Three Essays on Land Rights, Labor Mobility and Human Capital Investment in China

Dan Wang

A Dissertation

submitted in partial fulfillment of the

requirements for the degree of

Doctor of Philosophy

University of Washington

2013

Reading Committee:

Judith Thornton, Chair

Seik Kim

Hendrik Wolff

Program Authorized to Offer Degree:

Economics

University of Washington

Abstract

Three Essays on Land Rights, Labor Mobility and Human Capital Investment in China

Dan Wang

Chair of the Supervisory Committee:

Professor Judith Thornton

Department of Economics

This dissertation explores how institutional features of the Chinese economy impact the welfare and behavior of Chinese households. The first two chapters investigate the economic implications of varying land security in rural China. The third chapter provides an empirical test of household responses to China's One-Child Policy, looking at children's education attainments and subsequent earnings.

Chapter one first develops a theoretical model to understand how land rights security may affect farmers' employment choices. The model suggests that with secured land rights, households with high farming ability are likely to invest in land while households with low farming ability tend to invest in human capital and migrate to the city. This result is important because it suggests that land security promotes labor specialization based on ability, which results in higher efficiency in the labor market. This chapter also contributes to the debate of land tenure in rural China by using the regime of land adjustments to identify land security. Land security is identified based on whether the village has adopted small-scale land adjustment as its main land reallocation regime. The empirical results suggest that land security has a sorting function in employment decisions. Secured land rights increase participation in non-farm jobs such as migration and local wage

employments while decreasing the probability of full-time farm employment. The results imply that governmental policies promoting land security may facilitate both migration and investment in land.

Chapter two examines the role of rural land reallocation on household welfare and risk coping. The theoretical model suggests that in a self-sufficient agricultural economy, large-scale land reallocation help households to cope with labor supply shocks. However, when non-farm labor market and land rental market exist as well, the proportion of households that benefit from large-scale land adjustments will decrease. The empirical results suggest that illnesses tend to increase the probability of both local employment and migration by other family members; however, death of a family member has no significant effect on non-farm employment. Large-scale land reallocation has some mitigating effects on migration. In villages making use of large-scale reallocation, households are more likely to rent out land when they experience negative supply shocks compared with villages that use only small-scale land reallocation. Both migration and large-scale reallocation appear to serve as effective strategies to smooth out consumption. On the other hand, access to land rental markets, does not appear to improve household ability to smooth consumption. In this data, large-scale land reallocation appears to play a bigger role in smoothing consumption than in smoothing income.

Chapter three provides an empirical test to evaluate the impacts of the One-Child Policy (OCP) on children's education attainments and subsequent earnings. The introduction of OCP is used as a natural experiment to analyze how the exogenous restrictions on fertility affect labor market decisions. The baseline identification strategy uses a difference-in-difference approach to compare outcome for children born before and after OCP; it also compares outcomes between a treatment and a control group facing different institutional constraints at the same period of time. The study also estimates the Local Average Treatment Effect (LATE) for returns to education. Empirical results suggest that OCP has bigger impacts on years of education of urban men compared with urban women. Regarding the highest degree obtained, OCP increases the likelihood of obtaining a college degree and high school degree for men and women. Wage estimations show that one more year of education increases women's hourly wage earnings by 5.6 to 8.1 percentage points but an additional year has no significant impact on the wage of men. Thus, returns to education for women appear to be higher than for men.

Acknowledgements

I am extremely grateful to my dissertation committee, Judith Thornton, Seik Kim, Hendrik Wolff and Susan Whiting for their advice and encouragement. I am also grateful to James Kung for his inspiration, to Scott Rozelle for introducing me to Jikun Huang, who gives me my first job. In addition, I would like to thank Edward Rice for being my reference.

I am thankful to participants in the labor brownbag and CSDE seminars. I have benefitted from the help of faculty and staff of the economics department, my fellow graduate students, and my students. I appreciate conversations with Scott Tennican and Greg Teplow, which have contributed much to the dissertation.

I would also like to acknowledge the faculty at Tulane University and Harvard University. They motivate me tremendously in my pursuit of a doctorate in economics. I am truly grateful to classes of Gregory Mankiw and Edward Glaeser who have been tremendous models for me as teachers and researchers.

I benefited from the Positive Psychology class taught by Tal Ben-Shahar who has transformed my view of teaching and attitudes towards life in general. I am grateful for having Lan Yang as my first math teacher. She is devoted, insightful and loving and I have learned so much from her.

I am indebted to Sally, Brick and Zhengji Qian for their tremendous help in my most difficult times. I thank Yaw Agyeman and Connie O'Connor for helping me after Hurricane Katrina. I also want to extend my thanks to everybody else who has helped me along the way.

Finally, I would like to dedicate the dissertation to my parents for their unconditional support and education.

Contents

1 Land Security and Labor Specialization in Rural China 4

1.1 Introduction 4

1.2 Theoretical Framework 8

1.2.1 Basic Model: A Self-sufficient Agricultural Economy 9

1.2.2 Extend the Model: Including Non-farm Sector 13

1.2.3 Tenure Security and Labor Mobility 15

1.3 Data 19

1.3.1 China Living Standards Survey (CLSS) 19

1.3.2 Migration 19

1.3.3 Land Reallocation 21

1.4 Empirical Results 22

1.4.1 Land Security: Measurement and Endogeneity 22

1.4.2 Land Security on Human Capital Investment 25

1.4.3 Land Security on Land Investment 27

1.4.4 Land Security on Migration and Other Employments 29

1.4.5 Robustness Check 31

1.5 Conclusion 33

Appendix: Including a Financial Constraint in the Model 36

References 38

Figures and Tables 41

2 Risk Coping: Land Tenure, Land Rental Market and Migration 49

2.1 Introduction 49

2.2 Theoretical Framework 51

2.2.1 Welfare Effect of Land Reallocation in an Agricultural Economy.51

2.2.2 Including Land Rental Market and Non-farm Sector.....54

2.2.3 Including Labor Supply Shocks.....56

2.3 Data 58

2.3.1 Rural Household Survey by Development Research Center.....58

2.3.2 Key Variables.....60

2.4 Empirical Strategy and Main Results 62

2.4.1 Risk-Coping Strategies and the Role of Land Reallocation.....62

2.4.2 Labor Shocks, Household Welfare and Risk-Coping Strategies.....65

2.4.3 Alternative Specifications.....67

2.5 Conclusion 68

References.....70

Figures and Tables.....71

3 Unintended Consequences: One-child Policy in China 81

3.1 Introduction 81

3.2 Institutional Background 84

3.3 Data 86

3.3.1 China Health and Nutrition Survey (CHNS) 86

3.3.2 Descriptive Evidence: Education and Wage.....87

3.3.3 Key Variables 89
3.4 Identification Strategy: Difference-in-difference 91
3.4.1 Treatment Group 91
3.4.2 Rural Control Groups: Rural Households with OCP-Cohort 91
3.4.3 Urban Control Groups: Urban Households with Before-Cohort 93
3.4.4 Differences between Treatment Group and Control Groups 94
3.5 Main Results 95
3.5.1 OCP on Years of Education 95
3.5.2 OCP on Highest Level of Education 98
3.5.3 OCP on Wage Earnings 100
3.5.4 Parallel-trend Assumption 102
3.6 Conclusion 104
References 105
Figures and Tables 107

1 Land Security and Labor Specialization in Rural China

1.1 Introduction

An unresolved debate about land rights in China concerns whether the economic growth is trapped by its seemingly inefficient institutions. The agricultural de-collectivization in early 1980s has individualized the production of farms, but land remains collectively owned. Every village resident is entitled to an equal share of the arable land, which has resulted in the periodic land reallocation.[1] In rural China, there is no effective social insurance program and land remains the most important productive assets for households. For the poor, equal distribution of land could be a substitute for social insurance. To a certain extent, it means loss in farm productivity (Wen, 1995; Li et al., 1998; Jacoby et al., 2002), but it could also be a response to the missing markets. Burgess (1998) suggests equal land redistribution contribute greatly to nutrition intakes for Chinese farmers. Kung (1997) suggests that current land tenure helps farmers to diversify income risks.

While it is widely accepted that land insecurity discourage farm productivity, there is a lack of evidence on its labor market consequences. Researchers have documented the relationship between migration and land rights security, but the mechanisms through which the effects work are not clearly explored.

This paper identifies land security as whether the village has adopted small-scale land adjustments as its main reallocation regime. Past studies have tried several measures as proxies, such as the frequency of land reallocations, or the percentage of land adjusted, or percentage of households who have received land in the previous round of land adjustment.

[1] Land reform in 1984 allocated land to villagers based on household size, labor supply or both. The length of the land contract was 15 years in 1984 and then extended to 30 years in 1993. Despite the contract by law, most villages have reallocated land among households periodically in response to demographic and other structural changes.

It's problematic because there is no evidence that land security perceived by farmers is captured in these measures. Farmers understand that if they have more family members, they will have inadequate land to farm should land ownership be frozen for 30 years. Their perception of land security is unlikely to be simply determined by the frequency or magnitude of land relocations in the past.

This paper contributes to the debate of land tenure in rural China by using the regime of land adjustments to identify land security. Kung (2011) analyzed two types of land reallocation regimes and their determinants. Some villages adjust land on a large-scale basis in which all households are affected until every household has the same amount of land per person. Other villages adjust land in small-scale, in which only households with demographic changes are affected. Farmers have higher perception of land security with small-scale land adjustments.

In addition to the new measure of land security, this paper also contributes to the land security literature by using a new list of exogenous variables as instruments for land security. Researchers have found several factors that determine the choice of land tenure, such as off-farm activities and land rental markets (Kung, 2000; Brandt et al., 2004; Yao, 2004). Built upon the transaction cost story of Kung (2011), I treat land rights as the result of three sets of exogenous variables: factor endowment (land and labor), village topographies, and pressure from the higher authority. Pressures from higher authorities are important because villages under higher quota requirements are likely to be more concerned about efficiency.

I develop a two-period household model to show that secured land rights encourage rural-urban migration. Rural households, constrained by their wealth, have to choose between land investment and human capital investment.

Secured land rights increase the expected land holdings in the second period. High-ability farmers in agriculture have high marginal return to labor and are likely to invest more in land with more secured land rights. Low-ability farmers do not have a comparative advantage in farming and the optimal strategy would be to invest more in human capital and be prepared to take non-farm jobs in the second period. Labor specialization thus emerges.

Using data from China Living Standard Survey (CLSS), my estimates is largely consistent with the theoretical prediction. I estimate impacts of land security on human capital investment, land investment and employments, using instrumented probit model, two-part Tobit model and Biprobit model separately. The theory is based on the assumption that households are credit constrained and have to choose between investment in human capital and in land. CLSS does not include expenditures in the two items, so I estimate the two types of investments separately.

Education attainments of age group 15-25 are used to represent human capital investment of the household. This age group is chosen because the period 1984-1994 is when they received and finished education, which coincides with the land reform era and fit the identification of land security used in this paper. Empirical results indicate that land security promotes the overall education attainments and have stronger impact on households with lower farming ability.

In terms of land investment, I choose the usage of organic fertilizer as dependent variable. Since not every household uses organic fertilizer in land, a Tobit model is used in the estimation. Results indicate a positive impact of land security on the probability of using organic fertilizer, especially for households with high farming ability.

When it comes to the migration decisions, I divide migrants into two groups by migration duration: temporary migrants (away for less than one year) and permanent migrants (away for more than one year). Since permanent migration requires higher initial cost and involves more risk, it is likely to be affected differently by land security comparing to temporary migration. Empirical results suggest that land security actually has opposite effects on the two types of migration. For temporary migration, it is consistent with the theory: land security increases the probability of migration more for low-ability households. However, for permanent migrants, land security have stronger impacts for high-ability households, but other factors such as wealth and whether possessing an urban *hukou* are more important determinant for permanent migration.

Additional regressions on participations in farming and local wage jobs suggest that land security has a sorting function in employment decisions: it increases the probability of non-farm jobs and decrease participation in farming. Households with low farming ability benefit more from land security in their participation in temporary migration and local wage jobs, and households with high farming ability benefit more in their participation in farming. This result is also consistent with the labor specialization story in the theoretical model.

Furthermore, this paper is in line with the existing property rights literature by offering a theoretical model and empirical tests of the impact of property rights on farmers' employment decisions. To my knowledge, there hasn’t been other similar research. Economic research supports the importance of secured property rights for household decisions regarding labor (Field, 2007) and agriculture (Besley, 1995). Wang (2012) argued that urban housing has potential wealth that could be transformed into entrepreneurship through the formation of property rights. In rural China, with more secured land

rights, wealth embedded in land can also be transformed into farmers' productivity by improving human capital investments and labor mobility.

The rest of the paper is organized as follows. Section 1.2 develops a theoretical model to explore the mechanisms through which land rights have impacts on non-farm employments, especially on migration decisions. Section 1.3 presents data, variable definitions and descriptive statistics. Section 1.4 presents empirical strategy and results. Section 1.5 is conclusion.

1.2 Theoretical Framework

I develop a two-period household model that investigates the mechanisms through which land rights security affects land investment, human capital investment, and employment choices. Depending on their farming abilities, households in the first period make investment decisions, taking into account the expected effects of these decisions on their future wellbeing. Prior to the second period, two village-level shocks are realized, a land reallocation shock and a labor supply shock. Households then allocate variable factors of production for the second period production. The model assumes that farming doesn't require much human capital investment but non-farm jobs do.

The model proceeds in two steps. The first step is to set up a basic model of a self-sufficient agricultural economy without non-farm sector or labor supply shocks. When the village adopts big-scale land adjustments, in which all land are pooled together and equally distributed to households, every household in the village is affected. Land is taken from households with high abilities to those with low abilities. Anticipating losing part of the investment in land, high-ability households will reduce their land investment in the first period.

The second step is to include a non-farm sector. Constrained by wealth, households face the tradeoff between land investment and human capital investment. Non-farm jobs, especially migration, yield higher return than farming but also have higher costs. Two types of costs are associated with non-farm jobs. One is the investments in education and training, which are crucial in non-farm employments but not so important in agriculture. The other one is transaction costs mainly associated with migration, such as the cost of living permit in the city and expense in searching for jobs. The model suggests that with secured land rights, labor tend to specialize. High-ability households tend to stay on farm, because more secured land rights increase the expected holdings of land in the second period, thus encouraging land-related investment in the first period. Low-ability households tend to invest in human capital and take non-farm jobs because it is a better portfolio choice for them.

1.2.1 Basic Model: A Self-sufficient Agricultural Economy

Consider a self-sufficient agricultural village with N households (N is large). Each household is endowed with labor L_0 and land T_0. Land-labor ratio $\frac{T_0}{L_0}$ is τ. Households differ in their farm ability (or agricultural comparative advantage), A and their initial wealth Φ_0.

Every household lives for two periods. In the first period, there is no agricultural production. [2] Households make land-related investment, K, at a

[2] The model could also introduce farm production in the first period. However, since this complicates the model by a great deal while the only difference is in households' wealth level when they enter the second period, production is thus assumed away. Instead, I assume that households in the first period start with different level of wealth, which has the same impact as introducing farm production.

unit cost q. [3] I define effective land T^e as the production of land area T_0 and the capital invested in it, which can be seen as quality adjusted land:

$$T^e = T_0 K \tag{1}$$

Effective land captures that if households lose land, they also lose the irreversible capital investment in it. Land investment K follows the distribution of farm ability A. [4] Household wealth is divided into investment and consumption. Consumption per capita can be written as:

$$c_1 = \frac{\Phi_0 - qK}{\mathrm{L}_0} \tag{2}$$

Before the second period, land reallocations happen with probability ρ. The result is that every individual enjoys the same level of effective land $\bar{t}_2$:

$$\bar{t}_2 = \frac{1}{NL_0}\sum_{i=1}^{N} K_i T_0 = \frac{T_0}{L_0}\frac{1}{N}\sum_{i=1}^{N} K_i = \tau\bar{K} \tag{3}$$

where N is large enough so that changes in an individual's investment will not affect the village average level $\bar{K}$.

Without land reallocation, each family holds the same amount of land as in the first period:

$$t_2 = t_1 = \frac{T_0 K}{L_0} = \tau K \tag{4}$$

[3] Land-related investments refer to spending that will improve the quality of land, such as irrigation equipment, organic fertilizers and etc.

[4] Land investment K captures the kind of input in land that is non-removable and cannot be recovered once the land is taken away. An example of it is organic fertilizer. Farm ability A refers to other factors that will increase farm output but can be recovered once the land is taken away, such as farm experience, tractors, and other agricultural tools. If land is taken by the village, households will lose K but still possess A. Algebra later will show that high-ability households tend to have higher K

Assume a constant return to scale (CES) production function: $Q = AF(T^e, L)$, where the two inputs are effective land and labor supply. [5] Normalize output price to one, household consumption per capita is:

$$c_2 = \frac{AF(T^e, L)}{L} = Af(t) \tag{5}$$

If land reallocation happens, the consumption level is:

$$c_r = Af(\bar{t}_2), \qquad where\ \bar{t}_2 = \frac{T_0\bar{K}}{L_0} \tag{6}$$

Without land reallocation, the consumption level is:

$$c_n = Af(t_2), \qquad where\ t_2 = \frac{T_0\mathrm{K}}{L_0} \tag{7}$$

Assume an additively separable utility function, households choose land-related investment to maximize total expected utility over the two periods:

$$\max_K \ \ U(c_1, c_2) = U(c_1) + \beta EU(c_2) \tag{8}$$

where $(c_2) = \rho U(c_r - R_r) + (1-\rho)U(c_n - R_n)$; β is a discounting factor; R_r and R_n are risk premiums corresponding to two possible outcomes (with and without land reallocation).

