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Property rights reform to support China's rural - urban integration: household-level evidence from the Chengdu experiment

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In 2008, as part of a national experiment, Chengdu prefecture implemented ambitious property rights reforms including complete registration of all land together with measures to ease transferability and eliminate migration restrictions. Results from a difference-in-difference analysis of the National Statistics Bureau's regular household survey suggest that the reforms increased consumption and income, in particular for less wealthy and less educated households, with estimated benefits well above the cost of implementation. Local labour supply increased with the young shifting towards agriculture and the old towards off-farm employment. The reforms also 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 labour; 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, imperfections in factor markets undermined investment and functioning of land and labour markets, preventing high-value peri-urban land from being used most effectively and reducing job creation.

Key words: China, productivity, property rights, time use.

1. Introduction

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 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 expansion of industrial activity (Ding and Lichtenberg 2011) and economic growth (Glaeser 2011). At the same time,

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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 inequality (Dollar 2007; Wen and Xiong 2014). Moreover, it also led to inefficient land use (Du and Peiser 2014), bad loans secured with local governments' land banks (Au and Henderson 2006; Du and Peiser 2014), rural unrest (Whiting 2011), and given China's limited agricultural land endowment, concerns about negative impacts on food security (Lichtenberg and Ding 2008). 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 arguing for simultaneous action in a number of areas to address these concerns.

Cognisant of this challenge, a number of national experiments were conducted to explore the scope for alternative and potentially more sustainable arrangements (World Bank and DRC 2014). In this context, the prefecture 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 labour 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, 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 a key reform area by China's leadership, drawing the lessons from past reform experiments is important. Yet, beyond anecdotal accounts, few studies assess either the magnitude of impacts associated with the Chengdu experiment or their incidence among different types of households. This paper contributes to the literature by employing a difference-in-difference (DID) analysis of household survey data from the intervention area and a control group to assess the impact of the package of peri-urban factor market reforms implemented in 2008 on household welfare and economic activity, overall and for specific sub-groups in the population. Although we are unable to evaluate the impact of the different elements of the reform package separately, our finding of significant reform effects on welfare and income composition, labour market participation, crop choice, and agricultural productivity suggests that efforts to increase tenure security and improve land and labour market functioning were highly complementary.

To provide a rigorous quantitative assessment, we use the fact that the experiment was implemented in Chengdu prefecture, with neighbouring counties remaining unaffected. Data in 2005/06 and 2011/12 from National Bureau of Statistics' (NBS) regular rural household survey for counties on both sides of the boundary allow us to assess impacts of the reform package on household consumption and income, labour supply, incidence of land rental, crop choice and productivity of agricultural land use. We use a DID approach based on changes before (2005/06) and after (2011/12) the reform and inside versus 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. We 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 of the boundary.

Results suggest that 3 - 4 years after it was completed, the rural - urban integration reform experiment had led to significant consumption growth, estimated at 7.7%, 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 land titling. 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 that removal of constraints to land and labour market operation encouraged more effective use of highly productive peri-urban land to intensify agricultural production, thereby increasing job opportunities and resulting in changes of labour 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 2 provides context by highlighting how land and labour market imperfections affected the nature of China's urbanisation and discusses how reforms under the Chengdu experiment aimed to address both markets simultaneously. Section 3 introduces analytical methodology and presents descriptive statistics. Section 4 discusses impacts on household welfare, individual labour supply, and agricultural productivity and crop composition. Section 5 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, posing 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. Enhancing marketability of land, together with elimination of the residence (*hukou*) restrictions (or the unpalatable requirement of giving up land rights to access social benefits in urban areas), has often been advocated to address this. As it includes both elements (together with ways to make land transfers easier), the package of reforms introduced in 2008/09 in Chengdu prefecture thus provides a unique opportunity to contribute to the literature by empirically exploring the extent to which such reforms could live up to their potential. Next, we describe the nature of the reforms and our analytical approach to evaluate their impact.

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

In the 2000 - 2010 period, China experienced an enormous expansion in its urban areas (World Bank 2014), while the rural–urban income inequality widened (Dollar 2007; Wen and Xiong 2014). High rates of land conversion are viewed as a key contribution to this and, give rise to factor market distortions and often inefficient and unsustainable land use (Au and Henderson 2006; Du and Peiser 2014). This can largely be attributed to its dual land system under which 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,[1] land acquired in this way can be transferred by local government at prices hundred times or more what was paid in compensation (Murray and Frijters 2016).

