outside the Chengdu border. 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 and Y40,025, Y4,928 and Y8,549, and Y3,150 and Y6,078 in pre- and post-reform periods, respectively) than those outside (Y11,564 and Y29,752, Y3,770 and Y8,069, and Y2,668 and 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%). These shares changed significantly over time -to 30% and 40% for agriculture, 16% and 25% for migration, and 21% and 11% in local off-farm employment for treatment and control group, respectively. But the last column indicates pre-reform trends are not significantly different between the two, supporting our identification strategy.

With respect to agricultural production, households in Chengdu prefecture cultivated smaller areas (3.45 vs. 4.79 mu) in 2005/06 but spent more on inputs (456 vs. 368 Y/mu) and obtained higher monetary output per mu (1,880 vs. 1,254 Y/mu) and net revenues (1,406 vs. 957 Y/mu) than those outside. While pre-reform
trends suggest a strongly declining trend in most of these variables inside compared to outside Chengdu, a glance at 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. For example, the area share of vegetables increased from 14% to 21% inside and 10% to 13% outside the boundary. But value of output and net revenue per mu actually decreased, suggesting that econometric analysis that controls for other factors will be needed.

The bottom panel of table 1 illustrates that the period coincided with expansion of subsidies for grain, seed, and other inputs. Yet, if anything, the absolute magnitude and growth rate of these was more pronounced outside as compared to inside the Chengdu border. Similarly, the rural pension and cooperative medical schemes were rolled out over the period but our data suggest that net receipts from these schemes were, if anything, lower to for households inside the prefecture boundary than outside.

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.13 As discussed in detail below, we cannot reject the hypothesis of no significant differences in pre-reform trends between households inside and outside the border 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. Some significant pre-reform trends 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 inputs (-38% vs. -16%). Output shares of wheat and other grains increased and those of oil crops decreased in Chengdu while the opposite was true for households in neighboring counties. Also, key interventions in place during the period of concern are a new rural pension scheme (Lei et al. 2013), cooperative medical scheme (Wagstaff et al. 2009), and 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 in such schemes, in addition for a wide range of household-level observables, in our regressions.

3.2 Nature and cost of the certification process

To quantify costs of the reform, we use the overlap between the counties in our sample and a village survey administered in May 2014 on either side of comparable stretches of the administrative border of Chengdu prefecture (Deininger et al. 2015). Characteristics of the certification process for different types of land are described in table 2. The average village has an area of about 7,500 mu (5 km²) of which some 51% were

\[ Y_{it} = \alpha + \beta_1 C_i + \beta_2 T_t + \beta_3 C_i T_t + \epsilon_{it} \]

\[ \text{where } C_i \text{ is an indicator variable for location inside Chengdu and } T_t \text{ is a time. With } \beta_2 \text{ and } \beta_3, \beta_2 + \beta_3 \text{ as the pre-reform trend for households outside and inside the Chengdu boundary, significance of } \beta_3 \text{ implies that the parallel trends assumption can be rejected and we report the level of significance for this variable in table 1, col. 7.} \]
arable land, 23% forest, and close to 4% 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.

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 55% of villages, land registration led to dispute and, where this was the case, an average of 14.9 disputes per village emerged. Disputes was most pervasive for arable and forest land (which attracted disputes 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 disputes emerged, most cases were resolved by local 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 8.6 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 7.7 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 exceeded program cost. Reforms contributed to job creation with an increase in labor supply by males and a shift from migration to agricultural activities by the young and from farming to off-farm activities by the old. It also resulted in increases of agricultural yields by 55% and of profits by 38%, more intensive input use, a shift of crop composition towards higher-value crops, and higher rental market activity to transfer land from less to more productive users.

4.1 Welfare impacts of property rights reform

Estimates of reform-induced impacts on consumption and income as well as shifts in the contribution of different sources to total income 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 and per capita income of 7.7 and 6.7 percentage points, respectively, robust to clustering. This implies estimated annual reform benefits of Y 70 to Y 95 per mu,14 well above the Y 8.6 per mu it cost to implement the land certification program (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 suggests that effects of Chengdu’s land reforms on per capita consumption were pro-poor: income for households where the head’s education was below junior high is estimated to have increased by 14.7 points but those with more than this compulsory level of education are estimated to not have benefited at all. Similarly, the z-score for assets interacted with the Chengdu dummy is negative and significant. It suggests reforms benefited those with lower assets but not those with above average wealth.