The first order condition with respect to K is:

$$qU'(c_1) = \beta(1-\rho)T_0E[Af'(t_2)U'(c_n)] \tag{9}$$

The optimal investment level is when marginal cost of investment equals to the discounted marginal expected return.

The relationship between land security and land investment is shown as below:

[5] Unlike the concept of "effective land", I do not use "effective labor" in this equation. Instead, I use the technological parameter A to capture the labor ability. It will simplify the algebra by a great deal in later analysis.

$$\frac{\partial K}{\partial \rho} = -D_1 A f'(t_2) EU'(c_n) < 0 \tag{10}$$

where D_1 is a positive constant. [6] This relationship can be illustrated by dividing households into the high-ability ($K > \overline{K}$), and the low-ability ones ($K < \overline{K}$). From equation (10), households with high farming ability also tend to invest more in land. Assume that the initial wealth is the same for all households, the intertemporal consumption choices for high-ability and low-ability households can be illustrated as in Figure 1.

In Figure 1, curve i (blue) represents consumption level when capital investment is equal to the village average. In graph (a), curve ii shows that high-ability households invest more than the average level in the first period. If land reallocation does not happen, their second period consumption will be higher than the village average. If land reallocation does happen, their consumption would drop to the village average. The distance between curve ii and curve iii (red interval) represents the expected loss in consumption. Similarly, low-ability households also want to decrease investment when expecting land reallocation. The reason is that, the lower they invest, the higher the expected gain from land reallocation would be (red interval in (b)). Land reallocation acts like a subsidy to low-skill families. [7]

In a self-sufficient agricultural economy, the first best strategy for all households is to lower land investment if land rights are not secure.

[6] More details see Silberberg Structure of Economics page 158: Samuelson's "conjugate pairs" result.

[7] Figure 1 shows the cases when land reallocation happen and when it doesn't happen. If it happens with probability ρ, then it's easier to show the effect with algebra instead of graphs. For example, if high-ability households increase their investment by Δk, then the expected change in income will be $\frac{dy}{dk} * \Delta k - \rho[y(K + \Delta k) - y(\overline{K})]$. The second term is the expected loss in income. We can see that the higher ρ is, the higher the expected loss. For low-ability households, the story is the opposite. Their expected lost in subsidy by increasing investment is be $\frac{dy}{dk} * \Delta k - \rho[y(K) - y(K + \Delta k)]$. The more they invest, the less they receive.

Therefore, the average investment in the village decreases i.e. $\frac{\partial \bar{K}}{\partial \rho} < 0$ and land investment for the whole village will also decrease. In addition, equation (11) suggests that investment will decrease even faster high-ability farmers.

1.2.2 Extend the Model: Including Non-farm Sector

I extend the model by adding in a non-farm sector which includes local non-farm employment and migration. As previously discussed, migration requires higher education and additional transaction cost.[8] Assume that households need to invest H in human capital at price h in the first period to gain the skills necessary for non-farm jobs. Other transaction costs are assumed to be fixed as I. In the second period, those who invested in human capital could work in non-farm sector and earn income $G(HL_m)$. To simplify, I assume that if the household doesn't invest in human capital, it cannot participate in non-farm employment.

In period one, consumption per capita is:

$$c_1 = \frac{\Phi_0 - qK - hH - I}{\mathrm{L}_0} \tag{11}$$

In period two, household income could come from both farm and non-farm employments. If land reallocation happens, consumption per capita is:

$$c_r = \frac{AF\left(T_0\bar{K}, L_f\right) + G(HL_m)}{L_2} \tag{12}$$

If land reallocation doesn't happen, the consumption level is:

[8] If the household is self-employed, the initial cost could be the cost of borrowing or capital purchase. However, in rural China, it is usually difficult to borrow from official institutions and households usually use their accumulated wealth to pay for the starting up capital.

$$c_n = \frac{AF(T_0K, L_f) + G(HL_m)}{L_2} \tag{13}$$

Migration in the second period is contingent on human capital investment of the household in the first period. If $H = 0$, then non-farm income $g(HL_m)$ is also zero.

Labor supply in the second period is the sum of farm labor and non-farm labor:

$$L_2 = L_f + L_m \tag{14}$$

Households want to diversify the income sources. Define α as the share of labor working on the farm, thus farm labor $L_f = \alpha L_0$ and non-farm labor $L_m = (1 - \alpha)L_0$. Solve for FOCs with respect to K, H and α :

$$K: \quad qU'(c_1) = \beta(1-\rho)AT_0E[f'(t_2)U'(c_n)] \tag{15}$$

$$H: \quad hU'(c_1) = \beta g'L_mEU'(c_2) = \beta g'L_m\{\rho E[U'(c_r)] + (1-\rho)E[U'(c_n)]\} \tag{16}$$

$$\alpha: \quad AF_L(T_0\bar{K}, L_f) = G'(HL_m) \tag{17}$$

For each household, each dollar spent on K will yield an increase in farm income by AT_0F_K while a dollar spent on H will yield G_H. Which investment is more beneficial depends on the relative marginal return of the two investments.

The optimal investment in land and human capital are determined simultaneously by probability of reallocation, ρ and farm ability, A. The most interesting result is the relationship between land rights security and capital investment.

$$\frac{\partial K}{\partial \rho} = D_3\beta[EU_H(c_r) - EU_H(c_n)]\{qU_{cc}(c_1) + E[L_mG'U_{cc}(c_n)]\} + S \tag{18}$$

where $S = \beta EU_K(c_n)\{U_{HH}(c_1) + \beta[\rho EU_{HH}(c_r) + (1-\rho)U_{HH}(c_n)]\}$; D_3 is a positive constant; $U_H(\cdot)$ is the first derivative with respect to H. Function S is the same for every household no matter what level of land investment it has.

The first term captures the portfolio effect of investment between land investment and human capital investment. The expression in the big bracket is always negative due to diminishing marginal utility in consumption. The difference between the two first derivatives, $[EU_H(c_r) - EU_H(c_n)]$, is determined by the distribution of K. If $\bar{K} < K$, then $[EU_H(c_r) - EU_H(c_n)] > 0$ due to the concave nature of the utility function and K will increase as land rights become more secure.

What's substantial about this result is that by introducing a non-farm sector, land security can result in labor specialization. For a household with a large amount of initial investment, it runs the risk of losing much of the investment if land reallocation happens in the second period. If land rights security improves, the expected return in land investment will increase. On the other hand, if a household has little or no land investment to start with, then the optimal strategy is to specialize in non-farm jobs. [9]

1.2.3 Tenure Security and Labor Mobility

Assume that households are not credit constrained, i.e. $\Phi_0 - qK - hH - I = 0$ [10]. To decide whether to participate in the non-farm sector, households compare the expected utility under each employment choice. If not participating in

[9] A closer look at the determination of land investment suggests that not all households increase land investment when land rights are more secured. Given that farm skill and farm investment are positively related, high-ability households will invest more when land rights are more secure. However, for low-ability households, this may not be the case. As shown in equation (19), when $K > K$, the sign of the relative distribution effect is positive. As a result, the sign of $\frac{\partial K}{\partial \rho}$ depends on the relative magnitude of S. We can find a threshold level of farm ability, $\bar{A}$, above which $\frac{\partial K}{\partial \rho} < 0$, and below which $\frac{\partial K}{\partial \rho} > 0$. The result indicates that the most productive farmers will increase land related investment when land rights are more secure. For less productive farmers, the optimal strategy is to reduce land investment and switch to non-farm jobs.

[10] See the Appendix for discussion of the case when households are credit constrained.

non-farm sector, human capital investment is zero, the expected utility is thus:

$$V^N = U(c_1^N) + \beta[\rho U(c_r^N) + (1-\rho)U(c_n^N)] \tag{19}$$

where $c_1^N = \frac{\Phi_0 - qK}{L_0}$, $c_r^N = Af\left(\frac{T_0\bar{K}}{L_0}\right)$, $c_n^N = Af\left(\frac{T_0 K}{L_0}\right)$.

If households invest in human capital, then they could take non-farm jobs in the second period. The total expected utility is:

$$V^H = U(c_1^H) + \beta[\rho U(c_r^H) + (1-\rho)U(c_n^H)] \tag{20}$$

where $c_1^H = \frac{\Phi_0 - qK - H - I}{L_0}$, $c_r^H = \frac{AF(T_0\bar{K}, L_f) + G(HL_m)}{L_0}$, $c_n^H = \frac{AF(T_0 K, L_f) + G(HL_m)}{L_0}$.

Define ΔV as the difference between expected utility:

$$\Delta V = V^H - V^N \tag{21}$$

If $\Delta V > 0$, households choose take non-farm jobs; if $\Delta V < 0$, they stay on farms. If a household is indifferent, then $\Delta V = 0$. Plug equation (20) and (21) into (22):

$$\Delta V = U(c_1^H) - U(c_1^N) + \beta[\rho(B^H - B^N) + U(c_n^H) - U(c_n^N)] = 0 \tag{22}$$

where $B^H = U(c_r^H) - U(c_n^H)$ if $H > 0$, and $B^N = U(c_r^N) - U(c_n^N)$ if $H = 0$. Functions B^H and B^N can be seen as the absolute benefit from land reallocation.

The first derivative of ΔV with respect to ρ is:

$$\frac{d\Delta V}{d\rho} = \beta\left\{(B^H - B^N) - \rho\sigma A\frac{\partial\bar{K}}{\partial\rho}[U'(c_r^H)U'(c_n^H) - U'(c_r^N)U'(c_n^N)]\right\} \tag{23}$$

where σ is the land labor ratio $\frac{T_0}{L_0}$. The sign of the terms in the big bracket is determined by two parts. Before proceeding any further, we need to discuss the sign for the first term $(B^H - B^N)$. It can be solved from equation (13):

$$B^H - B^N = -\frac{1}{\rho}\left\{\frac{U(c_1^H) - U(c_1^N)}{\beta} - [U(c_n^H) - U(c_n^N)]\right\} \quad (24)$$

Households that have invested in human capital will have a lower consumption level in the first period, and thus $c_1^H < c_1^N$. The marginal return of non-farm jobs is higher than farm labor, so that $c_n^H > c_n^N$. The intuition is that if households have invested in human capital in the first period, they must have anticipated a higher return in the second period from non-farm jobs. Therefore, the value of $(B^H - B^N)$ is always positive.

The second term in the big bracket in equation (14), $[U'(c_r^H)U'(c_n^H) - U'(c_r^N)U'(c_n^N)]$, is always negative. The reason is that with human capital investment in the first period, the income in the second period will be higher and thus the expected marginal value of consumption is lower due to the concavity of the utility function.

We can find a pair of threshold values of farm technology $\tilde{A}$ and wealth $\tilde{\Phi}_0$ that make $\frac{d\Delta V}{d\rho} = 0$. If a household has farm technology lower than $\tilde{A}$ or wealth higher than $\tilde{\Phi}_0$, as ρ goes down, ΔV will go up, then the household will enter non-farm sector. On the other hand, if A is higher or Φ_0 lower than the threshold, then ΔV will go down as ρ goes down, and the household will choose farming. The result can be illustrated in figure 2.

A combination of A and Φ_0 can be traced out that makes a household indifferent between farming and migration. Farm ability and wealth are positively correlated when households are indifferent between farming and

migration. The indifference curve, $\Delta V(\Phi_0, A; \rho_1) = 0$, is convex in A. [11] It divides the space into two parts. Households above the indifference curve will enter migration and those below the curve stay in agriculture. Some of the farmers previously with higher initial wealth and lower farm ability will switch to non-farm jobs, as shown by area I, and some of the non-farm participants will switch back to agriculture, as shown by area II, if their farm ability is higher. The initial household wealth Φ_0 has to be greater than a minimum amount $\underline{\Phi}$ to finance the transaction cost and or startup capital for entering the non-farm sector. This change in the distribution of households can be illustrated by a steeper indifference curve in the figure. A household is not able to switch to non-farm jobs if it is financially constrained.

The model suggests that for households with high farm ability, secured land rights increases their expected holdings of effective land in the second period, thus the expected marginal return in farming ability will increase. Therefore, these households will have a higher incentive to invest in land instead of in human capital in the first period. The story is the opposite for households with low farming ability. They will have a high incentive to invest in human capital because given their expected return in land and human capital, their optimal portfolio choice would be to invest in human capital and participate in non-farm employments.

[11] From equation (22) and (23), $\frac{d\Delta V}{dA} < 0$ and $\frac{d\Delta V}{d\Phi_0} > 0$. Rewrite ΔV as a implicit function of key parameters A and Φ_0 and we can derive the relationship between A and Φ_0 when $\Delta V = 0$. We have $\frac{\partial \Phi_0}{\partial A} = -\frac{d\Delta V}{dA} \Big/ \frac{d\Delta V}{d\Phi_0} > 0$.

1.3 Data

1.3.1 China Living Standards Survey (CLSS)

Data used in this study is from China Living Standards Survey (CLSS), which was carried out in 31 villages in Hebei and Liaoning Provinces in the summer of 1995. [12] The survey collected detailed information on individual and household wealth, investments, labor supply in both farm and nonfarm activities. It also contains details in village-level characteristics as well as the political organization. In the 1995 survey, there are in total 880 households, in which 50 households were selected from the village surveyed in the 1930s and 20 from every other village. Households in each village were picked by random sampling using the most recent village registration.

The CLSS data is relatively old but has several advantages. First, it contains detailed information on past land redistribution practice and property rights policies, which is normally not recorded by other surveys available. Second, it eliminates the land rental markets and financial markets as determining factors on farmers' employments choice because before 1997 those markets were virtually non-existent in rural China. The survey facilitates the empirical tests by eliminating those two endogenous variables.

1.3.2 Migration

Migrants are defined as villagers that are away for more than one month, currently working or looking for a job in the city. About 38% of the households (15% of the individuals) participated in 1994 and they on average send out more than one migrant. Migrants on average have two more years of education than non-migrants. Most temporary migrants (away for work, for more

[12] The survey was a collaborative effort of Loren Brandt (University of Toronto), Paul Glewwe (University of Minnesota), Scott Rozelle (Stanford University) and Bai Nansheng (Renmin University of China). The sample selection was not entirely random. It was a follow up of a household investigation carried out by Japanese researchers in 1936 and 1937.

than 1 month but less than 1 year) are men while most permanent migrants (away for more than 1 year) women. Possessing an urban *hukou* (the city residential permit that allow rural workers to legally live in the city), is the most important determinant for permanent migration. Non-migrant households have more females and more children. Migrant households have more land, less farm-capital, lower savings and lower farm income.

Temporary migration presents a short-term, circular nature: migrants come back to the village and work on farm during busy harvest seasons. About 70% of the temporary migrants also work on farm. About 33% were away in 1994 for less than 3 months and only 16% for more than 9 months. The average time migrants working on farm are 23 days with 9 hours per day in busy season, quite close to local farmers. Among temporary migrants, 56% work as low-ability labor and their monthly salary is much higher than other local employments.

Agriculture remains the most important employment, with more than 87% households' participation. Agricultural income accounts for about half of the household net income. Land owned by the household ranges from 0.2 *mu* (0.03 acre) to 184 *mu* (29.4 acre), with farms in Liaoning larger than in Hebei. Family owned business and local nonfarm wage job are also major sources of income. About 40% of households reported to have family owned business and 20% with local wage employments. In farm labor supply, farmers in Hebei work for more days than those in Liaoning. No significant difference is found between male and female farmers.

1.3.3 Land Reallocation

Since 1984, most villages have redistributed land at least once and land holdings for most households have increased. [13] The most recent large-scale land reallocation for each village happens around 1993 and 1994, during which the state extended the land contract from 15 years to 30 years. During this reallocation, Liaoning had much bigger adjustments than Hebei. About 46% of the households on average were affected in Liaoning while in Hebei this number is only 25%. Farmers in Liaoning also had a more drastic change in their land holding with an average of 9.5 *mu* of increase or 4.7 *mu* of decrease, while in Hebei the two statistics are 2.3 *mu* and 2 *mu*.

The sample villages present a "bi-modal" structure of land adjustment: whereas some villages have only reallocated land on a large-scale basis, others mainly readjusted a tiny fraction of the village landholdings each time for households with demographic change. [14] There are 9 villages with only large-scale land reallocation, 8 of which are from Liaoning; 2 villages in Hebei only adjust land in small-scale; 17 villages mainly adjust land in small scale but with occasional village-wide land adjustment (most of those villages adjust land only in 1993 following the extension of land contract); 2 villages in Hebei have never adjusted land in any fashion. In terms of land rights policies, villages in Hebei are more lenient than in Liaoning. Farmers in Hebei are able to keep the farm land after they migrate, whereas those in Liaoning have to return the land.

Table 4 displays major differences in village characteristics by land reallocation regime. In villages where land is only reallocated in large

[13] In some villages, this is done through "reserved land". By law, about 5% of farm land can be reserved beforehand to meet the population change in households without carrying out the village-wide large scale reallocation. This method ensures the land rights security of farmers for a longer period of time.

[14] Many Chinese scholars suggest villages tend to adjust land in small-scale every three years and on a large scale every five years (*sannian yi xiaotiao wunian yi datiao*). This statement doesn't hold for all villages in the sample.

scale, there is higher participation in local employments and migration. They have higher percentage of land adjusted since 1984 and much smaller portion of paddy land. [15] Change in party secretaries is more frequent in villages with large-scale land adjustments only.

1.4 Empirical Results

The most important result of the theoretical model is the labor specialization effects of land security, i.e. land rights security will affect households with different farming ability differently. In empirical tests, I will first discuss the measurement of land security and the endogeneity issue, and then estimate the impacts of land security on human capital investment, land investment, and migration respectively.