The scope for realising 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 decentralisation reduced alternative revenue sources for local governments (Qun *et al*. 2015). Revenue generated in this way provides a huge implicit subsidy to industrialisation (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 is widely perceived as unsustainable (Au and Henderson 2006) 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), leading to inefficient

[1] Farmers' residential land is often not expropriated, which has led to the spread of 'urban villages', unplanned neighbourhoods that often shelter migrants and lower prices for neighbouring properties (Song and Zenou 2009). An estimated 140 - 150 million migrants live in some 50,000 urban villages (Tan *et al*. 2011).

use of a valuable resource (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).[2] 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 collateralisation of 'land banks', accumulation of bad debts, and 'land hoarding' all can lead to serious problems in the financial sector (Du and Peiser 2014).[3]

As land acquisition has increasingly become a focal point for legal disputes and rural unrest (Whiting 2011), there have been calls to increase compensation paid to farmers. 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.

Several experiments were undertaken to explore available options. These include integration of construction and collective land markets in Shenzhen, land security development in Chongqing, urban fringe redevelopment in Beijing, land readjustment in Meitan, and the rural–urban integration in Chengdu studied here (World Bank and DRC 2014). A more systematic evaluation of their impact on household welfare could help distil 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 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 reform under a Commission for Balanced Urban-Rural Growth (CBRUG). Three

[2] Between 1987 and 2001, alone, an estimated 40 - 50 million farmers lost half or more of their land to expropriation and of these only about half obtained an urban hukou giving them access to social services and education for their children (Tao and Xu 2007).

[3] Land has thus become a major policy issue (Wong 2014) with multiple institutional challenges (Pan, Huang, and Chiang 2015).

key changes were introduced (Li 2012) and rolled out in 2008 and 2009. 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.[4] The purpose was to establish clear and secure property rights as a basis for long-term contracts for agricultural or construction land.[5] Second, the Chengdu Rural Property Rights Exchange was established as a platform for transactions of all types of rural property rights,[6] including *zengjian guagou* quotas for construction land to allow market-oriented transparent mechanisms of price discovery.[7] It aimed to allow farmers and collectives to take the initiative in auctioning *zengjian guagou* quotas via competitive bidding, changing government's role 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 locals.[8] Third, as rural residents do not have to give up their land use rights to obtain a unified *hukou*, those who work and/or live in the urban areas can more actively participate in the land rental market without fear of losing land. In addition to unifying *hukou* and the social welfare systems, reforms thus explicitly eliminate the restrictions that had traditionally characterised farmers' land use rights.[9] As these elements were introduced concurrently, we can only evaluate their joint effect.

The experiment attracted interest from policy makers, scholars, and the media. While documented widely in Chinese newspapers, blogs and journals, there are very few quantitative studies exploring the effects of the Chengdu experiment. The small number of quantitative studies (Mao and Kong 2010; Li 2011; National School of Development 2012; Huang and Tan 2015;), nonetheless, points towards positive reform effects in terms of: (i) increased volume of land transactions for agricultural and construction land; (ii) higher levels of investment in high-value perennials and vegetables; (iii) accelerated transfer of rural labour out of agriculture; and (iv) increased income as gains

[4] Central government portal has relevant information at http://www.gov.cn/jrzg/2011-02/28/content_1812352.htm.

[5] Titles to homesteads were given on occupied land although the size of plots frequently exceeded legal norms or what was documented on past certificates. Use rights to collectively owned construction land, for example for rural enterprises, public interest, and other purposes, were also documented.

[6] The official website of the Chengdu Rural Property Rights Exchange is at http://www.cdaee.com/.

[7] *zengjian guagou* quotas refers to tradable development quota that was first introduced in 2006 in Shandong, Tianjin, Jiangsu, Hubei, and Sichuan, where increases in urban construction area had to be balanced by decreases in rural construction area (Economic Information Daily 2011).

[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.