In addition to levels of consumption and income, exploring reform impacts on income composition (col. 3-6) provides pointers on factors that may underpin such shifts. Panel A suggests that reforms led to a significant increase in the overall share of income from farming (by 4.6 percentage points) and a decrease in the income share of local wages (by some 2.7 percentage points). Again, bootstrapped p-values imply that 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 varied 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 7.3 (4.6) points- but no changes by those with higher initial education or asset levels, consistent with the notion that reduction of expropriation threats led to more effective use of agricultural land that created jobs for the less-skilled.

4.2 Impacts on time use

If, for example by promoting land-related investment or productivity-enhancing transfers of land to more efficient uses or users via rental markets, reforms increased productivity of land use and wages or changed certain activities’ relative productivity, we would expect corresponding shifts in overall labor supply or time allocation across sectors.15 As we have individual level data on labor supply, we can use regressions for all individuals of working age (16-60 or 16-55 for males and females) in the sample to disaggregate estimated reform effects by gender.16 Doing so suggests that reforms led to an expansion of labor market opportunities and a significant increase in total labor supply by males -with the young (16-40 years old) focusing on agriculture and the old (41-60 years old) on off-farm work and similar shifts, though no change in aggregate labor supply, by females.

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14 With a mean cultivated area of 3.45 mu, the estimated benefit per mu in terms of consumption and income is 3,150*0.077/3.45 and 4,928*0.067/3.45, respectively.

15 As we have information on time use at individual level, analyzing this aspect also allows us to obtain gender- and age-differentiated estimates of reform impacts, in line with evidence that such differences could be important (Wang 2014).

16 The age brackets of 16-60 years (or 55 for females) are in line with the age for participation in formal labor markets.
Results for males and females in the first two panels of table 4 imply that reforms led to an increase of overall annual labor supply of almost 0.4 months by males but not by females. Disaggregating by age suggests that young males spent more of their labor time in agriculture and less in off-farm (0.64 and 0.33 months, respectively), while the old worked more in off-farm self-employment (0.42 months). For females, the point estimate of changes in total labor supply is insignificant but we note a marginally significant (10% level) reduction in time spent migrating (0.44 months) by the young and a reduction of labor supply to agriculture (-0.55) that is only partly made up for by an increase (0.22) in time spent in off-farm activities. Aggregated over all individuals of working age to the household level (table 4 panel 3), the estimate for reform-induced changes in number of months worked is positive but insignificant. For the young, the significant reform-induced shift towards agriculture and away from off-farm and, to a lesser extent, migration, is confirmed.

4.3 Agricultural productivity and output composition

A plausible explanation for the estimated changes in income shares from and labor supply to farming is that reform made investment in agriculture more rewarding, thus increasing productivity in the sector. Table 5 and 6 present results with respect to reform effects on agricultural yields and profits, land market activity, input use, and composition of output from agricultural production that allow to empirically test this conjecture. Cols. 1 and 2 of table 5 panel A point towards reform-induced increases of revenues from agricultural production by more than 50% or an increase in profits of 38% (significant at 10%). Panel B suggests that such increases in yields and profits were particularly high for those with less than the required level of education. Panel C suggests that reform-induced increases in yield, but not profits, were particularly large for those with above-average levels of assets.

While we have information on one side (renting in) of the rental market only, reforms are estimated to have increased land market activity by 5.5 percentage points, beyond a secular increase of land rental activity of 2.5 percentage points (col. 3), a large increase compared to the initial level. A mechanism to plausibly explain this finding is that more secure tenure makes it easier to transfer land without having to fear it will be expropriated (Deininger and Jin 2005). Panel B points to insignificant variation with initial education while panel C suggests that reform effects on renting in were even more pronounced for those with higher levels of initial assets.17

Although significant differences in pre-reform trends of purchased input use and composition of output between households inside and outside Chengdu suggest that some ‘catching up’ may be involved, results in table 5 point towards a marked reform-induced substitution of purchased inputs for labor. As the effect

17 This contrasts to other studies (Deininger et al. 2014), reinforcing the notion that reform-induced increments in tenure security made investment in agriculture more attractive.
of fertilizer and pesticides are felt beyond the current production cycle (Jacoby et al. 2002), this is consistent with the notion of reforms having reduced investment disincentives and thus provided greater incentives to apply purchased inputs and adjust to rising wages (Ge and Yang 2014) and increase efficiency. Reforms are estimated to have reduced per-mu intensities of fertilizer, pesticides, and seeds by 108%, 67%, and 39%, respectively, while reducing that of hired labor by 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 (-1.2%) and wheat (-1.3%). With point estimates of -3.4% for wheat, and -2.8% for rice, the estimated magnitude of reform-induced effects exceeds that of secular trends. Such declines were almost entirely compensated for by reform-induced increases in the area devoted to vegetables (+2.6%), oil crops (+3.4%), and corn (+2.1%). 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), possibly due to the more capital-intensive or risky nature of this crop.