1.4.1 Land Security: Measurement and Endogeneity

Land rights security is endogenous because land tenure is determined intrinsically within the village. Past studies have used different proxies, such as the frequency of past land reallocations, the percentage of land that have been adjusts, the percentage of households that were affected in the last land adjustments. Carter and Yao (1999) constructed a land security index and suggested that frequent land reallocations in the past mean unsecured land rights. It is problematic because with frequent land reallocation, land is more equally allocated among households. It may instead indicate a more secured land rights in the future.

Kung and Liu (1997) employed a survey conducted in 8 counties within Zhejiang and Jilin province in 1994 and found that households prefer the egalitarian land arrangement because they consider it "fair". The result is somewhat surprising. It's hard to imagine that the households with more land per

[15] The percentage of land adjustments is not 100% because new arable land is developed over the years and some land has been set aside as reserved land without being allocated)

person are willing to give up land and give it to others without proper compensation. If a household receives land in some year when a new member joins the family, it must also anticipate giving up some of its land some other year if some family member leaves. Therefore, households' preference for egalitarian land reallocation cannot reflect their true wills but a reflection of the imposed moral requirement of the collective.

Turner, Brandt and Rozelle (2002) assume that village cadres make land reallocation decisions to maximize the total producer surplus in the village. The administrative reallocation plays the role of the land market and shift land between households until the marginal product of land equalize. The theory predicts that land will be redistributed more if village population grows faster and when non-farm employments proliferate. Population growth turns out to have a significant effect on the probability of land reallocation but non-farm employment opportunities are not in accord with the experience and their empirical result was contradicting to this hypothesis too. Their assumption on village cadres maximizing village welfare is not realistic and is against reality.

While non-farm market and land rental market may play important roles in village land tenure, they are highly endogenous. We need exogenous variables that explain land tenure while uncorrelated with the employment choices. Kung (2011) suggests that village topography is an important factor determining the fashion of land reallocation because it determines the transaction cost of doing so. Villages that tend to adjust land in small-scale usually have more complex topographies as well as large numbers of plots. Small-scale land adjustments have to consider transaction costs of mapping and matching land among households. Village cadres and production teams have to resurvey and recombine plots of different qualities, locations, and facilities before plots are reassigned to households with demographic changes. These costs only

happen when the village adjusts land in small-scale. On the other hand, large-scale land reallocations cause more efficiency loss but without those additional transaction costs.

I define land security following the suggestion by Kung (2011). He claims that large-scale land reallocation results in much higher land insecurity than small scale adjustments. In a village with large-scale adjustments, changes in land ownership will only happen in the next village-wide land adjustments. Villages with small-scale land adjustments only reallocate land when a household has demographic changes. Small-scale land adjustments have low uncertainty because farmers know exactly when the land change will be.

I choose three categories of exogenous variables as instrument for land security [16]: (1) village land endowment; (2) variables related to transaction costs of land reallocation, such as the number of households, number of plots and village topography variables including the percentage of paddy land and the percentage of plain land; (3) the number of party secretaries since HRS is used as a proxy for pressure from the state. Village heads in the sample elected by villagers and are changed less frequently. Village party secretaries are assigned from the higher authority (county or city), which is much more frequent.

The first stage results are shown in Table 5. Besides the explanatory variables discussed before, a province dummy is also included for column [3], [4] and [5] to capture the macroeconomic policy on the provincial level. As expected, villages with more households and smaller number of plots are more likely to adopt the large scale land reallocation in practice. Number of party secretaries and village topography variables do not have significant

[16] Although data used in this paper are from households who have no right to determine land tenure, we cannot rule out the unobserved variables in the error term in estimating equations, such as the innate abilities and other characteristics of the village.

impacts. Land-labor ratio has a negative impact on the likelihood of adopting large-scale land reallocation for the sample villages.[17]

I use "whether the village mainly adopts small-scale land reallocation" as the proxy for land rights security. Four instrumental variables are chosen from column [3]: number of households, number of land plots, land cultivated per person and number of party secretaries since HRS. I also experimented with different subsets of explanatory variables from Table 5 as instruments for land security, and the results are robust.

1.4.2 Land Security on Human Capital Investment

I divide land rights in rural China into two periods: before 1984 and after 1984. As discussed in the introduction, before 1984, land rights were determined by the State. After 1984, villages gained the authority to make land reallocation decisions, and thus we observed vast differences in land tenure between villages. Since the paper focuses on impacts of different land tenure on labor market outcomes, individuals selected should receive their education between 1984 and 1994. If children go to elementary school at the age of 6, they will finish middle school at 15 and finish high school at 18.[18] If children have received their education between 1984 and 1994, they will be between 15 and 25 in 1994.

In CLSS, the age group 15-25 has on average 8 years of education, with nearly 90% of middle school graduates. About 52% of children finished middle school and 7.8% finished high school. More than 43% of children have dropped out

[17] In studies by Kung (2011) , he did not find significant impact of land endowment per capita on land tenure choice.
[18] Less than 3% of the sample have received education beyond high school and thus were excluded from the analyses.

before high school.[19] It is common practice in rural China for children of age 13-16 to work on the farm or other employments, part-time or full-time.

I estimate the following specification:

$$EDU = \alpha_0 + \alpha_1 LS + \alpha_2 (LS * A) + \alpha_3 A + \alpha_4 IND + \alpha_5 HH + \alpha_6 V + \varepsilon \quad (25)$$

where EDU is the education attainment. Three indicators are used: years of education, whether the individual has finished middle school (1=finished middle school), and whether the individual dropped out before high school (1=dropped out before high school). Children who didn't finish school in 1994 are excluded from the sample. LS is the measure for land security. When $LS = 1$, the village adopts small-scale land reallocation regime and we consider land rights *secured*. A is farming ability of the household, proxied by the log value of farm capital owned per person.

IND captures individual characteristics such as age, gender, parents' education and type of *hukou* (urban or rural resident registration). HH is household characteristics such as household size and land cultivated per capita in 1984. V is village level characteristics such as distance to the closest county, if the village could access credit in 1988, and whether the village had migrants in 1988 (a proxy for migration network effect). [20]

I am interested in signs of α_1 and α_2, which capture the effect of the land security on education at different farming ability. If α_2 is negative, households with low farming ability will have higher education outcome and vice versa. It is noteworthy that unlike in linear models, the coefficients on interaction variables in probit models are not the usual parameters of

[19] Due to limited number in the sample, dropouts here refer to either dropping out of elementary school or middle school.
[20] I use variables from 1984 and 1988 as estimates for average household condition between 1984 and 1994 because education attainments are affected by the continuous changes in the household.

interest. Table 6 and later tables, I also focus on the coefficients of the interaction terms.

Dependent variables include a continuous variable (years of education) and binary variables (whether graduate from middle school; whether quit before high school), so two types of regressions are used. For the continuous variable, I use OLS and 2SLS estimates. For binary outcomes, probit models are used. Since land security is a binary endogenous variable, I use the two-stage correction. [21] This procedure uses a probit model to estimate the endogenous variable in the first step and then use the predicted value as the instrument in the second step. The main results are shown in Table 6.

Columns [1], [3] and [5] are baseline regressions, and other columns instrument land security with the list of variables chosen from Table 5. Results show that secured land rights increase the probability of graduating from middle school and decrease the probability of dropping out before high school. The coefficient is not significant for years of education at 10% level, but it is significant at 15% level. The sign of the interactive term is as expected--secured land rights on average have stronger effects for households with less farm capital in their education attainments. Overall, the empirical results confirm the theoretical prediction that land rights security promotes education attainments, and have stronger effects on households with low farming abilities.

1.4.3 Land Security on Land Investment

I choose the usage of organic fertilizer as the measurement for land investment. The effect of organic fertilizer could last for a few years, and thus their usage is subject to the risk of land reallocation. CLSS reveals a significant proportion of households with zero organic fertilizer usage and

[21] The two-step correction is suggested by Wooldridge (2002, section 15.7.3).

the rest with a positive level. OLS regression will not yield consistent estimates, so Tobit model is a better choice. It is more flexible to use the two-part model because the standard Tobit regression makes a strong assumption that the same probability mechanism generates both the zeros and the positive values. The first part of the two-part model is a binary outcome equation and the second part uses linear regression. The two parts are estimated separately.

I use the following specification. Let y denote land investment (the amount of organic fertilizer). Let s be a binary indicator such that $s=1$ if $y>0$ and $s=0$ if $y=0$. When $y=0$, we only observe $pr(s=0)$. When $y>0$, define $f(y|s=1)$ be the conditional density of y. The two-part model for y is:

$$f(y|X)=\begin{cases} pr(s=0|X) & if\ y=0 \\ pr(s=1|X)f(y|s=1,X) & if\ y>0 \end{cases} \quad (26)$$

For the first part, I use probit model, then $pr(s=1|X)=\Phi(X'\alpha)$, where X is the vector of all explanatory variables. For the second part, I first use an OLS regression and then use IV-GMM model to instrument for land security. The weighting matrix used in the GMM estimator accounts for heteroscedasticity and is asymptotically efficient. [22]

Main results are reported in Table 7. The unreported variables include quality and type of the plot, other plot characteristics, village control variables, and a province dummy. Columns [1] and [2] present estimates of equation (28) where the dependent variable is an indicator for using organic fertilizer. Columns [3] and [4] instrument land security with the list of variables chosen from Table 5.

[22] See Wooldridge, 2002; Baum, Schaffer, and Stillman, 2003.

Columns [2] and [4] show that land security (small-scale land adjustments) decrease the use of organic fertilizers if farm capital is low. As predicted by the theoretical model, when land rights are secure, households with more farm capital have a higher probability to use organic fertilizers. The impact of land security on the amount of fertilizer used in land is not as significant.

1.4.4 Land Security on Migration and Other Employments

I examine the employment decisions for age group 15-25. The theoretical model suggests that households invest in human capital to prepare for non-farm jobs, especially for migration. Migration decision is more complicated than other forms of employments because it could either be temporary or permanent depending on the duration. In empirical tests, the two outcomes in migration do not directly depend on each other, but the error terms may be correlated. Therefore, I choose an ordered multinomial model and assume two latent variables y_1^* and y_2^* as below:

$$y_i^* = \beta_i X_i + \varepsilon_i \quad i = 1,2 \tag{27}$$

where $\varepsilon_1$and ε_2 are jointly normally distributed with means of 0, variances of 1, and correlations of ρ. We observe the two binary outcomes

$$y_i^* = \begin{cases} 1 & if\ y_i^* > 0 \\ 0 & if\ y_i^* \leq 0 \end{cases} \quad i = 1,2 \tag{28}$$

The model collapses to two separate probit models if correlation $\rho = 0$. I use the same regressors in both estimates. Vector X_i includes individual, household, village controls as in the previous regressions.

One specification issue arises investigating the relationship between migration and household wealth. I use farm capital as a proxy for the household farming ability. It could also be a proxy for household wealth.

Past studies in migration has found numerous evidence on the inverted-U relationship between household wealth and migration. Du, Park and Wang (2005) found that the probability of migration first increases with household income, and then decrease in rural China. If the inverted-U relationship exists, by including the square of farm capital interacted with land security, we expected to have different coefficient for the interaction term. Main results are reported in Table 8.

Table 8 (a) presents basic results and table 8 (b) also includes the squared term of farm capital interacted with land security. Column [1] and [2] report results of the basic biprobit model. Column [3] and [4] instrument land security and education with lists of variables from Table 5 (for land security) and Table 6 (for education). Using instrumental variables yield significant different results. Therefore, I focus on results in column [3] and [4].

In 8 (a), the interactive term has a negative sign for temporary migration, but for permanent migration, the coefficient of the interactive term is not significant. In 8(b), by controlling for squared farm capital, the interactive term for temporary migration has a much bigger coefficient. Also, coefficient for permanent migration is positive and significant at 10% level.

The results suggest that at lower level of household farm capital, land security increase the probability of temporary migration but decrease the probability of permanent migration. One possible explanation is that permanent migration is associated with much higher initial cost comparing to temporary migration. When households have less farm capital, they are likely to be credit constrained to participate in permanent migration. The coefficient for $LS * A^2$ is negative, suggesting that the impact of secured land rights on households with little farm capital will be the smallest. Temporary

migration, on the other hand, is associated with less initial cost and thus households are less likely to be credit constrained to participate.

Other important employments include farming and local wage employment. Land security decreases the probability to be a full-time farmer but this effect is weaker for those with high farming ability. Local wage employments increase with land security and the participation increases faster for low-ability households. Overall, land security increases non-farm employment participation for low-ability households, in terms of both migration and local wage employments.

1.4.5 Robustness Check

1.4.5.1Nonlinearity in Farm Capital

The main results show that higher land security has larger impacts on households with low farm abilities in their investment in human capital and participation in migration. In all my estimates, farm ability is proxied by the amount of productive farm capital that the household owns. It is possible that the interactive term which yields the results is a proxy for nonlinearities in the effect of the farm capital. If this is true, then controlling for the nonlinearity will not yield significant results for the interactive term.

To examine whether the results are robust to nonlinearities, I estimate each equations by including a square term of farm capital. Results are presented in Table 9. It is clear that in both the basic models (without instruments) and the full models (with instruments), there is little change in the coefficients of interest. Therefore, the possibility of nonlinearities that may be driving the negative results can be ruled out.

1.4.5.2 Farm Output as Proxy for Household Farming Ability

The previous tests use farm capital owned by the household as the proxy for household farming ability. Another possible proxy is farm productivity, i.e. farm output per person. Farm capital owned indicates the household's potential in farm production, and farm output is a direct indicator on farming ability. I use farm output per person in 1993 as a proxy for farming ability for fertilizer usage and employment choices. For education attainment, we have to make the assumption that farm productivity for the household has been relatively stable between 1984 and 1994.

The results are shown in Table 10. The coefficients for the interactive term in 10 (a) and 10 (b) are consistent with previous tests. Table 10 (c) presents impacts of land security on migration and other employment choices. I did not include the square term of farm output because past studies have not shown evidence on the nonlinear relationship between farm output and employment decisions. 23 The results are similar to previous findings. However, the impact of land security on permanent migration is no longer significant. It could be because that the quality of the data on output is not as good as the farm capital in the survey. Also, permanent migration is defined as being away from village for more than one year, so it happens before farm output is realized. The causality could be reversed. In general, farm output is not as good an indicator as the farm capital because the amount of farm capital is relatively stable for a long time but farm output is affected by many factors such as weather, government policy or natural disasters.

[23] I estimated separate regressions to include the square term of farm output per person and interact the term with land security, and did not find evidence for any nonlinear effect. The coefficient for the square term is small and not significant. The coefficients for LS*A had little change.

1.5 Conclusion

The paper provides new evidence on labor market implications of land tenure in rural China. Large-scale land reallocations within a village affect all households and generate land rights insecurity, while small-scale land reallocations only affect those with demographic changes and thus have higher land security. For households with high farming ability, land security increases the expected land holding in the second period and in turn increases the marginal return to farming ability. Consequently, the incentive of those households to invest in human capital and participate in non-farm sector will be weaker. For households with low farming ability, the story is the opposite. They anticipate receiving more land from future land redistribution and the return to farming ability is lower. Their optimal investment strategy would be to invest in human capital and prepare for non-farm jobs. The theoretical results suggest that land security (small-scale land adjustments) facilitate labor specialization in rural area in that high-ability households focus on farming and low-ability households focus switch to the non-farm sector.

Different from past studies, I identify land rights security as whether the village has adopted small-scale land reallocation as its main regime. The advantage of this identification is that it reflects the perceived land security of farmers. Identifications used in past studies, such as the number of land reallocations since the land reform or the percentage of households affected in the last round of land reallocation, were somewhat arbitrary because there is no empirical evidence indicating that these measures reflect how farmers perceive land security. In empirical tests, following the transaction cost story, land security is instrumented with three sets of exogenous variables: village resource endowments, topography and the pressure from the higher authority.

The empirical results drawn from a 1995 CLSS survey data support the theoretical implications. I test the impact of land security on human capital investment, land investment and employment choices separately. It appears that education attainments for age group 15-25 is positively affected by land security and this effect is stronger for low-ability (in farming) households. Results from IV-probit models suggests that individuals are more likely to graduate from middle school and less likely to quite before high school with secured land rights, especially for low-ability households.

In terms of land investment, I use the probability of using organic fertilizer and its quantity used per *mu* as dependent variables. Organic fertilizers usage will have effects in land for several years and thus are subject to the risk of land reallocations. The IV-probit and GMM results suggest that at low levels of farm ability, land security decreases the probability of using organic fertilizer significantly, while at high levels of farm ability, land security increases the probability of using it.

Migration decision is complicated for two reasons. First, migration with different duration will be affected differently by land security. Long-term migration is subject to high initial costs (e.g. purchasing a city residential permit) and high risks in job search, while short-term migration has a circular nature that individuals travel between the city and the village with more flexibility. Temporary migrants are able to work on the farm during the busy season and go back to the city during the slack season. Second, farm capital is used as a proxy for farming ability of the household but it could also be a proxy for household wealth. Past studies have shown that there is an inverted-U relationship between household wealth and migration. Taking both factors into consideration, I estimate a biprobit model to test temporary and permanent migration decisions simultaneously. The result for temporary migration is as expected: land security facilitates

temporary migration overall and have stronger impacts for households with low farm capitals. For permanent migration, although the overall effect of land security is positive, the interactive term is also positive and significant at 10% level, which means land security increases permanent migration for households with more farm capitals. This result could be explained by the credit constraint story. Households with less farm capital to start with are more likely to be constrained to meet the initial costs of permanent migration. In the robustness check, when I use farm output as a proxy for farming ability, the coefficient for both land security and the interactive term becomes small and not significant. It indicates that land security is only important for temporary migration, and permanent migration is determined by other factors such as wealth.