[9] The NDRC website has relevant information at: http://tgs.ndrc.gov.cn/zhptggsd/201011/t20101122_381468.html.

from reforms are shared more broadly throughout the local economy. Although potentially valuable to identify underlying mechanisms, such evidence is often based on non-representative samples and lacks a clear counterfactual and thus does not allow rigorous quantification of the benefits from the reform.

3. Data and analytical approach

We use data from the National Bureau of Statistics' regular household survey in seven counties adjacent to the border of Chengdu prefecture (three counties inside and four outside the boundary),[10] 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.

3.1. Analytical approach

Reform effects are identified by comparing between households 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 representative panel data sets before (the 2005/06 panel data set) and after (the 2011/12 panel data set) the reform still allows us to control for time-invariant household characteristics within each panel data set.[11]

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 is of exceptionally high quality (Jalan and Ravallion 1999). Beyond information on consumption, the

[10] The data are sub-sample of China's rural household survey which has been conducted annually since the mid1980s by NBS. While the whole sample includes more than 68,000 households, we have access to 7 counties (3 counties inside and 4 outside the boundary of Chengdu prefecture) from two separate panels (2005/2006 panel and 2011/2012 panel). 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 representative panel data sets before (the 2005/06 panel data set) and after (the 2011/12 panel data set) the reform still allows us to control for time-invariant household characteristics within each panel data set. The quality of the NBS data is considered to be high; in fact, households maintain daily logs on items consumed and monetary spending, and checks by local survey staff are conducted every two weeks (Jalan and Ravallion, 1999). The survey collects a wide array of variables included in standard household surveys (e.g., household characteristics, expenditures, assets, income sources and detailed agricultural production).

[11] 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 2010 and maintain a balanced sample from before and after reform implementation.

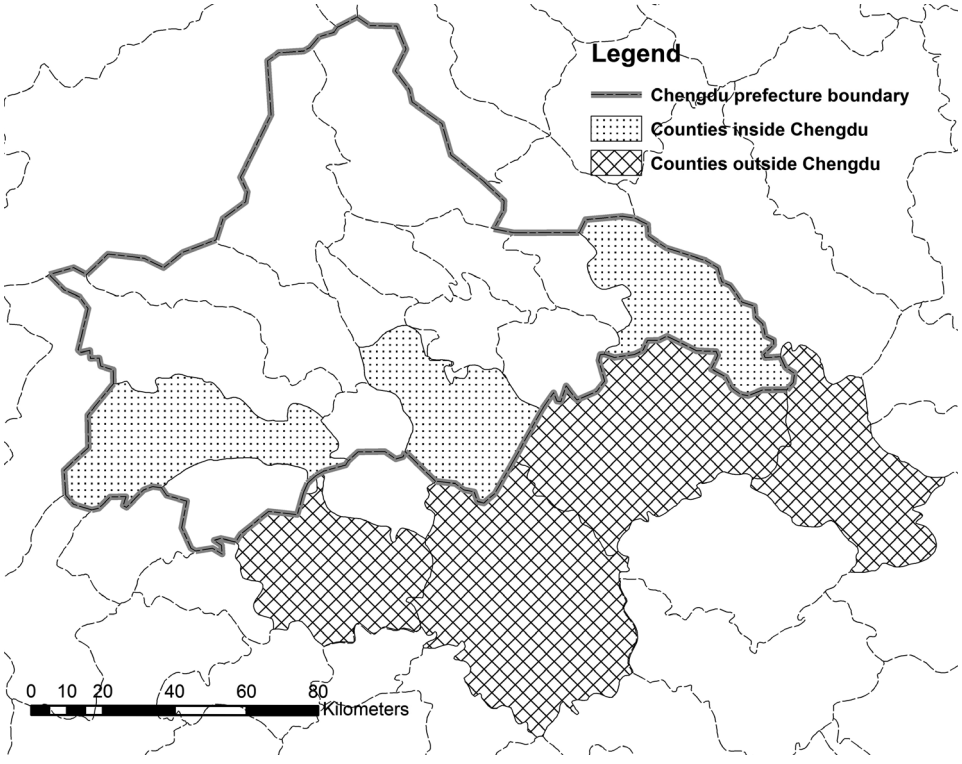

Figure 1 Location of treatment and control counties

survey includes (less precise) data on income and individual members' labour 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.[12] The post-reform sample 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 labour markets due to old age or disability, we end up with a sample of 285 pre-reform and 259 post-reform households inside Chengdu and 453 and 382 households in neighbouring counties

[12] 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.