5. Conclusion and policy implications

Our data suggest that Chengdu’s property rights reforms were implemented swiftly and effectively, with three main effects. First, reforms helped increase consumption and income, in particular for less educated and affluent households. Interestingly, estimated benefits exceed the cost of reform implementation. Second, they increased overall labor supply and contributed to a shift of labor by young males and females towards the agricultural sector, a move which, for females, coincided with a significant reduction of the time spent migrating. Finally, reforms contributed to higher agricultural yields and profits through three channels, namely (i) greater rental market activity that transferred land to more productive producers; (ii) substitution of purchased inputs for labor; and (iii) a shift out of grains towards vegetables, corn, and oilseeds, all of which offer higher levels of profitability.

All of these findings are consistent with the notion that, without reforms, tenure insecurity and transaction cost in factor markets undermined investment and functioning of land and labor markets, preventing high-value peri-urban land from being used most effectively and reducing job creation, especially for the less affluent and educated. As China considers how to build on what has been achieved, pilot results point to important substantive lessons in terms of key elements of reform implementation and elements of what has been done in Chengdu reform are thus likely to form an integral part of any future reform package. While we can only estimate impacts of the entire reform package rather than individual components, careful design of future reforms, with an emphasis on evaluation right from the start, could help to further enhance lessons

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18 Reform-induced increases in supply of (young) own labor noted above are consistent with this reduced reliance on hired labor.
for policy. Beyond China, there are many countries (e.g., Vietnam, Ethiopia, Nigeria, Tanzania) where a need for public sector intervention hampers the functioning of peri-urban land markets and negatively affects tenure security. Although not combined with Chinese-style migration restrictions, our results suggest that such policies could have sizeable effects on agricultural productivity and job creation in ways that would warrant policy makers’ attention and careful policy review.
Figure 1: Location of treatment and control counties
Table 1: Descriptive statistics for household outcomes

| Household characteristics                          | Before Outside | Inside | After Outside | Inside | Before Trend Outside | Inside | Sig. |
|---------------------------------------------------|----------------|--------|---------------|--------|----------------------|--------|------|
| 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 |      |
| Total assets per capita                            | 11,564         | 16,063 | 29,752        | 40,025 | 0.070                | 0.031  |      |
| 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 selfemp.              | 0.05           | 0.08   | 0.05          | 0.07   | 0.001                | 0.014  |      |
| Share of inc. from other                          | 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 |      |
| **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  |      |
| **Males 16-40 years old**                         |                |        |               |        |                      |        |      |
| Months for farming per member                     | 3.13           | 3.08   | 1.06          | 1.71   | -0.290               | -0.334 |      |
| Months for local off-farm per member              | 1.16           | 1.83   | 1.31          | 2.42   | -0.092               | 0.384  |      |
| Months for migration per member                    | 5.52           | 4.30   | 7.16          | 3.84   | 0.431                | 0.210  |      |
| **Males 41-60 years old**                         |                |        |               |        |                      |        |      |
| Months for farming per member                     | 7.53           | 5.57   | 4.83          | 2.50   | -0.304               | -0.504 |      |
| Months for local off-farm per member              | 1.33           | 2.15   | 2.44          | 4.22   | 0.197                | 0.006  |      |
| Months for migration per member                    | 1.04           | 1.55   | 2.14          | 2.37   | 0.267                | 0.482  |      |
| **Females 16-40 years old**                       |                |        |               |        |                      |        |      |
| Months for farming per member                     | 4.92           | 4.63   | 2.70          | 3.46   | -0.282               | -0.586 |      |
| Months for local off-farm per member              | 0.85           | 1.69   | 0.80          | 1.27   | -0.057               | -0.080 |      |
| Months for migration per member                    | 3.73           | 2.48   | 5.69          | 2.13   | 0.330                | 0.659  |      |
| **Females 41-55 years old**                       |                |        |               |        |                      |        |      |
| Months for farming per member                     | 8.03           | 7.35   | 6.72          | 4.73   | -0.040               | -0.301 |      |
| Months for local off-farm per member              | 1.11           | 1.02   | 0.82          | 1.73   | 0.006                | 0.093  |      |
| Months for migration per member                    | 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  |      |
| Value of output (yuan/mu)                          | 1,254          | 1,880  | 1,471         | 1,578  | -0.021               | -0.111 |      |
| Area share of wheat                                | 0.10           | 0.07   | 0.05          | 0.03   | 0.015                | 0.020  |      |
| Area share of rice                                 | 0.14           | 0.21   | 0.14          | 0.16   | 0.011                | 0.001  |      |
| Area share of corn                                 | 0.10           | 0.06   | 0.12          | 0.06   | -0.010               | 0.011  |      |
| Area share of other grain                          | 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 |      |
| **Agricultural assets (yuan/mu)**                  | 174.07         | 168.29 | 191.48        | 134.63 | 0.353                | -0.183 |      |
| **Expenses on labor, seed, pesticide (yuan/mu)**   | 283.10         | 456.04 | 368.23        | 392.65 | -0.161               | -0.377 |      |
| **Net revenue (yuan/mu)**                          | 957            | 1,406  | 1,091         | 1,168  | 0.142                | 0.079  |      |
| **Other interventions**                            |                |        |               |        |                      |        |      |
| **Agricultural subsidy (yuan/mu)**                 | 13.08          | 21.01  | 85.48         | 68.00  | -0.162               | 0.110  |      |
| Contribution to rural pension (yuan)               | 0.00           | 0.00   | 361.16        | 620.85 | 0.000                | 0.000  |      |
| Rural pension income (yuan)                        | 0.00           | 0.00   | 443.10        | 605.81 | 0.000                | 0.000  |      |
| **Expense on cooperative medical scheme (yuan)**   | 7.83           | 45.79  | 130.06        | 254.19 | 0.151                | 0.854  |      |
| Medical expense paid by CMS (yuan)                 | 2.80           | 5.16   | 79.43         | 85.53  | 0.036                | -0.006 |      |
| **Observations**                                   | 906            | 570    | 764           | 518    | 453                  | 285    |      |