The main result from secured land rights is the labor market specialization based on education and farming skills. It's important for policy makers to understand its implication. Large scale adjustment causes more distortions in land investment and employments than small-scale land adjustments. If rural credit market and non-farm labor market do not exist, large-scale land reallocation will benefit households with low farming ability and less farm capital. However, if other markets exist, the benefit of large-scale land distribution for low-ability households will decrease, and its distortion effect in land investment and non-farm employments will be more apparent. Land reform that aims at higher land security will increase the welfare of low-ability households in this case.

Appendix: Including a Financial Constraint in the Model

Without constraints on investments, the first order conditions of K and H show that the optimal capital investments are simultaneously determined by farm ability and household wealth. However, households are likely to be constrained on how much they can borrow and invest. Wealthier households are more likely to have a higher level of capital input and also easier access to the credit market.

To simplify algebra, I consider the case when the household is constrained only in the human capital investment H but not in farm capital K. The value of H depends on wealth and the amount that the household can borrow. It is possible that a constrained household chooses not to enter non-farm sector even though it would have if it were able to borrow. Credit constraints

therefore produce a correlation between household wealth and their likelihood to take local non-farm jobs and to migrate.

Assume that investment is financed by household wealth Φ_0, land rental income rT^r and borrowing B. Households can use illiquid assets, such as housing or farm equipment, as collateral to borrow at rental rate δ. Here I use Z to denote the value of all household assets that can be used as collaterals. Land cannot be used as collateral for loans because it's not owned by farmers. The model now has two additional constraints on investment and borrowing:

$$qK + H + I = \Phi_0 + rT^r + B \tag{1}$$

$$B \leq \alpha(\delta \mathrm{Z} + \Phi_0), \qquad 0 < \alpha < 1 \tag{2}$$

where T^r is the amount of land rented out. If the household rents in land, this term will be negative. The amount that a household can borrow, B, cannot exceed a fraction of its total wealth which includes the value of collaterals and the total wealth. And the household can also lend out the wealth Φ_0. Assuming that the shadow value of human capital is λ and the first order condition with respect to H becomes:

$$U'(c_1) = \beta g' L_m E U'(c_2) + \lambda \tag{3}$$

The marginal product of human capital is equal to the sum of its marginal return and shadow value. If the borrowing constraint is not binding, i.e. $\lambda = 0$, then H^* solves $U'(c_1) = \beta g' L_m E U'(c_2)$. If the constraint is binding, then $H^{cc} = \Phi_0 + \alpha(\delta \mathrm{Z} + \Phi_0)$. Therefore the human capital investment is:

$$H = min\{H^*, H^{cc}\} \tag{4}$$

For binding households, If $H^{cc} < H^*$, then $U[c_1(H^{cc})] < \mathrm{U}[c_1(H^*)]$. Here the level of constrained utility is lower than the non-binding case because utility is an increasing function of capital.

With more secured land rights, both credit constrained and non-constrained households will increase their labor participation in migration. For credit constrained households who have already participated in migration, with more secured land rights, their land rental value will go up and we shall see higher participation in local employments and migration.

If the land rental market is complete, households may mitigate risk and smooth out consumption by renting in or out effective land. In our equations, Af' will again be replaced by the land rental price r. The sign of $\frac{d\Delta V}{d\rho}$ no longer depends on the farm ability directly. The wealth determines the household's decision of participating in migration. As long as $\Phi_0 < \widetilde{\Phi}_0$, the household may choose to enter migration regardless of its farm ability. Introducing a land rental market will increase households' ability to cope with risk ex post. For example, if there is a positive labor supply shock, households could mitigate its impact by either participating in migration or renting out land or both.

References

[1] Acemoglu, Daron and Simon Johnson. (2005): Unbundling Institutions, *Journal of Political Economy*, 113(5): 949-995.

[2] Benjamin, Dwayne and Loren Brandt. (2002): Property Rights, Labor Markets, and Efficiency in A Transition Economy: The Case of China, *Canadian Journal of Economics*, 35(4): 689-716.

[3] Besley, Timothy. (1995): Property rights and investment incentives: Theory and evidence from Ghana. *Journal of Political Economy*, 103: 903-937

[4] Brandt, Loren, Scott Rozelle, and Matthew A. Turner. (2004): Local Government Behavior and Property Right Formation in Rural China, *Journal of Institutional and Theoretical Economics*, 160: 627-662.

[5] Brandt, Loren, Jikun Huang, Guo Li, and Scott Rozelle. (2002): Land Rights in Rural China: Facts, Fictions and Issues, *China Journal*, 47: 67-97.

[6] Carter, Michael and Yang Yao. (1999): Specialization Without Regret: Transfer Rights and Agricultural Investment in an Industrializing Economy. World Bank Policy Research Working Paper

[7] De Brauw, Alan, John Giles. (2008): Migrant Labor Markets and the Welfare of Rural Households in the Developing World: Evidence from China, Policy Research Working Paper Series 4585, The World Bank.

[8] De Soto, Hernando. (2000): The Mystery of Capital: Why Capitalism Triumphs in the West and Fails Everywhere Else, New York: Basic Books.

[9] Deiniger, Klaus and Gershon Feder. (2001): Land Institutions and Land Markets, in Bruce L. Gardner and Gordon C. Rausser, *Handbook of Agricultural Economics*, 1: 288-331.

[10] Du, Yang, Albert Park, and Sangui Wang. (2005): "Migration and Rural Poverty in China." *Journal of Comparative Economics*, 33, 688-709.

[11] Jin, Songqing and Klaus Deininger. (2009): Land Rental markets in the Process of Rural Structural Transformation, *Journal of Comparative Economics*, 37(4): 629-646.

[12] Kung, James Kai-sing, Nansheng Bai, and Yiu-Fai Lee. (2011): Human Capital, Migration, and 'vent' for Surplus Rural Labor in 1930s' China: the Case of the Lower Yangzi. *Economic History Review*, 64 (1): 117–141. Lattimore, O., 1962. I

[13] Kung, James Kai-sing and Ying Bai. (2011): Induced Institutional Change or Transaction Costs? The Economic Logic of Land Reallocations in Chinese Agriculture, *Journal of Development Studies*, 47(10): 1510-1528.

[14] Kung, James Kai-sing. (2002): Off-farm Labor Markets and the Emergence of Land Rental Markets in Rural China, *Journal of Comparative Economics*, 30 (2): 395-414.

[15] Kung, James Kai-sing and Shouying Liu. (1997): "Farmers' Preferences regarding Ownership and Land Tenure in Post-Mao China: Unexpected Evidence from Eight Counties," *China Journal*, 38 (1997): 33–63

[16] Li, Guo, Scott Rozelle, Loren Brandt. (1998): Tenure, Land Rights, and Farmer Investment Incentives in China. *Agricultural Economics*, 19 (1-2), 63–71.

[17] Liu, Shouying, Michael Carter and Yang Yao. (1996): Dimensions and diversity of property rights in rural China: Dilemmas on the road to further reform. Agricultural and applied economics (Staff Paper Series No. 395, revised). Madison, Wisconsin: University of Wisconsin—Madison

[18] Taylor, John. Edward, Scott Rozelle, and Alan de Brauw. (2003): Migration and Incomes in Source Communities: A New Economics of Migration Perspective from China,' *Economic Development and*

Cultural Change, 52: 75-101.

[19] Turner, Matthew, Loren Brandt, and Scott Rozelle. (1998): "Local Government Behavior and Property Right Formation in Rural China," Manuscript, University of Toronto

[20] Wang, Shing-Yi. (2012), "Credit Constraints, Job Mobility and Entrepreneurship: Evidence from a Property Reform in China," *Review of Economics and Statistics*, 94(2): 523-551.

[21] Wen, Guanzhong James. (1995): The Land Tenure System and its Saving and Investment Mechanism: The Case of Modern China. *Asian Economics*, 9(31): 233-259.

[22] Yang, Dennis Tao. (1997): China's land Arrangement and Rural Labor Mobility, *China Economic Review*, 8(2): 101-115.

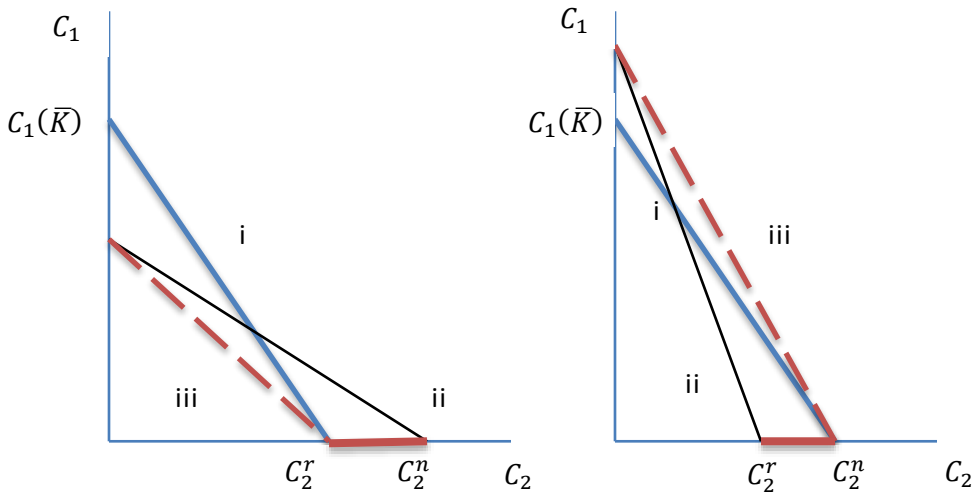
[23] Yao, Yang. (2000): The Development of the Land Lease Market in Rural China, *Land Economics*, 76: 252-266.

[24] Yao, Yang. (2004): Land Tenure Choice in Chinese Villages: The Rational Versus the Political Model, *Land Economics*, 80: 477-489.

[25] Zhao, Yaohui. (1999): Leaving the Countryside: Rural-to-Urban Migration Decisions in China. *American Economic Review*, 89(2): 281–286.

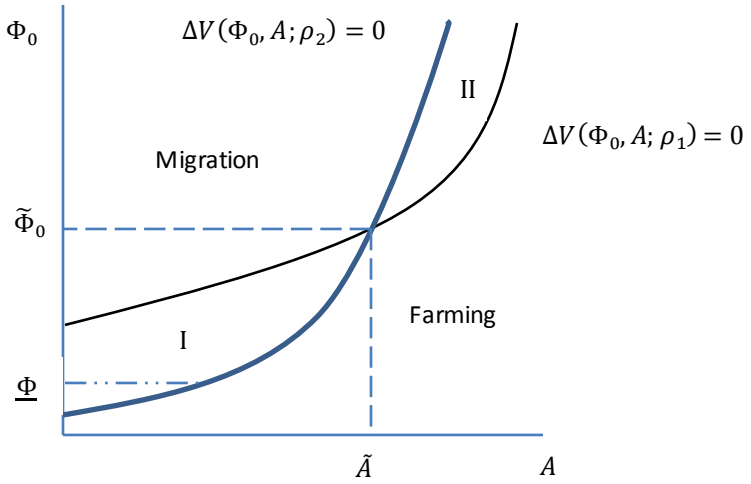
Figures and Tables

Figure 1: INTERTEMPORAL CONSUMPTIONS



(a) High-ability households (b) Low-ability households

Figure 2: LAND REALLOCATION AND MIGRATION



NOTE: ρ is the probability of land reallocation in period two and $\rho_1 > \rho_2$

Table 1 BASIC HOUSEHOLD STATISTICS BY MIGRATION STATUS

Variable mean	Non-migrants		Permanent migrants (away>1 year)		Temporary migrants (away>1 month)	
Age	31.78	[18.51]	30.05	[7.20]	32.99	[11.54]
Education	5.34	[3.31]	7.42	[3.13]	7.36	[2.45]
Male, percentage	0.52	[0.50]	0.32	[0.47]	0.8	[0.40]
Urban *hukou*, percentage	0.05	[0.21]	0.26	[0.44]	0.09	[0.28]
N	3,272		434		136	

NOTE:

(1) Means are calculated at individual level. Standard deviations are in parentheses.

(2) Education is the number of years of school completed.

(3) Having urban registration means the ability to access urban welfare programs.

Table 2 DESCRIPTIVE STATISTICS FOR HOUSEHOLDS BY MIGRATION STATUS

Variable mean	Non-migrant households (n=454)		Migrant households (n=333)	
Migration and demographic variables				
Number of migrants	..	..	1.91	[1.20]
Household size	3.83	[1.00]	3.54	[1.35]
Age of household head	39.07	[9.60]	51.8	[11.64]
Number of female	1.91	[0.87]	1.76	[0.89]
Number of children, age 0-7	0.35	[0.52]	0.24	[0.47]
Number of seniors, age>55	0.3	[0.64]	0.84	[0.90]
Household Wealth				
Land owned, *mu*	18.07	[13.54]	21.27	[13.54]
Present value of farm capital owned, *yuan*	2738.5	[3371.88]	2535.94	[2991.02]
Use value of nonproductive durable goods	437.96	[555.70]	289.98	[409.07]
Household saving, *yuan*	8076.98	[18645.97]	3734.24	[6910.85]
Income sources				
Farm income (87.4%)	3970.92	[5949.81]	2804.3	[3363.05]
Nonfarm wage income (19.1%)	5285.41	[3228.02]	6052.02	[3412.26]
Remittances (28.8%)	795.24	[1147.84]	1244.57	[1994.85]
Family owned business (39.6%)	39673.31	[127579.23]	31745.4	[96180.60]
Other income (52%)	1219.07	[2430.12]	1151.2	[2438.70]

NOTE:

(1) Means are calculated at household level. Standard deviations are in parentheses.

(2) Percentage in the bracket in income sources is the participation rate.

(3) Household size refers to numbers of family members living at home. Non-productive durable goods refer to furniture, TV and etc. Farm capital refers to all productive capital such as irrigation equipment and tractors and their total present value are reported. Other income includes pension, health care, rent and etc.

(4) 1 *yuan*=0.12 dollar in 1995. 1 *mu*=0.17 acre.

Table 3 FARM LABOR, LAND AND OUTPUT BY PROVINCE

Variable mean	Hebei (n=393)		Liaoning (n=394)	
Farm labor supply, days				
Family male	68.09	[53.61]	49.04	[39.93]
Family female	69.99	[47.64]	50.21	[34.86]
Hired labor	38.8	[78.97]	7.65	[12.78]
Exchange labor	7.87	[6.77]	8.71	[7.41]
Total farm labor supply	169.92	[118.48]	111.71	[98.06]
Farm output and capital, *yuan*				
Farm output	4356.1	[3072.80]	8285.89	[9080.44]
Land, *mu*	7.32	[4.6]	15.52	[15.84]
Farm capital	3038.22	[2978.18]	2194.74	[3474.00]
Households with land change, percentage				
Received land(past 2 years)	8%	[0.27]	26%	[0.44]
Lost land (past 2 years)	18%	[0.38]	22%	[0.41]
Received land (since 1984)	38%	[0.49]	63%	[0.48]
Lost land(since 1984)	10%	[0.30]	3%	[0.16]

NOTE:

(1) Means are calculated at household level. Standard deviations are in parentheses.
(2) Farm capital refers to all productive capital like irrigation equipment and tractors. Their present values are reported.
(3) Much of the farm output was sold in 1994 at fixed or negotiated price to the state. In calculating farm output, this portion of sold output is corrected by 1994 market price.
(4) 1 *yuan*=0.12 dollar in 1995. 1 *mu*=0.17 acre.

Table 4 VILLAGE CHARACTERISTICS BY LAND REALLOCATION REGIME

	Large-scale		Small-scale	
Number of households	312.38	[110.08]	500.33	[262.71]
Number of party secretaries since HRS	3.29	[2.05]	2.78	[1.79]
If the last election was competitive	1.2	[0.41]	1.22	[0.44]
Percentage local wage employment	0.13	[0.10]	0.11	[0.08]
Percentage temporary migrants	0.03	[0.06]	0.01	[0.03]
Percentage permanent migrants	0.04	[0.06]	0.03	[0.03]
Number of land reallocations since HRS	2.29	[2.61]	3	[3.54]
Percentage of land adjusted since HRS	0.85	[0.32]	0.76	[0.36]
Percentage of paddy land	0.09	[0.22]	0.44	[0.39]
Percentage villages with plain land only	0.33	[0.48]	0.56	[0.53]

NOTE: Standard deviations are in brackets.

Table 5 DETERMINANTS OF LAND TENURE CHOICE: PROBIT MODEL

	Dependent variable: land security (small-scale land adjustment=1)				
	[1]	[2]	[3]	[4]	[5]
Number of households, log	-1.782*	-1.842*	-2.833*	-2.419*	-1.875**
	[0.858]	[0.889]	[1.197]	[1.080]	[0.720]
Number of plots per household, log	1.289*	1.344*	1.139*		
	[0.571]	[0.601]	[0.489]		
Land cultivated per person, log	-0.683	-0.693	0.966**	1.605***	1.025**
	[0.510]	[0.510]	[0.303]	[0.315]	[0.358]
Number of party secretary since HRS		-0.053	0.213	0.302	0.234
		[0.157]	[0.212]	[0.189]	[0.204]
Percentage of paddy land				-1.549	
				[1.200]	
If village has only plain land					-0.587
					[0.741]
Liaoning			-3.176***	-3.090***	-3.123***
			[0.426]	[0.387]	[0.581]
Constant	10.973*	11.462*	14.889*	12.285*	10.546*
	[5.137]	[5.411]	[7.076]	[6.190]	[4.891]
Clustered SE	No	No	Yes	Yes	Yes
Pseudo R^2	0.346	0.349	0.512	0.494	0.465

Table 6: EDUCATION ATTAINMENT OF AGE GROUP 15-25

	Years of education		If graduate from middle school		If quit before high school	
	OLS	2SLS	PROBIT	IVPROBIT	PROBIT	IVPROBIT
	[1]	[2]	[3]	[4]	[5]	[6]
LS	0.339	0.767	0.428	1.330*	-0.694	-1.786*
	[0.447]	[0.575]	[0.420]	[0.608]	[0.445]	[0.752]
LS*A	-0.032	-0.089	-0.049	-0.170*	0.06	0.206*
	[0.070]	[0.088]	[0.052]	[0.079]	[0.056]	[0.097]
A	0.055	0.093	0.014	0.098	-0.049	-0.147+
	[0.051]	[0.062]	[0.042]	[0.070]	[0.047]	[0.086]
EDU_father	0.167*	0.164**	0.090**	0.082**	-0.050*	-0.044+
	[0.061]	[0.059]	[0.029]	[0.028]	[0.024]	[0.025]
Observations	639	639	676	676	676	676

NOTES:

(1) Clustered robust standard errors are in brackets. *** denotes significance at the 0.1% level, ** at the 1% level, * at the 5% level, + at the 10% level.