(Meishan and Ziyang) in the pre-reform and post-reform sample, respectively.

Using the DID approach, reform effects are identified based on difference between: (i) pre-reform and post-reform periods; and (ii) households located just inside Chengdu prefecture, and thus affected by the reform, and those located just outside, and thus unaffected. In the absence of one panel data set including both pre-reform and post-reform periods, we are in line with literature using panel methods on repeated cross-sectional data. This was first suggested by Deaton (1985) to make up for the lack of panel data. The DID approach based on repeated cross-sectional data has been used in many empirical studies (Finkelstein 2002; Davidoff *et al.* 2005). Since our data sets collected before and after the reform are panelled within each period, we further control for time-invariant household characteristics within each panel data set by taking a difference. The basic DID equation of interest can be written as:

$$\Delta Y_{ijt} = \beta_1 + \beta_2 C_{ij} + \beta_3 R_t + \beta_4 C_{ij} R_t + \beta_5 \Delta X_{ijt} + \beta_6 \Delta V_{ijt} + \Delta \varepsilon_{ijt} \qquad (1)$$

where variables with delta are taken a difference. Y_{ijt} is the outcome of interest for household i in village j in year t;[13] C_{ij} is an indicator variable for households inside of Chengdu; R_t is an indicator variable for the post-reform period (2011/12); 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; and ε_{ijt} is an error term. βs are parameters to be estimated. Our main interest is in β_4, the estimated mean impact of the reform.

To explore whether effects vary with households' endowment of human capital and physical assets, we augment Equation (1) by adding interaction terms between initial endowment and reform-related indicator variables as follows:

$$\begin{aligned}\Delta Y_{ijt} = \gamma_1 + \gamma_2 C_{ij} + \gamma_3 R_t + \gamma_4 E_{ijt-1} + \gamma_5 C_{ij} R_t + \gamma_6 E_{ijt-1} R_t + \gamma_7 C_{ij} E_{ijt-1} + \\ \gamma_8 C_{ij} E_{ijt-1} R_t + \gamma_9 \Delta X_{ijt} + \gamma_{10} \Delta V_{ijt} + \Delta \varepsilon_{ijt}\end{aligned} \qquad (2)$$

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 standardised value of physical assets and the γs are

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

parameters to be estimated and the main parameters of interest are the mean reform effect, γ_5, and its variation with pre-existing endowments, γ_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 (β_4, γ_5, and γ_8) 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.

3.2. Descriptive statistics

Table 1 reports descriptive statistics on household characteristics, welfare, agricultural production and time use for the pre-reform and post-reform periods inside and outside of Chengdu (columns 1 - 4), estimated pre-reform trends (columns 5 and 6), and a *t*-test of the significance of differences in such trends between households inside and outside the Chengdu border (column 7). While households inside and outside Chengdu differed from each other in terms of income, time use, and agricultural yields, there are no statistically significant differences in pre-reform trends except agricultural production which declined more rapidly inside as compared to outside Chengdu.

We note that households in the treatment and control are comparable with respect to basic characteristics: they comprise 3 - 4 adults and had a head born in the late 1950s, education between junior high and high school, and 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 (¥16,063 and ¥40,025, ¥4,928 and ¥8,549, and ¥3,150 and ¥6,078 in pre-reform and post-reform periods, respectively) than those outside (¥11,564 and ¥29,752, ¥3,770 and ¥8,069, and ¥2,668 and ¥4,997). They also allocated labour 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.