Note: Monetary values are deflated to 2005 by CPI for rural Sichuan. Educational levels are coded as 1=illiterate; 2=primary school; 3=junior high school; 4=high school or vocational school; 5=college and above. 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

| Main characteristics | Total | Collect | Contract | Forest | Constr. | Housing | Houses |
|----------------------|-------|---------|----------|--------|---------|---------|--------|
| **Total area**       | 14,377| 7,747   | 3,949    | 1,799  | 312     | 313     | 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** | 3,585 | 91      | 931      | 741    | 522     | 895     | 872    |
| **Area titled (mu)** | 10,673| 6,741   | 3,737    | 1,494  | 275     | 269     | 302    |
| **Total labor from village (man-days)** | 2,408 |          |          |        |         |         |        |
| **Total labor from outside (man-days)** | 271   |          |          |        |         |         |        |
| **Total cost (Y/mu)** | 8.60  |          |          |        |         |         |        |
| **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 done 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  |
| 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 based on 153 villages.*
Table 3: Estimated impact of property rights intervention on overall welfare

|                | Cons.       | Income      | Farming     | Local wage  | Off farm    | Migration   |
|----------------|-------------|-------------|-------------|-------------|-------------|-------------|
|                | Total       |             |             |             |             |             |
|                |             | Income from |             |             |             |             |
|                | Chengdu     | -0.038***   | -0.078***   | -0.022***   | 0.015***    | 0.015***    | -0.011*     |
|                |             | (0.002)     | (0.012)     | (0.004)     | (0.001)     | (0.001)     | (0.004)     |
|                | Post reform | 0.132***    | -0.006      | -0.001      | 0.000       | -0.013***   | -0.022*     |
|                |             | (0.012)     | (0.033)     | (0.004)     | (0.004)     | (0.002)     | (0.009)     |
|                | Chengdu*post| 0.077***    | 0.067**     | 0.046***    | -0.027**    | -0.002      | -0.002      |
|                |             | (0.007)     | (0.018)     | (0.004)     | (0.005)     | (0.004)     | (0.007)     |
| Bootstrapped p-value | 0.000 | 0.114 | 0.000 | 0.156 | 0.675 | 0.587 |
| Observations  | 1.379 | 1.379 | 1.379 | 1.379 | 1.379 | 1.379 |
| R-squared     | 0.136 | 0.104 | 0.034 | 0.035 | 0.030 | 0.077 |