(2) LS is whether the village adopts small-scale land adjustments as its main reallocation regime. Small-scale adjustments represent land security. A is household farming ability, proxied by log farm capital per person. EDU_father is the years of education of the father.

Table 7 USAGE OF ORGANIC FERTILIZERS

	If use organic fertilizer		Organic fertilizer per *mu*	
	PROBIT	IVPROBIT	OLS	GMM
	[1]	[2]	[3]	[4]
LS	-0.619	-3.281***	-1.042***	-1.368+
	[0.613]	[0.868]	[0.252]	[0.828]
LS*A	0.12	0.477***	0.109**	0.104
	[0.096]	[0.124]	[0.039]	[0.107]
A	-0.228*	-0.465***	-0.119***	-0.168+
	[0.089]	[0.098]	[0.033]	[0.088]
IMR			1.203*	2.522*
			[0.471]	[1.072]
Observations	1141	1141	491	491

NOTES:
(1) Clustered robust standard errors are in brackets. *** denotes significance at the 0.1% level, ** at the 1% level, * at the 5% level, + at the 10% level.
(2) LS is whether the village adopts small-scale land adjustments as its main reallocation regime. Small-scale adjustments represent land security. A is household farming ability, proxied by log farm capital per person.
(3) IMR (Inverse Mill Ratio) is calculated based on regression [2].

Table 8 LAND SECURITY ON MIGRATION

	Migration temporary	Migration permanent	Migration temporary	Migration permanent
	BIPROBIT		IV-BIPROBIT	
	[1]	[2]	[3]	[4]
a. BASIC REGRESSION				
LS	-0.189	0.109	0.553	0.525^{+}
	[0.384]	[0.259]	[0.598]	[0.303]
LS*A	-0.075	0.01	-0.140***	0.011
	[0.061]	[0.069]	[0.026]	[0.063]
A	0.082*	-0.01	0.110**	-0.02
	[0.040]	[0.075]	[0.036]	[0.075]
EDU	-0.011	-0.026	-0.146	0.223**
	[0.055]	[0.039]	[0.137]	[0.081]
b. CONTROLLING FOR NONLIEANRITY OF FARM CAPITAL				
LS	0.017	0.231	1.705***	0.543
	[0.302]	[0.175]	[0.517]	[0.338]
LS*A	-0.253^{+}	0.377^{+}	-0.433**	0.475^{+}
	[0.149]	[0.207]	[0.159]	[0.262]
LS*A^2	0.03	-0.060*	0.04	-0.074*
	[0.027]	[0.024]	[0.028]	[0.032]
A	0.151	-0.364^{+}	0.258*	-0.448^{+}
	[0.132]	[0.204]	[0.123]	[0.249]
A^2	-0.014	0.061*	-0.021	0.072*
	[0.024]	[0.025]	[0.020]	[0.030]
EDU	-0.018	-0.019	-0.16	0.214^{+}
	[0.054]	[0.033]	[0.156]	[0.110]
Observations	744	744	676	676

NOTES:

(1) Clustered robust standard errors are in brackets. *** denotes significance at the 0.1% level, ** at the 1% level, * at the 5% level, + at the 10% level.

(2) LS is whether the village adopts small-scale land adjustments as its main reallocation regime. Small-scale adjustments represent land security. A is household farming ability, proxied by log farm capital per person. EDU is years of education.

Table 9 LAND SECURITY ON OTHER EMPLOYMENTS

	Only Farming		Only Local	
	PROBIT	IVPROBIT	PROBIT	IVPROBIT
	[1]	[2]	[3]	[4]
LS	-0.309^{+}	-1.768***	0.23	1.553***
	[0.182]	[0.456]	[0.323]	[0.384]
LS*A	0.045	0.265**	0.075	-0.132
	[0.048]	[0.082]	[0.082]	[0.107]
A	-0.052	-0.227**	-0.147**	0.021
	[0.045]	[0.075]	[0.056]	[0.090]
EDU	-0.014	-0.099	-0.021	0.333***
	[0.033]	[0.158]	[0.063]	[0.033]
Observations	521	482	521	482

Table 10: ROBUSTNESS CHECK

a. EDUCATION ATTAINMENT

	Years of education		If graduate from middle school		If quit before high school	
	OLS	2SLS	PROBIT	IVPROBIT	PROBIT	IVPROBIT
	[1]	[2]	[3]	[4]	[5]	[6]
LS	0.362	0.789	0.445	1.353*	-0.708	-1.814*
	[0.436]	[0.557]	[0.412]	[0.597]	[0.436]	[0.737]
LS*A	-0.036	-0.094	-0.052	-0.175*	0.063	0.211*
	[0.068]	[0.085]	[0.052]	[0.078]	[0.054]	[0.095]
A	0.026	0.051	-0.005	0.051	-0.032	-0.094
	[0.113]	[0.112]	[0.073]	[0.082]	[0.066]	[0.092]
A^2	0.005	0.007	0.003	0.008	-0.003	-0.009
	[0.019]	[0.019]	[0.013]	[0.014]	[0.008]	[0.009]

b. FERTILIZER USAGE

	If use organic fertilizer		Organic fertilizer per *mu*	
	PROBIT	IVPROBIT	OLS	GMM
	[1]	[2]	[3]	[4]
LS	-0.322	-2.985***	-1.120***	-1.181
	[0.427]	[0.816]	[0.239]	[0.738]
LS*A	0.071	0.431***	0.125**	0.098
	[0.067]	[0.113]	[0.038]	[0.099]
A	-0.012	-0.269*	-0.061	0.105
	[0.091]	[0.111]	[0.055]	[0.087]
A^2	-0.022*	-0.021*	-0.01	-0.039**
	[0.009]	[0.009]	[0.008]	[0.013]

Table 11 ROBUSTNESS CHECK: FARM OUTPUT AS PROXY FOR ABILITY

a. EDUCATION ATTAINMENT

	Years of education		If graduate from middle school		If quit before high school	
	OLS	2SLS	PROBIT	IVPROBIT	PROBIT	IVPROBIT
	[1]	[2]	[3]	[4]	[5]	[6]
LS	0.001	1.702	0.208	3.094*	-0.26	-3.844**
	[0.704]	[2.089]	[0.594]	[1.462]	[0.596]	[1.391]
LS*A	0.033	-0.194	0.003	-0.384^{+}	-0.028	0.454*
	[0.105]	[0.297]	[0.080]	[0.208]	[0.062]	[0.188]
A	-0.017	0.103	-0.039	0.159	0.021	-0.221
	[0.089]	[0.186]	[0.062]	[0.134]	[0.036]	[0.141]

b. FERTILIZER USAGE

	If use organic fertilizer		Organic fertilizer *(cubic meters per mu)*	
	PROBIT	IVPROBIT	OLS	GMM
	[1]	[2]	[3]	[4]
LS	2.314	-20.108***	-4.648*	-16.191
	[2.032]	[2.472]	[2.043]	[11.009]
LS*A	-0.304	2.647***	0.565*	2.066
	[0.280]	[0.328]	[0.275]	[1.473]
A	0.467^{+}	-1.831***	-0.675***	-1.819^{+}
	[0.266]	[0.308]	[0.192]	[1.036]

C. EMPLOYMENT CHOICES

	Migration temporary	Migration permanent	Migration temporary	Migration permanent	Only Farming		Only Local	
	BIPROBIT		IV-BIPROBIT		PROBIT	IVPROBIT	PROBIT	IVPROBIT
	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]
LS	0.675	-1.089*	1.947***	0.489	-0.347	0.292	-1.812**	-5.352*
	[0.658]	[0.534]	[0.465]	[0.378]	[0.487]	[0.601]	[0.637]	[2.307]
LS*A	-0.142	0.178^{+}	-0.164***	0.009	0.078	0.007	0.273***	0.732*
	[0.088]	[0.104]	[0.030]	[0.051]	[0.083]	[0.057]	[0.074]	[0.322]
A	0.006	-0.099	0.015	0.039	0.201**	0.238***	-0.236**	-0.338
	[0.054]	[0.088]	[0.042]	[0.124]	[0.064]	[0.066]	[0.080]	[0.254]
EDU	-0.013	-0.029	-0.183	0.212^{+}	-0.008	-0.08	-0.029	0.446***
	[0.053]	[0.040]	[0.182]	[0.110]	[0.037]	[0.148]	[0.073]	[0.092]

NOTES:

(1) Clustered robust standard errors are in brackets. *** denotes significance at the 0.1% level, ** at the 1% level, * at the 5% level, + at the 10% level.
(2) LS is whether the village adopts small-scale land adjustments as its main reallocation regime. Small-scale adjustments represent land security. A is household farming ability, proxied by log farm output per person from the previous year.

2 Risk Coping: Land Tenure, Land Rental Market and Migration

2.1 Introduction

Despite the rapid growth in the economy, rural China doesn't have an effective social security system. For most villages, households get access to only the basic social and medical welfare programs. Farm land remains to be the most important form of insurance for living. During a large-scale land adjustment where everyone in the village is affected, land will be taken from households with high land-labor ratio to those with low land-labor ratio until every individual enjoys the same amount of land. Periodic land reallocations on the village level help households to counter labor supply shocks and maintain the same level of living standard as before.

Large-scale land reallocation was crucial in supporting the poor in rural villages when farming was the only employment option for villagers. In the commune period (1958-1984), farmers had no other employment choices besides farming, and rural-urban migration was strictly prohibited. For households, there were no other ways to cope with labor supply risks other than relying on land reallocations. Imagine a household started with only two adults. For some reason, two new family members joined the household (marriage, birth, and etc.). Without land adjustment, each member in the household will enjoy only half of the land as before, and income per person will drop. Kung (1994) suggested that equal land reallocation diversifies income risk for rural households. However, gains from land reallocation will be less significant when other employment options are available. For instance, the household in the example could send two members (surplus labor) to take non-farm jobs. Or, if land rental market exists, they could rent in additional land to support the additional household members. On the other hand, if the household has

lost some family members due to death or migration, it may rent out the extra land to others to cope with the negative labor supply shock.

Rural households can cope with risk either ex ante or ex post (Morduch, 1995). Ex ante, households can smooth income by diversifying income sources through both farm and non-farm employments. Ex post, households could smooth consumption through borrowing or saving (Meng, 2003), accumulation or depletion of productive assets (Rosenzweig and Wolpin, 1993) or risk-sharing arrangements such as land reallocation. If credit and insurance markets are missing, income and consumption of the household may be closed related. This paper will discuss risk coping strategies in rural China and the role of land reallocation in coping with labor supply shocks to households.

In rural China, ownership of the land belongs to the collective, which generates complications in both risk coping strategies and land investments. Households have land use rights to the land, which provides a form of social insurance (Naughton, 2007). However, since land is not privately owned, households are not able to exploit the value of land to smooth consumption easily. Villages step in to adjust land for the households, but this practice not only affects the household with labor supply shocks but also others who do not experience any labor shocks. This inevitably causes inefficiency in long-term land related investments. In addition, because of the poorly-defined property rights in land, the development of land rental markets in China has also been slow even though land rentals are widely encouraged in many places. In villages with only small-scale land reallocations, given that land rights are relatively more secured, we anticipate to see higher level of land rental activities.

This paper utilizes a unique data set that was specifically designed for exploring land reallocation regimes. The survey was carried out in 2003 by

the Development Research Center (DRC). It includes information in how land was reallocated each time since the land reform in 1984, for both large-scale and small-scale land adjustments. No data sets in the past have recoded small-scale land reallocated in such details.

Chapter one presented the labor market distortions associated with large-scale land reallocation (land rights insecurity). This chapter will examine the role of land security on household welfare and its impact on household ability to cope with labor market shocks. In section 2, I set up a theoretical model, first including only a closed agricultural economy, then adding in land rental market and non-farm labor market, and lastly discussing the welfare implications of land reallocation when a labor supply shock happens. Section 3 describes data and descriptive statistics. Section 4 presents the main results and robustness checks. Section 5 is conclusion.

2.2 Theoretical Framework

2.2.1 Welfare Effect of Land Reallocation in an Agricultural Economy

As discussed in Chapter one, higher land security will increase land investment. Higher investment in the first period means lower consumption assuming that credit market does not exist. The model setup is the same as in Chapter one from equation (1) to (10). Let V be the indirect utility function and it can be written as:

$$V(\rho, A) = U[c_1^*(\rho, A)] + \beta EU[c_2^*(\rho, A)] \quad (1)$$

By Envelope theorem, the impact of land security on the household expected utility is:

$$\frac{\partial V}{\partial \rho} = \beta \left\{ [U(c_r^* - R_r) - U(c_n^* - R_n)] + A\rho\tau U'(c_r^* - R_r) f'(\bar{t}) \frac{\partial \bar{K}}{\partial \rho} \right\} \quad (2)$$

The sign of the first term, $[U(c_r^* - R_r) - U(c_n^* - R_n)]$, depends on the distribution of land investment K. This term is negative for households with capital investment that is greater than the village average, i.e. $K > \bar{K}$, and positive for those with $K < \bar{K}$. It captures the *relative* effect of land reallocation on household welfare: households with less investment will benefit more from land reallocation when farming is the only employment option.

The second term $A\rho\tau U'(c_r^* - R_r)f'(\bar{t})\frac{\partial \bar{K}}{\partial \rho}$ is always negative regardless of investment distribution. The farm ability of the household determines the magnitude of this effect. The higher the farm ability, the lower gains households will receive from land reallocation (insecurity). This term captures the *absolute* effect of land rights insecurity because it is not affected by household investment.

We can solve for the threshold level of farm ability, $\tilde{A}$, at which household welfare is indifferent about land reallocation by setting $\frac{\partial V}{\partial \rho} = 0$. From equation (2), if $K > \bar{K}$, household welfare will be negatively affected by land reallocation ($\frac{\partial V}{\partial \rho} < 0$). For households with $K < \bar{K}$, their welfare could be improved by land reallocation if the farm ability A is less than the threshold level $\tilde{A}$.

The relationship between expected utility V and farm ability A is illustrated in Figure 1. Curve $V(c_r)$ represents the expected utility without land reallocation. Curve $V(c_r)$ represents the expected utility after land reallocation, where all households have the same land investment $\bar{K}$ (the village average). Household welfare captured by area II is transferred from high-ability households in area II to low-ability ones in area I. By and

large, land reallocation will benefit those with lower A and lower K, but not those with higher A and higher K.

The relationship between the optimal capital investment K^* and the technology parameter A is more complicated because it's determined by the portfolio choice of the household. The response of capital with a change in technology is:

$$\frac{\partial K^*}{\partial A} = D_2\left\{U'(c_n - R_n)[1 - \bar{r} + Ar\frac{\partial R_n}{\partial A}]\right\} \quad (3)$$

where D_2 is a positive constant; $\bar{r}$ is the relative risk aversion coefficient and r is the absolute risk aversion coefficient. When the rural household has a higher technology level, it has two effects on the capital investment. Firstly, higher A will increase the return from farming directly, promoting the incentive to invest in the first period. Secondly, the effect of A on K^* is also affected by the risk preference. Empirical evidence in the literature has shown that most people exhibit decreasing absolute risk aversion (DARA), implying that $\frac{\partial R_n}{\partial A} > 0$.[24] If $\bar{r} \leq 1$(weak relative risk aversion), then with higher A, the household will increase investment, i.e. $\frac{\partial K^*}{\partial A} > 0$. On the other hand, if the household has $\bar{r} > 1$, (strong relative risk aversion), then an improvement in technology may weaken the household's incentive to invest if A is below certain threshold level. In other words, for low-skilled households, if they are strongly risk averse we may have $\frac{\partial K^*}{\partial A} < 0$. If the household is risk neutral and the relative risk aversion coefficient is equal to one, then $\frac{\partial K^*}{\partial A} = 0$. Throughout the rest of the paper, we assume that farmers are risk averse and their land investment increases with farming ability.

[24] See Chavas and Holt, 1996.

To sum up, in an economy with only the agricultural sector, secured land rights will benefit households with high farming ability because they employ the highest level of investments. Yet for low-ability households, they benefit from land reallocation. The current land reallocation regime is out of egalitarian consideration rather than efficiency. Although the less skilled households prefer the periodic land reallocation in an agricultural economy, we will show in the following sections that by adding in land rental market and non-farm market, low-ability household will gain less from land reallocation, and distortions of land reallocation on land investment will go up.