Table 1 Descriptive statistics for household outcomes

	Before		After		Before Trend		
	Outside (1)	Inside (2)	Outside (3)	Inside (4)	Outside (5)	Inside (6)	*t*-tests (7)
Household characteristics							
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 (yuan)	2,668	3,150	4,997	6,078	−0.025	−0.052	
Total assets per capita (yuan)	11,564	16,063	29,752	40,025	0.070	0.031	
Net income per capita (yuan)	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 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	
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							
	8.03	7.35	6.72	4.73	−0.040	−0.301	

Table 1 (*Continued*)

	Before		After		Before Trend		
	Outside (1)	Inside (2)	Outside (3)	Inside (4)	Outside (5)	Inside (6)	*t*-tests (7)
Months for farming per member							
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	0.45	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	***
Agricultural assets (yuan/mu)	174.07	168.29	191.48	134.63	0.353	−0.183	***
Expenses on labour, 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; and 5 = college and above. Column (7) reports the significance in pre-reform trends between households inside and outside Chengdu using *t*-tests. ***$P < 0.01$, **$P < 0.05$ and *$P < 0.1$.

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 yuan/mu) and obtained higher monetary output per mu (1,880 vs. 1,254 yuan/mu) and net revenues (1,406 vs. 957 yuan/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-reform 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 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. 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 neighbouring 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.

3.3. Land titling processes and the associated cost

To quantify costs of land titling, 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.* 2019). Characteristics of the titling process for different types of land are described in Table 2. The average village has an area of about 7,500 mu (5 km^2) of which some 51% were 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, 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 organisations (23%), representatives (14%), or leaders (1%). Organisation 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

Table 2 Key characteristics of land titling

	Total (1)	Collect (2)	Contract (3)	Forest (4)	Constr. (5)	Housing (6)	Houses (7)
Main characteristics							
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 labour from village (man-days)	2,408						
Total labour from outside (man-days)	271						
Total cost (yuan/mu)	8.60						
Share of cost borne by village	0.380						
Organisation 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. organisations	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
Organisation done by village leaders	0.264	0.237	0.276	0.222	0.165	0.261	0.285
Organisation done by village representatives	0.059	0.059	0.053	0.089	0.064	0.061	0.053
Organisation done by village assembly	0.121	0.112	0.138	0.111	0.119	0.130	0.132
Organisation done by village econ. organisations	0.083	0.059	0.099	0.096	0.064	0.096	0.093
Organisation 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
Measurement by village econ. organisations	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

Table 2 (*Continued*)

	Total (1)	Collect (2)	Contract (3)	Forest (4)	Constr. (5)	Housing (6)	Houses (7)
... 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.

disputes per village emerged. Disputes were 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 six 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 titling, 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 towards a total cash cost for the program of appproximately 8.6 yuan per mu of which close to half (38%) was contributed by the village and the remainder from outside. Villagers contributed nearly 2,000 man-days of labour (about 3 days per household) and, with somewhat more than 10 person-months of labour by outsiders, contributions from above the village remained limited.

4. Econometric results

The estimated results indicate the reforms led to a significant increase of 7.7 per cent 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 labour 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 agricultural yield increases of 55% and profit increases of 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.[14] 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 70 to 95 yuan per mu,[15] well above the 8.6 yuan per mu it cost to implement the land titling program (Table 2). In other words, estimated income gains even in 1 year are more than sufficient to pay for the cost of the program. Panels B and C suggest the 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 (columns 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,

[14] While consistent with the literature of impact evaluation, we present the estimated results for the key variables of interest in Table 3 - 6, the full results with coefficients for all the control variables are available upon request.

[15] 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.

Table 3 Estimated impact of property rights intervention on overall welfare

	Total		Income from			
	Cons. (1)	Income (2)	Farming (3)	Local wage (4)	Off-farm (5)	Migration (6)
Panel A						
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*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)
Bootstrapped *P*-value	0.000	0.270	0.156	0.156	0.559	0.404
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*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)
Bootstrapped *P*-value	0.000	0.114	0.156	0.156	0.675	0.743
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

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 labour, 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. ***$P < 0.01$, **$P < 0.05$, and *$P < 0.1$.

reforms increased productivity of land use and wages or changed certain activities' relative productivity, we would expect corresponding shifts in overall labour supply or time allocation across sectors.[16] As we have individual-level data on labour supply, we can use regressions for all individuals of working age (16 - 60 or 16 - 55 for males and females) in the

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

sample to disaggregate estimated reform effects by gender.[17] Doing so suggests that reforms led to an expansion of labour market opportunities and a significant increase in total labour 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 labour supply, by females.