|                | Panel B     |             |             |             |             |             |
| Chengdu        | -0.076***   | -0.052***   | -0.039***   | 0.026***    | 0.014***    | -0.023*     |
|                | (0.010)     | (0.008)     | (0.005)     | (0.003)     | (0.001)     | (0.007)     |
| Post reform    | 0.096***    | -0.030      | -0.002      | 0.002       | -0.014***   | -0.016      |
|                | (0.016)     | (0.036)     | (0.004)     | (0.004)     | (0.002)     | (0.009)     |
| > Junior high educ. | -0.037**   | -0.044***   | 0.019***    | -0.008*     | -0.002*     | 0.013**     |
|                | (0.008)     | (0.008)     | (0.002)     | (0.003)     | (0.001)     | (0.003)     |
| Chengdu*post   | 0.147***    | 0.056*      | 0.073***    | -0.054***   | -0.003      | 0.015       |
|                | (0.010)     | (0.022)     | (0.006)     | (0.007)     | (0.004)     | (0.012)     |
| > Junior high educ.*post | 0.107***   | 0.084***    | -0.002      | -0.000      | 0.006**     | -0.025**    |
|                | (0.011)     | (0.014)     | (0.002)     | (0.002)     | (0.001)     | (0.003)     |
| Chengdu*> junior high educ. | 0.099**   | -0.055***   | 0.038***    | -0.025**    | 0.001       | 0.027*      |
|                | (0.025)     | (0.009)     | (0.004)     | (0.005)     | (0.004)     | (0.010)     |
| Chengdu*> junior high educ.*post | -0.205*** | 0.002      | -0.067***   | 0.076***    | 0.004       | -0.042**    |
|                | (0.031)     | (0.017)     | (0.004)     | (0.004)     | (0.005)     | (0.013)     |
| Bootstrapped p-value | 0.156 | 1.000 | 0.156 | 0.000 | 0.482 | 0.416 |
| Observations  | 1.379 | 1.379 | 1.379 | 1.379 | 1.379 | 1.379 |
| R-squared     | 0.138 | 0.107 | 0.042 | 0.042 | 0.030 | 0.081 |

|                | Panel C     |             |             |             |             |             |
| Chengdu        | -0.041***   | -0.079***   | -0.022***   | 0.015***    | 0.015***    | -0.011*     |
|                | (0.003)     | (0.012)     | (0.003)     | (0.001)     | (0.001)     | (0.004)     |
| Post reform    | 0.132***    | -0.006      | -0.001      | -0.000      | -0.013***   | -0.022      |
|                | (0.012)     | (0.033)     | (0.004)     | (0.004)     | (0.002)     | (0.009)     |
| Z assets       | -0.045***   | -0.040***   | 0.014***    | 0.003**     | -0.003*     | -0.008**    |
|                | (0.005)     | (0.002)     | (0.001)     | (0.001)     | (0.001)     | (0.002)     |
| Chengdu*post   | 0.080***    | 0.069**     | 0.046***    | -0.027**    | -0.001      | -0.003      |
|                | (0.006)     | (0.018)     | (0.004)     | (0.005)     | (0.004)     | (0.007)     |
| Z assets*post  | 0.030***    | 0.035***    | -0.012***   | -0.010***   | 0.000       | -0.000      |
|                | (0.005)     | (0.002)     | (0.001)     | (0.001)     | (0.001)     | (0.002)     |
| Chengdu*z assets | 0.062***   | 0.035***    | 0.006      | -0.007***   | 0.001       | -0.012**    |
|                | (0.009)     | (0.007)     | (0.002)     | (0.000)     | (0.002)     | (0.003)     |
| Chengdu*z assets*post | -0.095*** | -0.044***  | -0.011***   | 0.029***    | 0.005       | 0.001       |
|                | (0.010)     | (0.011)     | (0.003)     | (0.003)     | (0.002)     | (0.007)     |
| Bootstrapped p-value | 0.000 | 0.266 | 0.000 | 0.000 | 0.408 | 0.905 |
| Observations  | 1.379 | 1.379 | 1.379 | 1.379 | 1.379 | 1.379 |
| R-squared     | 0.141 | 0.107 | 0.040 | 0.039 | 0.030 | 0.082 |

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 by age and gender, number of old people, family’s highest education, female household head, head’s age, agricultural subsidies received, contribution to rural pension, rural pension income, expense on cooperative medical scheme, and medical expense paid by cooperative medical scheme. Village characteristics include total labor, 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