2.2.2 Including Land Rental Market and Non-farm Sector

Without an effective land rental market, the household has to absorb the additional workers into the existing land, causing an inverse relationship between farm size and input intensity (Brandt, 2002). This relationship is usually used as an evidence for farm inefficiency in rural China. However, when land rental market exists, households could equalize their marginal return to labor through renting in or out land, and thus the inverse relationship could break down. To avoid duplication, the following model only includes equations that are different from Chapter one. If land rental market exists, consumption per capita in the first period is:

$$c = Af\left(t_2^f\right) + r\left(t_2 - t_2^f\right) \tag{4}$$

where t_2^f denotes land cultivated per person and t_2 land owned per person. When land is redistributed, we have t_2 equal to the village average landholdings, $\bar{t_2}$; r is the land rental fee per *mu*. [25] For simplicity, I assume away the transaction cost in land rental activities, which does not change the main

[25] Land rental fees are assumed to be the same regardless of renting in or renting out.

results of the theoretical model. Households live for two periods and maximize total expected utility. First order condition with respect to K is:

$$qU'(c_1) = \beta(1-\rho)T_0 rU'(c_n - R_n) \tag{5}$$

Comparing to equation (9) in the previous chapter, this new FOC replaces $Af'(t_2)$ with market rental rate r. In this case, the optimal capital investment level is not directly constrained by farming ability anymore. The marginal return to land is equal to the market rental price r. Land cultivated by a household, t_2^f, therefore, should be the same with or without land reallocation. High-ability households will rent in land and low-ability households rent out until their marginal return to land is equal to the market rental rate. The expected consumption for the household will also be the same with or without land reallocation, i.e. $c_r^* = c_n^*$.

The impact of probability of land reallocation on the household's welfare is thus:

$$\frac{\partial V}{\partial \rho} = \beta\left\{[U(c_r^* - R_r) - U(c_n^* - R_n)] + r\rho\tau U'(c_r^* - R_r)\frac{\partial \bar{K}}{\partial \rho}\right\} \tag{6}$$

The impact of the probability of land reallocation on the indirect utility also depends on the relative level of land investment with respect to the village average capital. Farm ability doesn't play an important role here comparing to the case of the self-sufficient agricultural economy. When land rental market is present, farm ability has only an impact on marginal utility through increased income, but not a direct effect on household utility. Farm ability still plays a role in determining land investment, but the difference in land investment will be much smaller than in the agriculture economy. If households are risk averse, some low-ability households still benefit from land reallocation. However, if households are risk neutral, then this benefit

will disappear. In this case, $c_r^* = c_n^*$, and the first term in the big bracket in equation (5) will drop out. We have:

$$\frac{\partial V}{\partial \rho} = \beta r \rho \tau U'(c_r^* - R_r) \frac{\partial \bar{K}}{\partial \rho} < 0 \tag{7}$$

Higher probability of land reallocation (land insecurity) will decrease the indirect utility. In other words, secured land rights will increase expected utility for every household, i.e. it's a Pareto improvement for all.

If we add in non-farm labor market, the functional form for the second period consumption becomes:

$$c = \frac{L_f \left[Af\left(t_2^f\right) + r\left(t_2 - t_2^f\right) \right] + g(HL_m)}{L_2} \tag{8}$$

where $t_2 = \bar{t}_2$ if land reallocation happens. $\bar{t}_2$ is the village average level of land. Despite the complicated functional form of consumption, the expression for $\frac{\partial V}{\partial \rho}$ is the same as in equation (20) in Chapter one. The difference is that consumption level here is higher because non-farm employments are assumed to have higher rate of return than farming. A non-farm labor market will further reduce the proportion of households that benefit from land reallocation. In conclusion, when land rental market and non-farm employment opportunities both exist, households are able to cope with labor supply shocks through those two markets instead of solely relying on land reallocation.

2.2.3 Including Labor Supply Shocks

This section will show that when labor shocks exist, gains from land reallocation will be smaller than when labor shocks don't exist. I follow the approach of mean-preserving spreads by introducing an exogenous labor shock l

to labor endowment L_0. [26] A labor supply shock could be any demographic changes that affect household productivity, such as death, birth, diseases, marriage and so on. Assuming that a labor shock happens right before the second period, then labor supply in the second period is:

$$L_2 = L_0 + l \tag{9}$$

where labor shock l follows a known distribution with mean 0 and variance σ^2. Assume that the village is big enough so that shock to one household will not affect the average labor supply in the village.

Solve FOC with respect to K in a closed agricultural economy

$$qU'(c_1) = \beta(1-\rho)T_0 E\left[Af'(t_2)U'(c_n)\frac{L_0}{L_2}\right] \tag{10}$$

The marginal utility function $U'(c)$ is convex in labor supply. [27] Thus, if the income prospect becomes more risky (i.e. its probability distribution undergoes a mean-preserving spread), the expected utility of a risk-averse household will fall. The right hand side of the equation, i.e. the expected marginal return, is higher with labor supply shock than without the shock. A household will increase the land investment in the first period to insure itself against the possible risk in the second period.

The relationship between household utility and land rights security with a labor supply shock is:

$$\frac{\partial V}{\partial \rho} = \beta\left\{[U(c_r^* - R_r) - U(c_n^* - R_n)] + A\rho E\left[U'(c_r^*)f'(\bar{t})\frac{T_0}{L_2}\right]\frac{\partial \bar{K}}{\partial \rho}\right\} \tag{11}$$

[26] See Silberberg *Structure of Economics* (2001) for more details of this approach.

[27] On the right hand side of the FOC, $E\left[Af'(t_2)U'(c_n - R_n)\frac{L_0}{L_2}\right] = E\left[\frac{\partial U(c_n - R_n)}{\partial K}\right] = \mathrm{E}(U_K)$. Given $\frac{\partial^2 U_K}{\partial L^2} > 0$, which indicates the convexity of the marginal utility function in labor.

where $L_2 = L_0 + l$. Since $E(\cdot)$ is convex in L_2, then $E(U') > U'$. The proportion of households that benefit from land reallocation shrinks with labor supply shock. In turn, the benefits that poor households could obtain from land reallocation will also shrink when we include the land rental and non-farm markets.

The relationship between household welfare, land reallocation, land rental market and non-farm market can be illustrated in Figure 2.

Curve $V(c_n|farm)$ represents household utility in a pure agricultural economy; Curve $V(c_n|risk)$ introduces the labor market risk; Curve $V(c_n|markets)$ represents utility with labor market risk as well as all other markets. $\tilde{A}$ represents the threshold of farm ability below which households will benefit from land reallocation. It's clear from Figure 2 that without the labor supply risk, households between $\tilde{A}_1$ and $\tilde{A}_2$ would have gained from land reallocation. However, to cope with possible labor market risks, households have to take precautionary investment in the first period by reducing consumption. Their capital level is then above the village average level and they no longer benefit from land reallocation (land insecurity). In a word, when facing labor supply shock, a higher proportion of households would prefer a more secured land rights.

2.3 Data

2.3.1 Rural Household Survey by Development Research Center

The survey was carried out in 2003 by the Development Research Center (DRC). It includes six provinces: Zhejiang, Fujian, Hunan, Anhui, Sichuan and Heilongjiang.[28] The first two provinces were chosen to represent the richer rural areas along the south-eastern coast. The following two represent areas

[28] Thank Professor James Kung for providing the data.

with dense populations in agriculture and with active rural-urban migration activities. The last two provinces were chosen to represent the southwest and northeast. Two counties were selected from each province. Four townships were chosen from each county: one each from higher- and lower-income categories and two from the middle. Two villages were selected from each county following the same selection criteria as the county. Finally, 22 households in each village were selected randomly. In total, the survey includes 2112 households, 96 villages, 48 townships and 12 counties.

The survey was designed to unveil the history of land reallocation so it collected rich variables on agricultural de-collectivization such as the time of land de-collectivization, the frequency of land allocations and what criteria did each land adjustment follow. Distinctions between large-scale and small-scale land adjustments were drawn clearly. No survey in the past has collected such rich information on land reallocation practice, especially concerning the small-scale land adjustments.

Kung (2011) has pointed out that villages alternate between large- and small-scale land adjustments are without basis. Because according to the survey, less than 30 percent of the villages have adopted both practices; the rest have reallocated land either in small-scale (41%) or in large-scale (30%), but not both.

Table 1 reports summary stats on the household level. There is little difference in the basic demographic variables. In terms of land, LS-villages have smaller number of plots, bigger areas of each plot, higher amount of arable land per labor and higher frequency of land reallocation. In addition, LS-villages enjoy higher income in almost every source except for agricultural income. Variables on the village level tell a similar story. In general, when not controlling for other variables, villages with large-scale

land reallocation are richer, enjoy higher level of land per person and have more active off-farm employments participation.

2.3.2 Key Variables

2.3.2.1Choice of Land Tenure

Land tenure is by nature endogenous because it's the choice of local villagers. Villages choose land tenure based on village topography, land endowment and pressures from higher authorities. The advantage of using this identification is that all explanatory variables are exogenous. Kung and Bai (2010) use the same data sets and test the determinants of land tenure. Their dependent variable is constructed as the share of the overall land reallocations in the village. I adopt a slightly different identification and define LS-villages as those who adopted large-scale land reallocation as their main land adjustment regime. Survey statistics show that less than 30% of the villages have adopted both land regimes.

In the sample, villagers with different land regimes have distinctive characteristics. LS-villages have on average larger households, higher labor ratio and more party members living in the villages. More than 96% of LS-villages have land transfer, in contrast to 78% of SS-villages. In terms of land conditions, SS-villages have much more scattered plots and smaller size of arable land. Farming activities in SS-villages are more labor intensive, uses more cattle and fewer machines. There is higher percentage of households engaging in agriculture in SS-villages than in LS-villages.

I choose three categories of exogenous variables as instrument for land tenure: (1) village land endowment; (2) variables related to transaction costs of land reallocation, such as the number of households, number of plots and percentage of paddy land; (3) the number of party secretaries in the

village, which represents the pressure from higher authorities. Party secretaries are assigned from the higher level of government. It is different from village heads who are elected within the village.

My results are consistent to Kung and Bai's findings. Table 3 reports the main results. Besides the explanatory variables discussed before, a province dummy is also included for column [4], [5] and [6] to capture the macroeconomic policy on the provincial level. As expected, villages with smaller number of plots are more likely to adopt LS land reallocation in practice. Villages with higher numbers of party secretaries are more likely to adopt LS reallocation. Land-labor ratio has no significant impacts on the likelihood of adopting LS land reallocation for the sample villages. The coefficient of number of households is not statistically significant either but remains negative.

2.3.2.2 Household Welfare, Non-farm Employments and Rental Market

Household welfare is measured by both income and consumption per person. Income is constructed by adding up money income from agriculture, non-farm local employments and migration. Due to data limitations, consumption is defined as the total spending on food and clothing in the previous year.

Local non-farm wage employment and migration are defined on the household level and thus is endogenous. I use village level labor market conditions to instrument household participation in non-farm jobs. [29] Migrants are defined as those who work outside the county in the previous year for more than three months. It is further divided into short-term migrants who were away less than nine months out of one year, and long-term migrants who were away for more than nine months. Out of 2083 households, about 35% of them have at

[29] More discussions regarding this method refer to Ham (1986), Reilly (2002), Benjamin and Brandt (2002), Taylor and Rozelle (2003). They all use the local measures to instrument for the household or individual variables.

least one migrant. SS-villages have higher ratios of migration participation than LS-villages.

Land rental activities are quite active in the sample. As shown in Table 1, LS-villages have more active land rental markets than the SS-villages. It is mainly because LS-villages have larger areas of land and higher degree of machine utilization in their farm productions.

2.3.2.3Other Control Variables

Control variables for empirical estimations include: (1) household demographics: cube of average age of the household, average education, dependent ratio (ratio of children < 7 years old plus ratio of seniors > 65 years old), whether the household has village cadre, tax burden as a percentage of net income, arable land per person, and the ratio of income from economic crops; (2) village characteristics: log village population; log distance to the closest county; total size of arable land (taking into account rent-in and rent-out land), and log village income per person.

2.4 Empirical Strategy and Main Results

2.4.1 Risk-Coping Strategies and the Role of Land Reallocation

Giving the missing credit market, there are mainly three methods of risk-coping strategies in rural areas to smooth out income or consumption: land reallocation on the village level, sending out local wage workers or migrants, and participation in the land rental market. When a household is subject to a negative labor supply shock—either serious disease or death—it could resort to the three methods. Since the dependent variables here are binary, I choose a probit model as follows:

$$STRATEGY = Pr(\alpha_0 + \alpha_1 L\_SHOCK + \alpha_2 L\_SHOCK * LS + \alpha_3 HH + \alpha_4 V + \varepsilon) \quad (12)$$

where $STRATEGY$ refers to the three risk-coping methods. Variable LS represents whether the village adopts large-scale land reallocation as its main land regime. Probit models are used to test equation (12). I also test the impact of labor shocks on the amount of land rental. Since a significant proportion of households have zero land rental and the rest have positive level of land rental, I use Tobit models in my estimation. Let y denote the size of land rental, and y^* as an unobserved latent variable. Then we have:

$$y^* = \alpha_0 + \alpha_1 L\_SHOCK + \alpha_2 L\_SHOCK * LS + \alpha_3 HH + \alpha_4 V + \varepsilon \quad (13)$$

where $\varepsilon \sim N(0,\sigma^2)$. The observed variable y is related to the latent variable y^* through the observation rule:

$$y = \begin{cases} y^* & if\ y > 0 \\ 0 & if\ y \leq 0 \end{cases} \quad (14)$$

Two-stage correction procedure is also used in all estimations because the endogenous variable LS is binary. This procedure uses a probit model to estimate the endogenous variable in the first step and then uses the predicted value as the instrument in the second step and then correct for the standard errors. [30] Three measures are chosen to represent labor supply shocks: whether the household had illness in the last two years, whether the household had illness in the last 5 years, and whether the household had death in the previous year. Main results are presents in Table 4 and Table 5.

Table 4 presents results with four different dependent variables: whether the household has participated local wage employment, whether sent out migrants, whether sent out short-term migrants (away for less than 9 month) and whether sent out long-term migrants (away for more than 9 month but less than a year). Column [1], [3], [5] and [7] presents the average effects of having a labor

[30] The two-step correction is suggested by Wooldridge (2002, section 15.7.3).

supply shock on the probability of non-farm employments. The results suggest illness in the past 5 years will significantly increase the probability of both local employments and migration. Furthermore, the impact is stronger for short-term migration than long-term migration. In contrast to the 5-year illness, illness in the last 2 years has only moderate effects on migration, and death in the last year has no significant effects on non-farm employments. The results suggest that households tend to resort to non-farm employments for labor shocks that have happened a while back. In other words, there is some delay in households' participation in non-farm jobs when facing labor supply shocks.

Columns [2], [4], [6] and [8] present results with the interaction of labor shocks and LS. There are no significant differences in LS- and SS-villages in their risk coping strategies in the case of non-farm employments with the exception of short-term migration. When there is illness in the last 5 years, the probability of short-term migration will still go up but LS-villages will have smaller increase than SS-villages. In addition, when death happened in the household, the probability of short-term migration will go down and it decreases more in LS-villages. In a word, migration, especially short-term migration is an effective risk-coping strategy to reduce the negative impact of labor supply shocks.

Table 5 presents results of labor shocks on land rental activities. Column [1] and [5] suggest that illnesses will decrease the probability of renting out land significantly but not much on the size of land rent out. On the other hand, column [3] and [7] suggest that illnesses have no significant impacts on land rent in. Death in the previous year has negative impacts on the size of land rent in but not on other dependent variables (Table 5c).

One interesting finding in Table 5 is that LS land reallocation plays an important role in participating in land rental market. After adding in LS and an interactive term of labor supply shock and LS, Column [2] and [6] show that if labor supply shocks happen, LS land reallocation will increase the probability of renting out as well as the area rent out significantly. For land rent in, LS will decrease the area or land rental when there is an illness but not death. The results indicate that in LS-villages, households are more likely to rent out land when they experience negative supply shocks than in SS-villages. In other words, households in LS-villages are more likely to resort to land rental market as a risk-coping strategy than in SS-villages.

2.4.2 Labor Shocks, Household Welfare and Risk-Coping Strategies

The theoretical model suggests that land distribution help households to counter negative labor supply shocks and thus to smooth out income and consumption. However, when non-farm employments exist, this effect will be smaller.

I estimate the following specification:

$$lnc = \alpha_0 + \alpha_1 L\_SHOCK + \alpha_2 L\_SHOCK * STRATEGY + \alpha_3 HH + \alpha_4 V + \varepsilon \quad (15)$$

where lnc is log consumption per person of a household. Variable L_SHOCK is labor supply shock. I use three measures to proxy labor shock: whether some household member had experienced serious disease in the past two years, in the past five years, or death of a family member in the previous year. Variable $STRATEGY$ refers to the three risk-coping strategies. It could be land reallocation on the village level, participating in non-farm employments, and land rental. Variables HH and V are control variables on household and village level respectively.

Coefficient α_1 is expected to be negative. Coefficient α_2 shall be positive following the theoretical model: non-farm employments and land rental market will counteract the impact of negative labor supply shock.

The dependent variables are log values of consumption and income per person. I use OLS and 2SLS estimates. Since land security is a binary endogenous variable, I use the two-stage correction as well. The main results are presented in Table 6 and Table 7.

Impacts of labor shocks on consumption per person are as expected. Columns 6a [1], 6b [1] and 6c [1] show that illness do not affect log consumption much without controlling for risk coping strategies. Also, if family members die, consumption per person will slightly go up. Since the data did not give more information on the reasons people die, it is likely that most death happen to elderly rather than to working age labors.

Then in column 6a [2], 6b [2] and 6c [2], I add in LS and the interaction of LS and labor supply shock. Without controlling for non-farm local jobs, migration or land rental market, we can see that LS land reallocation positively counteract the effect of illness in last 5 years, but not to illness in the last 2 years or death.