Results for males and females in the first two panels of Table 4 imply that reforms led to an increase of overall annual labour supply of almost 0.4 months by males but not by females. Disaggregating by age suggests that young males spent more of their labour 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 labour 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 labour 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 labour supply to farming is reform made investment in agriculture more rewarding, thus increasing productivity in the sector. Tables 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. Columns 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, a large increase compared to the initial level (Table 1). 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

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

Table 4 Estimated impact of property rights intervention on time use

	Males only						
	Total	Young (16–40)			Old (40–60)		
		Farming	Off-farm	Migration	Farming	Off-farm	Migration
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Panel 1							
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
	Females only						
	Total	Young (16–40)			Old (40–55)		
		Farming	Off-farm	Migration	Farming	Off-farm	Migration
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Panel 2							
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
	Entire sample						
	Total	Young people (16–40)			Old people (40–60/55)		
		Farming	Off-farm	Migration	Farming	Off-farm	Migration
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Panel 3							
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 the number 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 labour, 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. ***$P < 0.01$, **$P < 0.05$, and *$P < 0.1$.

Table 5 Estimated impact of property rights intervention on agricultural productivity

	Yield	Profit	Rent in	Purchased input use			
				Labour	Seed	Fertiliser	Pesticide
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Panel A							
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*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)
Bootstrapped *P*-value	0.270	0.114	0.000	0.272	0.000	0.150	0.000
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*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)
Bootstrapped *P*-value	0.114	0.114	0.150	0.306	0.156	0.000	0.156
Chengdu*z assets*post	0.320***	−0.014	0.027***	0.297***	−0.389***	0.227***	0.536***
	(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 labour, 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. ***$P < 0.01$, **$P < 0.05$, and *$P < 0.1$.

education while panel C suggests that reform effects on renting in were even more pronounced for those with higher levels of initial assets.[18]

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 labour. As the effect of fertiliser and pesticides is 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

[18] 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.

Table 6 Estimated impact of property rights intervention on crop choice

	Share of area planted with					
	Wheat (1)	Rice (2)	Corn (3)	Oth. grain (4)	Vegetable (5)	Oil crops (6)
Panel A						
Chengdu*post	−0.034*** (0.004)	−0.028*** (0.003)	0.021** (0.005)	−0.025** (0.004)	0.026** (0.005)	0.034*** (0.004)
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*post	−0.045*** (0.005)	−0.035*** (0.003)	0.017* (0.006)	−0.030*** (0.005)	0.057*** (0.006)	0.030*** (0.005)
Bootstrapped *P*-value	0.000	0.000	0.282	0.000	0.098	0.000
Chengdu*> junior high educ.*post	0.039*** (0.004)	0.022*** (0.004)	0.012* (0.004)	0.016 (0.007)	−0.092*** (0.004)	0.006 (0.004)
Bootstrapped *P*-value	0.228	0.118	0.160	0.204	0.000	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*post	−0.035*** (0.004)	−0.027*** (0.003)	0.020** (0.005)	−0.025** (0.004)	0.028** (0.005)	0.034*** (0.004)
Bootstrapped *P*-value	0.000	0.388	0.130	0.098	0.130	0.000
Chengdu*z assets*post	−0.003 (0.008)	0.027*** (0.002)	−0.033*** (0.003)	0.002 (0.004)	0.012** (0.003)	−0.002 (0.009)
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 labour, 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. ***$P < 0.01$, **$P < 0.05$, and *$P < 0.1$.

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 fertiliser, pesticides and seeds by 108%, 67%, and 39%, respectively, while reducing that of hired labour by 17%.[19] 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 grain, with point estimates of −3.4% for wheat, −2.8% for rice, and −2.5% for other grain. 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 labour supply and contributed to a shift of labour 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 labour; 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, prior to the reforms, imperfections in factor markets undermined investment and functioning of land and labour 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 suggest that the elements implemented in Chengdu are thus likely to be 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, could help to further enhance lessons for policy. Beyond China, there are many countries (e.g. Vietnam, Ethiopia,

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

Nigeria, Tanzania) where current policies impose restrictions on the operation of peri-urban land markets. Although these are not always combined with Chinese-style migration restrictions, our results suggest that such policies are likely to affect agricultural productivity and job creation and that policy changes to improve the operation of peri-urban factor markets could be associated with considerable social and economic benefits.

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