|                  | Total       | Males only | Females only | Entire sample |
|------------------|-------------|------------|--------------|---------------|
|                  | Farming     | Young (16-40) | Migration | Farming | Off farm | Migration | Farming | Off farm | Migration |
| Panel 1          |             |            |             |           |           |           |           |           |           |
| Chengdu          | 0.172       | -0.100     | 0.619**     | -0.226    | -0.161    | -0.092    | 0.028    |
|                  | (0.089)     | (0.067)    | (0.109)     | (0.123)   | (0.137)   | (0.080)   | (0.151)  |
| Post reform      | 0.103       | 0.333      | -0.147      | 0.317     | 0.389*    | 0.011     | -0.504** |
|                  | (0.156)     | (0.302)    | (0.079)     | (0.244)   | (0.153)   | (0.150)   | (0.134)  |
| Chengdu*post     | 0.389***    | 0.646**    | -0.332***   | 0.092     | 0.082     | 0.415**   | 0.335    |
|                  | (0.039)     | (0.127)    | (0.045)     | (0.061)   | (0.179)   | (0.109)   | (0.206)  |
| Bootstrapped p-value | 0.268     | 0.258      | 0.146       | 0.148     | 0.651     | 0.000     | 0.424    |
| Observations     | 1,242       | 748        | 748         | 748       | 765       | 765       | 765      |
| R-squared        | 0.272       | 0.079      | 0.031       | 0.079     | 0.040     | 0.060     | 0.078    |
|                  |             |            |             |           |           |           |           |
| Panel 2          |             |            |             |           |           |           |           |
| Chengdu          | 0.144**     | 0.112      | -0.019      | 0.021     | -0.159*   | 0.120     | 0.039    |
|                  | (0.025)     | (0.114)    | (0.036)     | (0.123)   | (0.055)   | (0.069)   | (0.078)  |
| Post reform      | 0.898       | 0.480      | 0.182**     | 0.370     | 0.789     | 0.208     | -0.419   |
|                  | (0.473)     | (0.515)    | (0.045)     | (0.163)   | (0.514)   | (0.208)   | (0.241)  |
| Chengdu*post     | -0.232      | 0.315      | 0.040       | -0.435*   | -0.548**  | 0.221***  | 0.182    |
|                  | (0.148)     | (0.149)    | (0.109)     | (0.144)   | (0.128)   | (0.035)   | (0.089)  |
| Bootstrapped p-value | 0.256     | 0.202      | 0.909       | 0.202     | 0.102     | 0.102     | 0.374    |
| Observations     | 1,101       | 688        | 688         | 688       | 527       | 527       | 527      |
| R-squared        | 0.311       | 0.132      | 0.063       | 0.099     | 0.086     | 0.067     | 0.024    |
|                  |             |            |             |           |           |           |           |
| Panel 3          |             |            |             |           |           |           |           |
| Chengdu          | 0.372**     | 0.095      | 0.528***    | -0.117    | -0.275    | 0.076     | 0.003    |
|                  | (0.079)     | (0.130)    | (0.086)     | (0.159)   | (0.122)   | (0.178)   | (0.188)  |
| Post reform      | 0.837       | 0.585      | -0.058      | 0.342     | 1.110*    | 0.265     | -1.015** |
|                  | (0.541)     | (0.541)    | (0.086)     | (0.296)   | (0.402)   | (0.248)   | (0.189)  |
| Chengdu*post     | 0.269       | 0.964***   | -0.438***   | -0.258*   | -0.116    | 0.292     | 0.556    |
|                  | (0.141)     | (0.085)    | (0.054)     | (0.106)   | (0.206)   | (0.201)   | (0.283)  |
| Bootstrapped p-value | 0.278     | 0.136      | 0.000       | 0.000     | 0.783     | 0.358     | 0.356    |
| Observations     | 1,283       | 974        | 974         | 974       | 812       | 812       | 812      |
| R-squared        | 0.335       | 0.235      | 0.044       | 0.098     | 0.311     | 0.084     | 0.114    |

Note: Dependent variable is no. of months worked. Household characteristics that are controlled for throughout include number of children, number of adults by age and gender, number of old people, family's highest education, female household head, head's age, agricultural subsidies received, contribution to rural pension, rural pension income, expense on cooperative medical scheme, and medical expense paid by cooperative medical scheme. Village characteristics include total labor, 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. Average level of education and gender composition for the specific group are also controlled for. Robust standard errors in brackets are clustered by treatment status. *** p<0.01, ** p<0.05, * p<0.1.
Table 5: Estimated impact of property rights intervention on agricultural productivity