When we add in the local employment variable and its interaction with labor shocks, the significance of LS on labor shock is smaller than without the local employment if the shock is illness in the last 5 years. Column 6c [3] now also shows some counteracting effect of LS land distribution, but the coefficient is small.

The next step is to add in migration and its interaction with labor shocks. I did not include both migration and local employments in the same regression because they are highly correlated and tend to be affected by the same

unobserved characteristics on both household and village levels. Table 6a and 6c suggest that when including migration, LS has no significant impacts on labor shocks. However, table 6b has bigger coefficient for the interaction term and LS. When there is illness in the last 5 years, both migration and LS seem to be effective consumption smoothing strategies.

The last step is to add in land rental market. The coefficients on ($SHOCK * LS$) are not significant in any tables. The magnitude of these coefficients is quite close to without the land rental market. Therefore, we can conclude that land rental market actually is not an important consumption smoothing strategy for the household.

Impacts of labor shocks on log income person are presents in Table 7. In Table 4, without including other risk coping variables, having LS land reallocation will increase household income when there is death but has no significant impacts with the other two labor shocks. After we add in the local employments, all coefficients on ($SHOCK * LS$) become significant. After adding in migration, LS has some moderate effects on death. Land rental market again does not change how LS interact with illness. However, the impact of LS on death is no longer significant. Among all households who rent out land, those with death have lower income than those without death.

2.4.3 Alternative Specifications

Previous tests focus on the impacts of labor supply shocks on employment decisions and household welfare. However, they do not shed light on the mechanisms by which labor supply shocks affects consumption or income. For example, migrants may relax the credit constraints locally through remittances, resulting in higher productive investment in farming or non-farm activities. In this case, we will see a higher land investment. At the same time, LS land reallocation will appear to be less important as well.

The theoretical model suggests that LS-villages will discourage land investment more than the SS-villages if credit market is missing. [31] I use a Tobit model to test the impact of labor supply shocks on land investment. To capture the nature of the long-term investment, I use whether the household has used organic fertilizer in the previous year as the dependent variable. The key explanatory variables are whether the village adopts LS as its main land reallocation regime and the interaction terms of labor supply shocks and LS. Other explanatory variables include the same sets of households and village level characteristics. Main results are reported in Table 8.

It is clear that LS will discourage the probability of using organic fertilizers in all specifications. Columns [2], [4] and [6] show that when households have negative labor shocks, LS will increase the probability of land investment on average. The results suggest that LS indeed contributes to counter the effects of illness in the past 2 or 5 years. For death, the counteracting effect is significant at 10% level and is smaller in magnitude. By and large, although LS land reallocation discourages the use of organic fertilizers, it mitigates some of the negative impacts of labor supply shocks that happen to the household.

2.5 Conclusion

The paper focuses on three risk coping strategies in rural China: land reallocation on the village level, participating in non-farm employments, and land rental. The theoretical model suggests that land reallocation helps to counteract the negative labor supply shocks, but this effect will be smaller when non-farm labor market or land rental market exist. Using Rural Household Survey by Development Research Center (2002), I test impacts of LS and labor supply shocks on migration, land rental activities, and household

[31] More details see chapter 1.

welfare. Three measures are chosen to proxy the labor supply shock: whether the household had illness in the past 2 years, in the past 5 years or death in the last year.

The empirical results suggest that illness in the past 5 years will significantly increase the probability of both local employments and migration. In contrast to the 5-year illness, illness in the last 2 years has only moderate effects on migration, and death in the last year has no significant effects on non-farm employments.LS has some mitigation effects on migration. LS-villages tend to have less migration than SS-villages.

Illness will decrease the probability of land rent out but have no significant impacts on land rent in. In LS-villages, households are more likely to rent out land when they experience negative supply shocks than in SS-villages. In other words, households in LS-villages are more likely to resort to land rental market as a risk-coping strategy than in SS-villages.

In terms of consumption and income smoothing, we have mixed results. Firstly, we find that when there is illness in the last 5 years, both migration and LS are effective consumption smoothing strategies. Land rental market, on the other hand, is not important. The impact of LS land reallocation on income is not as significant as that on consumption. When adding in only local employments, LS has significant effects on income. However, if including migration or land rental market, LS is no longer significant. The results are largely consistent with the theoretical prediction that LS plays an important role in income and consumption smoothing, but when migration and land rental market exist, the importance of LS will go down.

The policy implication is that for the purpose of poverty reduction, large-scale land adjustments become less necessary. Local government should encourage the development of non-farm labor markets to help the poor to cope

with negative labor supply shock rather than relying on large scale land allocations.

References

[1] Alderman, Harold. "Saving and economic shocks in rural Pakistan." *Journal of Development Economics* 51.2 (1996): 343-365.

[2] Benjamin, Dwayne, and Loren Brandt. "Property rights, labor markets, and efficiency in a transition economy: the case of rural China." *Canadian Journal of Economics/Revue canadienne d'économique* 35.4 (2002): 689-716.

[3] Dercon, Stefan. "Income risk, coping strategies, and safety nets." *The World Bank Research Observer* 17.2 (2002): 141-166.

[4] Ham, John C. "Testing whether unemployment represents intertemporal labor supply behaviour." *The Review of Economic Studies* 53.4 (1986): 559-578.

[5] Ham, John C., and Kevin T. Reilly. "Testing intertemporal substitution, implicit contracts, and hours restriction models of the labor market using micro data." *The American Economic Review* 92.4 (2002): 905-927.

[6] Kung, James Kai-sing, and Ying Bai. "Induced Institutional Change or Transaction Costs? The Economic Logic of Land Reallocations in Chinese Agriculture." *Journal of Development Studies* 47.10 (2011): 1510-1528.

[7] Morduch, Jonathan. "Income smoothing and consumption smoothing." *The journal of economic perspectives* 9.3 (1995): 103-114.

[8] Meng, Xin. "Unemployment, consumption smoothing, and precautionary saving in urban China." *Journal of Comparative Economics* 31.3 (2003): 465-485.

[9] Naughton, Barry. "The Chinese economy: Transitions and growth." *MIT Press Books* 1 (2007).

[10] Rosenzweig, Mark R., and Kenneth I. Wolpin. "Credit market constraints, consumption smoothing, and the accumulation of durable production assets in low-income countries: Investments in bullocks in India." *Journal of political economy* (1993): 223-244.

[11] Taylor, J. Edward, Scott Rozelle, and Alan De Brauw. "Migration and incomes in source communities: A new economics of migration perspective from China*." *Economic Development and Cultural Change* 52.1 (2003): 75-101.

Figures and Tables

Figure 1: FARM ABILITY AND HOUSEHOLD WELFARE IN A CLOSED AGRICULTURAL ECONOMY

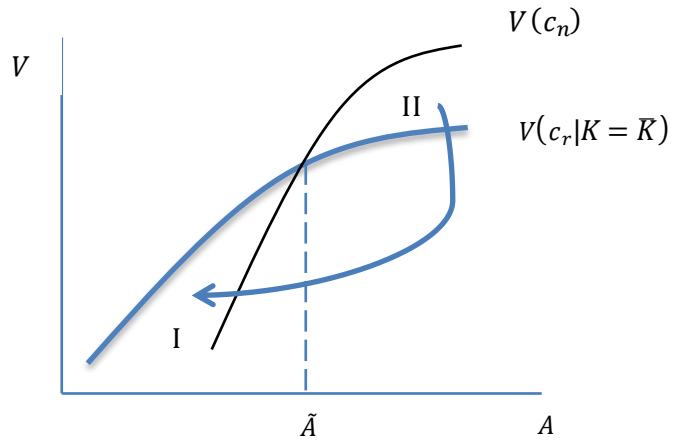


Figure 2:

FARM ABILITY AND HOUSEHOLD WELFARE WITH LABOR SUPPLY SHOCK AND OTHER MARKETS

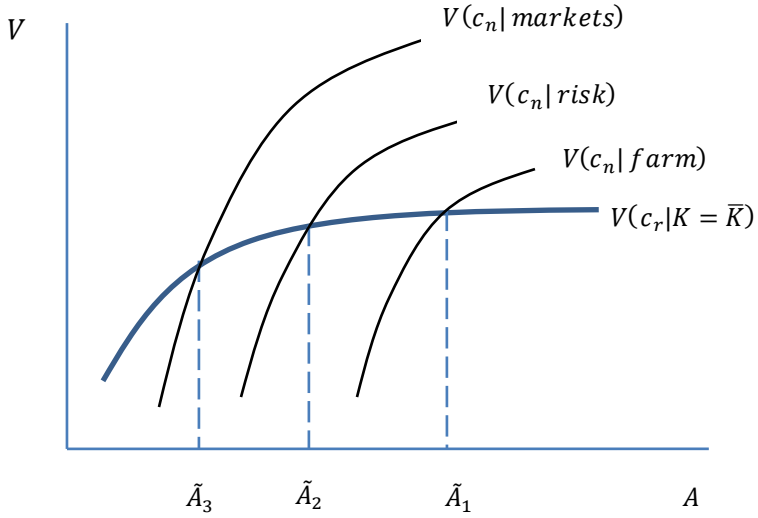


Table 1 DESCRIPTIVE STATISTICS FOR HOUSEHOLDS BY LAND TENURE

Variable mean	Small-scale (n=898)		Large-scale (n=1185)	
Demographic variables				
Age of household head	47.28	[11.59]	46.38	[11.00]
Education of household head	2.59	[0.83]	2.62	[0.84]
Household size	4	[1.38]	4.02	[1.32]
Dependent ratio	0.31	[0.25]	0.31	[0.27]
Land-related variable				
Average plot size, *mu*	2.08	[3.72]	2.74	[4.87]
Number of plots	1.97	[1.64]	1.2	[1.23]
Arable land per labor, mu	10.94	[12.87]	11.32	[17.30]
Frequency of land reallocations	2.1	[1.33]	2.5	[1.62]
Income sources (*yuan*)				
Net income per person	2837.47	[4652.53]	3608.84	[8986.20]
Agricultural income	6683.47	[18633.66]	6029.78	[19488.55]
Non-farm income	7834.69	[6997.13]	12200.43	[26545.95]
Migration income	15408.98	[15018.35]	18251.32	[39874.11]
Percentage of households				
Only farming	33.90%		36%	
Non-farm local employments	33%		39%	
Migration	39%		33%	
Rent out land	8.80%		10.11%	
Rent in land	12.23%		16.69%	

NOTE:

(1) Means are calculated at household level. Standard deviations are in parentheses.

(2) Frequency of land reallocations include both small- and large-scale adjustment. It is truncated at 7 if the village has reallocated the land more than 6 times.

(3) 1 *yuan*=0.12 dollar in 2002. 1 *mu*=0.17 acre.

Table 2 DESCRIPTIVE STATISTICS OF VILLAGE VARIABLES

Variable mean	Small-scale (n=41)		Large-scale (n=54)	
Village demographic variables				
Average size of households	3.69	[0.62]	4.5	[5.01]
Male labor ratio	0.56	[0.08]	0.59	[0.16]
Number of party members	34.65	[14.18]	44.02	[16.55]
Percentage of households in agriculture	0.33	[0.21]	0.31	[0.15]
Percentage of households in industry	0.11	[0.10]	0.13	[0.12]
Land related variables				
Percentage of villages with land transfer	0.78	[0.42]	0.96	[0.19]
Land, *mu*	3660.16	[7202.25]	6582.02	[8838.58]
Arable land, *mu*	3659.05	[5541.66]	4082.71	[5731.97]
Average number of plots per household	7.95	[9.56]	4.57	[2.63]
Percentage of land using machines for farming	0.4	[0.43]	0.67	[0.35]
Percentage of land using cattle for farming	0.42	[0.43]	0.24	[0.30]
Percentage of land using labors for farming	0.18	[0.35]	0.09	[0.19]

NOTE:

(1) Means are calculated at household level. Standard deviations are in parentheses.

(2) 1 *yuan*=0.12 dollar in 2002. 1 *mu*=0.17 acre.

Table 3 DETERMINANTS OF LAND TENURE CHOICE: PROBIT MODEL

	Dependent variable: if village adjust land in large-scale					
	[1]	[2]	[3]	[4]	[5]	[6]
Number of households, log	0.236	-0.099	-0.753*	-0.357	-0.456	-0.35
	[0.201]	[0.244]	[0.367]	[0.397]	[0.424]	[0.397]
Land cultivated per person, log	-0.152	-0.433**	-0.435**	-0.182	-0.182	-0.171
	[0.135]	[0.164]	[0.168]	[0.252]	[0.250]	[0.252]
Number of plots per household, log		-1.234***	-1.198***	-1.079***	-1.033**	-1.091***
		[0.299]	[0.298]	[0.320]	[0.333]	[0.319]
Number of party members since HRS			1.454**	1.215*	1.372*	1.175*
			[0.561]	[0.563]	[0.558]	[0.552]
Percentage of paddy land					-1.112+	
					[0.608]	
If village has only flat land						-0.148
						[0.322]
Province dummies	No	No	No	Yes	Yes	Yes
Clustered SE	No	No	Yes	Yes	Yes	Yes
Observations	95	95	94	94	94	94
Pseudo R^2	0.018	0.176	0.24	0.28	0.299	0.281

NOTE:
(1) Robust standard errors are in brackets. *** denotes significance at the 0.1% level, ** at the 1% level, * at the 5% level, + at the 10% level.

(2) Unreported variables include province dummies and a constant.

Table 4 IMPACT OF LABOR SUPPLY SHOCK ON LOCAL EMPLOYMENTS AND MIGRATION

	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]
	Local	Local	Migration	Migration	Migration < 9 month	Migration < 9 month	Migration > 9 month	Migration > 9 month
4a. SHOCK: illness in last 2 years								
SHOCK	0.221	0.307	0.282+	0.507*	0.339	0.742*	0.253	0.460*
	[0.149]	[0.234]	[0.150]	[0.208]	[0.225]	[0.349]	[0.161]	[0.216]
LS		-0.008		-0.281		-0.164		-0.28
		[0.249]		[0.242]		[0.273]		[0.283]
SHOCK*LS		-0.05		-0.416		-0.558		-0.402
		[0.303]		[0.304]		[0.476]		[0.322]
4b. SHOCK: illness in last 5 years								
SHOCK	0.372***	0.392*	0.291*	0.428*	0.306+	0.674*	0.286*	0.383+
	[0.112]	[0.198]	[0.115]	[0.192]	[0.165]	[0.264]	[0.121]	[0.208]
LS		-0.02		-0.276		-0.109		-0.285
		[0.255]		[0.249]		[0.278]		[0.294]
SHOCK*LS		0.032		-0.279		-0.649+		-0.211
		[0.264]		[0.270]		[0.367]		[0.291]
4c. SHOCK: death in the last year								
SHOCK	0.071	0.123	0.073	0.149	0.149	0.486+	0.052	0.064
	[0.096]	[0.179]	[0.104]	[0.186]	[0.149]	[0.257]	[0.116]	[0.205]
LS		-0.003		-0.277		-0.095		-0.292
		[0.266]		[0.265]		[0.292]		[0.310]
SHOCK*LS		-0.006		-0.208		-0.703*		-0.081
		[0.276]		[0.273]		[0.347]		[0.306]
Observations	1060	1042	1121	1103	708	697	980	967

NOTE:
(1) Robust standard errors are in brackets. *** denotes significance at the 0.1% level, ** at the 1% level, * at the 5% level, + at the 10% level.
(2) Unreported variables include province dummies, a polynomial of household average age, household and village level control variables and a constant.
(3) LS is whether the village mainly adopts large-scale land reallocation regime, instrumented by variables in Table 3.
(4) Local is whether a household member is working in local wage employment. Migration is whether the household has migrants outside the county. Rent_out is whether the household has rented out land in the previous year. All three variables are instrumented by the village level of corresponding variables as a percentage of village population.
(5) All the first stage F-statistics are greater than the rule of thumb value of 10.

Table 5 IMPACTs OF LABOR SUPPLY SHOCK ON LAND RENTAL AVTIVITIES

	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]
	Rent-out	Rent-out	Rent-in	Rent-in	log rent-out	log rent-out	log rent-in	log rent-in
5a. SHOCK: illness in last 2 years								
SHOCK	-0.727^{+}	-5.521***	0.033	0.415	-0.354	-3.801***	-0.085	0.362^{+}
	[0.419]	[0.166]	[0.136]	[0.262]	[0.394]	[0.550]	[0.154]	[0.210]
LS		-1.071		0.265		-0.405		0.112
		[0.653]		[0.313]		[0.487]		[0.248]
SHOCK*LS		5.496***		-0.563		3.973***		-0.620^{+}
		[0.511]		[0.410]		[0.678]		[0.345]
5b. SHOCK: illness in last 5 years								
SHOCK	-0.770**	-1.833***	0.084	0.384^{+}	-0.600^{+}	-5.939*	0.143	0.425**
	[0.260]	[0.417]	[0.117]	[0.218]	[0.323]	[2.498]	[0.134]	[0.162]
LS		-1.117		0.276		-0.335		0.128
		[0.692]		[0.323]		[0.470]		[0.255]
SHOCK*LS		1.714**		-0.404		5.811*		-0.453^{+}
		[0.548]		[0.324]		[2.579]		[0.264]
5c. SHOCK: death in the last year								
SHOCK	0.265	-0.704^{+}	-0.152	-0.101	0.386	-0.44	-0.258^{+}	-0.2
	[0.246]	[0.417]	[0.104]	[0.193]	[0.237]	[0.302]	[0.151]	[0.167]
LS		-1.277^{+}		0.243		-0.464		0.063
		[0.677]		[0.312]		[0.476]		[0.250]
SHOCK*LS		1.579**		-0.287		1.090*		-0.177
		[0.562]		[0.293]		[0.490]		[0.267]
Observations	1254	947	1477	1450	1254	1236	1477	1450

NOTE:
(1) Robust standard errors are in brackets. *** denotes significance at the 0.1% level, ** at the 1% level, * at the 5% level, + at the 10% level.
(2) Unreported variables include province dummies, a polynomial of household average age, household and village level control variables and a constant.
(3) LS is whether the village mainly adopts large-scale land reallocation regime, instrumented by variables in Table 3.
(4) Local is whether a household member is working in local wage employment. Migration is whether the household has migrants outside the county. Rent_out is whether the household has rented out land in the previous year. All three variables are instrumented by the village level of corresponding variables as a percentage of village population.
(5) All the first stage F-statistics are greater than the rule of thumb value of 10.