|                  | Yield | Profit | Rent in | Labor | Purchased input use | Seed | Fertilizer | Pesticide |
|------------------|-------|--------|--------|-------|---------------------|------|------------|-----------|
| **Panel A**      |       |        |        |       |                     |      |            |           |
| Chengdu          | -0.106** | -0.019 | 0.021** | 0.296*** | -0.030* | -0.650*** | -0.375*** |
|                  | (0.023) | (0.053) | (0.005) | (0.046) | (0.009) | (0.011) | (0.029) |
| Post reform      | -0.073 | -0.231 | 0.025** | 0.026 | -0.044 | -0.205*** | -0.257** |
|                  | (0.048) | (0.111) | (0.007) | (0.074) | (0.027) | (0.023) | (0.056) |
| Chengdu*post     | 0.548*** | 0.382* | 0.055*** | -0.172* | 0.387*** | 1.077*** | 0.667*** |
|                  | (0.073) | (0.128) | (0.004) | (0.065) | (0.020) | (0.028) | (0.056) |
| Bootstrapped p-value | 0.114 | 0.252 | 0.306 | 0.306 | 0.000 | 0.156 | 0.000 |
| Observations     | 1.379 | 1.379 | 1.379 | 1.379 | 1.379 | 1.379 | 1.379 |
| R-squared        | 0.138 | 0.077 | 0.031 | 0.032 | 0.032 | 0.061 | 0.039 |
| **Panel B**      |       |        |        |       |                     |      |            |           |
| Chengdu          | -0.091** | 0.038 | 0.015 | 0.193* | -0.105** | -0.574*** | -0.445*** |
|                  | (0.029) | (0.050) | (0.009) | (0.062) | (0.017) | (0.001) | (0.034) |
| Post reform      | -0.063 | -0.271* | 0.005 | 0.082 | -0.014 | -0.046* | -0.188** |
|                  | (0.056) | (0.114) | (0.009) | (0.077) | (0.037) | (0.019) | (0.057) |
| > Junior high educ. | 0.089** | 0.072 | -0.049*** | 0.095* | -0.080** | 0.611*** | 0.114** |
|                  | (0.021) | (0.043) | (0.007) | (0.035) | (0.017) | (0.013) | (0.024) |
| Chengdu*post     | 0.583*** | 0.440** | 0.049** | -0.168 | 0.332*** | 1.021*** | 0.742*** |
|                  | (0.085) | (0.137) | (0.009) | (0.088) | (0.040) | (0.044) | (0.071) |
| > Junior high educ.*post | -0.043 | 0.124** | 0.070*** | -0.196*** | -0.093* | -0.542*** | -0.252*** |
|                  | (0.029) | (0.031) | (0.008) | (0.027) | (0.031) | (0.018) | (0.036) |
| Chengdu*> junior high educ. | -0.059** | -0.161*** | 0.025 | 0.236** | 0.208** | -0.325*** | 0.149* |
|                  | (0.017) | (0.018) | (0.014) | (0.072) | (0.062) | (0.001) | (0.062) |
| Chengdu*> junior high educ.*post | -0.103* | -0.223** | 0.011 | 0.103 | 0.221** | 0.275** | -0.152 |
|                  | (0.038) | (0.058) | (0.017) | (0.047) | (0.057) | (0.061) | (0.075) |
| Bootstrapped p-value | 0.220 | 0.114 | 0.639 | 0.382 | 0.108 | 0.156 | 0.260 |
| Observations     | 1.379 | 1.379 | 1.379 | 1.379 | 1.379 | 1.379 | 1.379 |
| R-squared        | 0.140 | 0.080 | 0.035 | 0.034 | 0.034 | 0.074 | 0.043 |
| **Panel C**      |       |        |        |       |                     |      |            |           |
| Chengdu          | -0.104** | -0.028 | 0.022** | 0.310*** | -0.045* | -0.637*** | -0.366*** |
|                  | (0.022) | (0.048) | (0.005) | (0.039) | (0.015) | (0.010) | (0.030) |
| Post reform      | -0.080 | -0.245 | 0.025** | 0.035 | -0.051 | -0.193*** | -0.256** |
|                  | (0.054) | (0.118) | (0.007) | (0.070) | (0.027) | (0.029) | (0.058) |
| Z assets         | 0.074*** | 0.059** | 0.017*** | 0.041* | -0.146*** | 0.039** | -0.016 |
|                  | (0.005) | (0.011) | (0.001) | (0.015) | (0.008) | (0.011) | (0.009) |
| Chengdu*post     | 0.553*** | 0.396* | 0.054*** | -0.187** | 0.404*** | 1.061*** | 0.666*** |
|                  | (0.076) | (0.131) | (0.004) | (0.058) | (0.015) | (0.035) | (0.059) |
| Z assets*post    | -0.125*** | -0.026* | -0.026*** | -0.036 | 0.149*** | -0.113*** | -0.148*** |
|                  | (0.010) | (0.011) | (0.002) | (0.018) | (0.009) | (0.017) | (0.009) |
| Chengdu*z assets | 0.001 | 0.276*** | -0.019* | -0.342*** | 0.376*** | -0.347*** | -0.182*** |
|                  | (0.008) | (0.020) | (0.004) | (0.028) | (0.009) | (0.011) | (0.020) |
| Chengdu*z assets*post | 0.320*** | -0.014 | 0.027*** | 0.297*** | -0.389*** | 0.227*** | 0.526*** |
|                  | (0.009) | (0.025) | (0.003) | (0.014) | (0.021) | (0.038) | (0.022) |
| Bootstrapped p-value | 0.156 | 0.494 | 0.300 | 0.114 | 0.000 | 0.000 | 0.150 |
| Observations     | 1.379 | 1.379 | 1.379 | 1.379 | 1.379 | 1.379 | 1.379 |
| R-squared        | 0.166 | 0.104 | 0.032 | 0.037 | 0.039 | 0.074 | 0.053 |

Note: Household characteristics include number of children, number of adults by age and gender, number of old people, family’s highest education, female household head, head’s age, agricultural subsidies received, contribution to rural pension, rural pension income, expense on cooperative medical scheme, and medical expense paid by cooperative medical scheme. Village characteristics include total labor, 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.

Robust standard errors in brackets are clustered by treatment status. *** p<0.01, ** p<0.05, * p<0.1.
Table 6: Estimated impact of property rights intervention on crop choice

| Panel A                  | Share of area planted with | Wheat | Rice | Corn | Oth. grain | Vegetable | Oil crops |
|--------------------------|----------------------------|-------|------|------|------------|-----------|-----------|
| **Chengdu**              |                            | 0.029** | 0.007*** | -0.009** | 0.020*** | -0.007 | -0.044*** |
| Post reform              |                            | -0.013* | -0.012*** | -0.013* | 0.010 | 0.019 | 0.009 |
| Chengdu*post             |                            | -0.034*** | -0.028*** | 0.021** | -0.025*** | 0.026** | 0.034*** |
| Bootstrapped p-value     |                            | 0.000 | 0.228 | 0.130 | 0.098 | 0.130 | 0.000 |
| Observations             |                            | 1,369 | 1,369 | 1,369 | 1,369 | 1,369 | 1,369 |
| R-squared                |                            | 0.103 | 0.072 | 0.030 | 0.064 | 0.049 | 0.054 |

**Panel B**

| **Chengdu**              |                            | 0.026** | 0.006 | -0.006 | 0.023*** | -0.017** | -0.032*** |
| Post reform              |                            | -0.009 | -0.010*** | -0.010 | 0.012 | 0.017 | 0.001 |
| > Junior high educ.      |                            | 0.006*** | -0.001 | 0.006*** | -0.004 | -0.004 | 0.004 |
| Chengdu*post             |                            | -0.045*** | -0.035*** | 0.017* | -0.030*** | 0.057*** | 0.030*** |
| > Junior high educ.*post |                            | -0.012*** | -0.005*** | -0.009*** | -0.006** | 0.000 | 0.028*** |
| Chengdu*> junior high educ. |                       | 0.008 | 0.001 | -0.008* | -0.004 | 0.025** | -0.030*** |
| Chengdu*> junior high educ.*post |                   | 0.039*** | 0.022*** | 0.012* | -0.009*** | 0.006 | 0.005 |
| Bootstrapped p-value     |                            | 0.228 | 0.118 | 0.160 | 0.204 | 0.100 | 0.472 |
| Observations             |                            | 1,369 | 1,369 | 1,369 | 1,369 | 1,369 | 1,369 |
| R-squared                |                            | 0.108 | 0.075 | 0.031 | 0.065 | 0.058 | 0.058 |

**Panel C**

| **Chengdu**              |                            | 0.030** | 0.007*** | -0.009** | 0.021*** | -0.007 | -0.044*** |
| Post reform              |                            | -0.013** | -0.011*** | -0.013* | 0.010 | 0.019 | 0.009 |
| Z assets                 |                            | 0.010*** | -0.000 | -0.007*** | 0.002* | -0.004*** | 0.000 |
| Chengdu*post             |                            | -0.035*** | -0.027*** | 0.020** | -0.025** | 0.028** | 0.034*** |
| Z assets*post            |                            | -0.006** | 0.004** | 0.011*** | -0.006** | -0.002 | -0.003 |
| Chengdu*z assets         |                            | -0.007 | -0.003* | 0.011*** | -0.007** | 0.012** | -0.005 |
| Chengdu*z assets*post    |                            | -0.003 | 0.027*** | 0.033*** | 0.002 | 0.012** | -0.002 |
| Bootstrapped p-value     |                            | 0.883 | 0.160 | 0.100 | 1.000 | 0.098 | 1.000 |
| Observations             |                            | 1,369 | 1,369 | 1,369 | 1,369 | 1,369 | 1,369 |
| R-squared                |                            | 0.105 | 0.080 | 0.035 | 0.066 | 0.051 | 0.055 |

Note: Household characteristics include number of children, number of adults by age and gender, number of old people, family’s highest education, female household head, head’s age, agricultural subsidies received, contribution to rural pension, rural pension income, expense on cooperative medical scheme, and medical expense paid by cooperative medical scheme. Village characteristics include total labor, 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. Robust standard errors in brackets are clustered by treatment status. *** p<0.01, ** p<0.05, * p<0.1.
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