Table 6 IMPACT OF LABOR SHOCKS ON LOG CONSUMPTION PER PERSON: KEY VARIABLES

	6a. SHOCK: illness in last 2 years					6b. SHOCK: illness in last 5 years					6c. SHOCK: death in the last year				
	[1]	[2]	[3]	[4]	[5]	[1]	[2]	[3]	[4]	[5]	[1]	[2]	[3]	[4]	[5]
SHOCK	-0.073	-0.095***	0.029	-0.177***	-0.101***	-0.04	-0.099***	0.033	-0.161**	-0.110**	0.061+	0.073***	0.191***	-0.053	0.083**
	[0.043]	[0.020]	[0.043]	[0.041]	[0.030]	[0.028]	[0.017]	[0.046]	[0.052]	[0.036]	[0.028]	[0.019]	[0.050]	[0.049]	[0.029]
SHOCK*LS		0.049	-0.027	0.06	0.042		0.116*	0.105*	0.127*	0.09		-0.03	-0.065+	0.001	-0.035
		[0.060]	[0.050]	[0.058]	[0.112]		[0.051]	[0.047]	[0.064]	[0.084]		[0.051]	[0.035]	[0.049]	[0.096]
SHOCK*Local			-0.237**					-0.296***					-0.212*		
			[0.075]					[0.083]					[0.092]		
SHOCK*Migration				0.200**					0.164+					0.225***	
				[0.071]					[0.093]					[0.059]	
SHOCK*Rent_out					-0.355***					0.122					-0.013
					[0.079]					[0.310]					[0.105]
LS		-0.004	0.016	-0.033	-0.037		-0.013	0.005	-0.046	-0.054		0.011	0.02	-0.024	-0.021
		[0.048]	[0.062]	[0.059]	[0.062]		[0.048]	[0.063]	[0.059]	[0.068]		[0.047]	[0.070]	[0.054]	[0.069]
Local			0.226**					0.264**					0.242**		
			[0.080]					[0.093]					[0.093]		
Migration				-0.337***					-0.352***					-0.415***	
				[0.063]					[0.073]					[0.065]	
Rent_out					0.055					0.019					0.06
					[0.070]					[0.103]					[0.083]
Observations	1521	1494	1042	1103	947	1521	1494	1042	1103	947	1521	1494	1042	1103	947

NOTE:
(1) Robust standard errors are in brackets. *** denotes significance at the 0.1% level, ** at the 1% level, * at the 5% level, + at the 10% level.
(2) Household and village level controls are reported in the next page. Unreported variables include province dummies, a polynomial of household average age and a constant.

(3) LS is whether the village mainly adopts large-scale land reallocation regime, instrumented by variables in Table 3.
(4) Local is whether a household member is working in local wage employment. Migration is whether the household has migrants outside the county. Rent_out is whether the household has rented out land in the previous year. All three variables are instrumented by the village level of corresponding variables as a percentage of village population.

(5) All the first stage F-statistics are greater than the rule of thumb value of 10.

Table 6 CONTINUE: OTHER VARIABLES

	4a. SHOCK: illness in last 2 years					4b. SHOCK: illness in last 5 years					4c. SHOCK: death in last 10 years				
	[1]	[2]	[3]	[4]	[5]	[1]	[2]	[3]	[4]	[5]	[1]	[2]	[3]	[4]	[5]
average education, years	0.032^{+}	0.032**	0.019	0.085***	0.025**	0.033^{+}	0.034**	0.018	0.086***	0.027***	0.034^{+}	0.035**	0.03	0.089***	0.028**
	[0.013]	[0.012]	[0.024]	[0.018]	[0.009]	[0.013]	[0.012]	[0.023]	[0.020]	[0.008]	[0.014]	[0.013]	[0.023]	[0.017]	[0.009]
dependent ratio	-0.415**	-0.418***	-0.407***	-0.466***	-0.531***	-0.415**	-0.413***	-0.405***	-0.468***	-0.535***	-0.421**	-0.424***	-0.418***	-0.491***	-0.535***
	[0.086]	[0.078]	[0.081]	[0.089]	[0.123]	[0.084]	[0.073]	[0.084]	[0.087]	[0.112]	[0.084]	[0.076]	[0.081]	[0.085]	[0.114]
if have cadre	0.013	0.008	0.021	-0.004	0.007	0.012	0.007	0.018	-0.005	0.005	0.012	0.006	0.019	-0.009	0.004
	[0.013]	[0.012]	[0.022]	[0.022]	[0.015]	[0.012]	[0.012]	[0.021]	[0.023]	[0.014]	[0.011]	[0.012]	[0.020]	[0.020]	[0.016]
ratio of tax burden	-0.018*	-0.018***	-0.014	-0.032***	-0.027***	-0.018*	-0.018**	-0.013^{+}	-0.032***	-0.030***	-0.019**	-0.020***	-0.022**	-0.032***	-0.029***
	[0.005]	[0.005]	[0.010]	[0.007]	[0.007]	[0.005]	[0.006]	[0.007]	[0.007]	[0.007]	[0.005]	[0.005]	[0.007]	[0.006]	[0.006]
arable land per person	-0.005**	-0.006***	-0.006***	-0.005***	0.001	-0.005**	-0.005***	-0.006***	-0.005***	0.002	-0.005**	-0.006***	-0.006***	-0.005***	0.001
	[0.001]	[0.001]	[0.001]	[0.001]	[0.005]	[0.001]	[0.001]	[0.001]	[0.001]	[0.005]	[0.001]	[0.001]	[0.001]	[0.001]	[0.004]
income ratio of economic crops	0.093*	0.097***	0.091**	0.139***	0.082*	0.094*	0.098***	0.091*	0.139***	0.085*	0.084*	0.088***	0.092**	0.130***	0.073^{+}
	[0.027]	[0.025]	[0.035]	[0.025]	[0.041]	[0.027]	[0.024]	[0.036]	[0.027]	[0.040]	[0.026]	[0.023]	[0.035]	[0.024]	[0.039]
village population, log	-0.031	-0.03	-0.01	-0.048^{+}	-0.039	-0.031	-0.031	-0.007	-0.048^{+}	-0.036	-0.029	-0.029	-0.003	-0.048^{+}	-0.034
	[0.028]	[0.029]	[0.027]	[0.025]	[0.040]	[0.028]	[0.028]	[0.027]	[0.026]	[0.038]	[0.027]	[0.028]	[0.027]	[0.026]	[0.041]
distance to town, log	-0.039***	-0.042***	-0.015^{+}	-0.041***	-0.044***	-0.039***	-0.042***	-0.017^{+}	-0.040***	-0.044***	-0.040***	-0.042***	-0.016	-0.039***	-0.044***
	[0.006]	[0.007]	[0.008]	[0.006]	[0.006]	[0.006]	[0.008]	[0.009]	[0.007]	[0.007]	[0.005]	[0.007]	[0.010]	[0.008]	[0.006]
village arable land, log	0.005***	0.005***	0.006***	0.005***	-0.02	0.005***	0.005***	0.006***	0.005***	-0.021	0.005***	0.005***	0.006***	0.005***	-0.020^{+}
	[0.001]	[0.000]	[0.001]	[0.001]	[0.012]	[0.001]	[0.001]	[0.001]	[0.001]	[0.013]	[0.001]	[0.000]	[0.001]	[0.001]	[0.012]
village income per person, log	0	-0.000^{+}	0	0	0	0	-0.000^{+}	0	0	0	-0.000^{+}	-0.000*	0	0	0
	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
Observations	1521	1494	1042	1103	947	1521	1494	1042	1103	947	1521	1494	1042	1103	947

Table 7 IMPACT OF LABOR SHOCKS ON LOG INCOME PER PERSON: KEY VARIABLES

	4a. SHOCK: illness in last 2 years					4b. SHOCK: illness in last 5 years					4c. SHOCK: death in the last year				
	[1]	[2]	[3]	[4]	[5]	[1]	[2]	[3]	[4]	[5]	[1]	[2]	[3]	[4]	[5]
SHOCK	0.12	-0.098	0.181	0.105	0.279	0.088	-0.234	0.089	-0.055	0.223***	0.039	-0.273	-0.232	-0.294	0.072
	[0.119]	[0.235]	[0.512]	[0.333]	[0.233]	[0.077]	[0.243]	[0.638]	[0.575]	[0.062]	[0.089]	[0.213]	[0.507]	[0.499]	[0.211]
SHOCK*LS		0.406	0.796*	0.327	-0.402		0.579	0.801*	0.424	-0.167		0.580*	0.991***	0.540+	0.156
		[0.451]	[0.397]	[0.456]	[0.289]		[0.417]	[0.385]	[0.317]	[0.185]		[0.284]	[0.164]	[0.288]	[0.268]
SHOCK*Local			-1.405+					-1.314					-0.91		
			[0.767]					[0.933]					[0.808]		
SHOCK*Migration				-0.445					-0.436					-0.011	
				[0.698]					[0.825]					[0.870]	
SHOCK*Rent_out					0.689**					-0.398					-1.897**
					[0.225]					[0.397]					[0.734]
LS		-1.144	-1.498*	-1.18	0.103		-1.189	-1.520*	-1.198	0.11		-1.198	-1.585**	-1.232	-0.034
		[0.843]	[0.657]	[0.953]	[0.407]		[0.854]	[0.668]	[0.947]	[0.420]		[0.841]	[0.602]	[0.957]	[0.403]
Local			2.739**					2.893**					2.714**		
			[0.864]					[0.978]					[0.992]		
Migration				1.638+					1.760+					1.625	
				[0.851]					[0.986]					[1.010]	
Rent_out					0.759					0.854+					1.084**
					[0.494]					[0.463]					[0.406]
Observations	1521	1494	1042	1103	947	1521	1494	1042	1103	947	1521	1494	1042	1103	947

NOTE:

(1) Robust standard errors are in brackets. *** denotes significance at the 0.1% level, ** at the 1% level, * at the 5% level, + at the 10% level.
(2) Household and village level controls are reported in the next page. Unreported variables include province dummies, a polynomial of household average age and a constant.

(3) LS is whether the village mainly adopts large-scale land reallocation regime, instrumented by variables in Table 3.
(4) Local is whether a household member is working in local wage employment. Migration is whether the household has migrants outside the county. Rent_out is whether the household has rented out land in the previous year. All three variables are instrumented by the village level of corresponding variables as a percentage of village population.

(5) All the first stage F-statistics are greater than the rule of thumb value of 10.

Table 7 CONTINUE: OTHER VARIABLES

	4a. SHOCK: illness in last 2 years					4b. SHOCK: illness in last 5 years					4c. SHOCK: death in last 10 years				
	[1]	[2]	[3]	[4]	[5]	[1]	[2]	[3]	[4]	[5]	[1]	[2]	[3]	[4]	[5]
average education, years	0.246^{+}	0.250*	-0.125	0.057	0.349***	0.245^{+}	0.252*	-0.126	0.041	0.342***	0.243^{+}	0.257*	-0.064	0.069	0.343***
	[0.115]	[0.116]	[0.123]	[0.198]	[0.042]	[0.116]	[0.114]	[0.128]	[0.200]	[0.043]	[0.116]	[0.116]	[0.124]	[0.181]	[0.047]
dependent ratio	-1.267*	-1.380***	-1.297***	-0.989*	-0.409	-1.269*	-1.354***	-1.245***	-0.930^{+}	-0.401	-1.262*	-1.380***	-1.268***	-0.978^{+}	-0.534*
	[0.360]	[0.370]	[0.382]	[0.501]	[0.249]	[0.352]	[0.348]	[0.373]	[0.507]	[0.266]	[0.355]	[0.372]	[0.371]	[0.515]	[0.260]
if have cadre	0.153	0.173	0.305*	0.234	0.112	0.155	0.174	0.299*	0.247	0.115	0.153	0.167	0.301*	0.228	0.114
	[0.086]	[0.109]	[0.146]	[0.166]	[0.086]	[0.085]	[0.107]	[0.151]	[0.166]	[0.085]	[0.086]	[0.115]	[0.131]	[0.162]	[0.085]
ratio of tax burden	-0.214*	-0.234***	-0.104	-0.175*	-0.218***	-0.214*	-0.234***	-0.1	-0.172^{+}	-0.211***	-0.217*	-0.222***	-0.095	-0.159^{+}	-0.229***
	[0.055]	[0.056]	[0.080]	[0.084]	[0.057]	[0.057]	[0.059]	[0.070]	[0.090]	[0.062]	[0.056]	[0.057]	[0.065]	[0.084]	[0.067]
arable land per person	0.018	0.018*	0.020*	0.017*	-0.032*	0.018	0.018*	0.020*	0.017*	-0.034*	0.018	0.017^{+}	0.018*	0.016^{+}	-0.024
	[0.010]	[0.009]	[0.008]	[0.008]	[0.014]	[0.010]	[0.009]	[0.008]	[0.008]	[0.016]	[0.010]	[0.009]	[0.008]	[0.009]	[0.015]
income ratio of economic crops	0.586**	0.601***	0.558*	0.602***	0.401***	0.584**	0.598***	0.557*	0.607***	0.399***	0.580**	0.583***	0.629*	0.597***	0.381***
	[0.123]	[0.101]	[0.247]	[0.142]	[0.102]	[0.124]	[0.099]	[0.266]	[0.148]	[0.109]	[0.133]	[0.113]	[0.247]	[0.157]	[0.099]
village population, log	-0.125	0.08	0.368**	0.186	-0.128	-0.124	0.077	0.375**	0.191	-0.131	-0.127	0.062	0.346*	0.17	-0.104
	[0.086]	[0.263]	[0.141]	[0.208]	[0.232]	[0.089]	[0.258]	[0.130]	[0.207]	[0.240]	[0.086]	[0.249]	[0.136]	[0.205]	[0.224]
distance to town, log	-0.014	-0.079**	0.054	0.036	-0.098^{+}	-0.013	-0.078**	0.052	0.033	-0.098^{+}	-0.014	-0.077**	0.056	0.036	-0.096
	[0.056]	[0.025]	[0.098]	[0.022]	[0.056]	[0.056]	[0.025]	[0.088]	[0.020]	[0.058]	[0.056]	[0.028]	[0.115]	[0.023]	[0.059]
village arable land, log	-0.024^{+}	-0.019^{+}	-0.016*	-0.019*	0.079	-0.025^{+}	-0.019*	-0.017*	-0.019*	0.083^{+}	-0.024^{+}	-0.019^{+}	-0.015^{+}	-0.019*	0.066
	[0.010]	[0.010]	[0.008]	[0.008]	[0.049]	[0.010]	[0.010]	[0.008]	[0.008]	[0.050]	[0.010]	[0.010]	[0.008]	[0.008]	[0.050]
village income per person, log	0	0	0.000*	0.000^{+}	-0.000^{+}	0	0	0.000*	0	-0.000*	0	0	0.000^{+}	0	0
	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
Observations	1521	1494	1042	1103	947	1521	1494	1042	1103	947	1521	1494	1042	1103	947

Table 8 LABOR SHOCKS ON LAND INVESTMENT

	Dependent Variable: If used organic fertilizer last year					
	[1]	[2]	[3]	[4]	[5]	[6]
LS		-0.249*		-0.234*		-0.241*
		[0.118]		[0.116]		[0.122]
ill5	0.066*	-0.031				
	[0.025]	[0.033]				
ill5*LS		0.183**				
		[0.061]				
ill2			0.061*	-0.004		
			[0.021]	[0.021]		
ill2*LS				0.123**		
				[0.038]		
death					0.031	-0.044
					[0.036]	[0.041]
death*LS						0.130+
						[0.078]
average education, years	0.029	0.036	0.028	0.035+	0.027	0.036+
	[0.021]	[0.022]	[0.020]	[0.020]	[0.020]	[0.021]
dependent ratio	-0.034	-0.043	-0.032	-0.049	-0.029	-0.047
	[0.028]	[0.027]	[0.029]	[0.032]	[0.029]	[0.031]
if have cadre	0.006	0.003	0.005	0.002	0.005	0
	[0.047]	[0.034]	[0.047]	[0.035]	[0.047]	[0.035]
ratio of tax burden	-0.052***	-0.058***	-0.053***	-0.058***	-0.055***	-0.057***
	[0.007]	[0.007]	[0.007]	[0.007]	[0.007]	[0.007]
arable land per person	0.002	0.003**	0.002	0.002**	0.002	0.002**
	[0.001]	[0.001]	[0.001]	[0.001]	[0.001]	[0.001]
income ratio of economic crops	0.027	0.03	0.029	0.032	0.024	0.025
	[0.097]	[0.089]	[0.096]	[0.086]	[0.101]	[0.093]
village population, log	0.007	0.031	0.006	0.031	0.005	0.026
	[0.037]	[0.031]	[0.037]	[0.033]	[0.038]	[0.031]
distance to town, log	0.015	0.007	0.015	0.007	0.015	0.007
	[0.013]	[0.016]	[0.013]	[0.016]	[0.013]	[0.017]
village arable land, log	-0.003	-0.002*	-0.003	-0.002*	-0.003	-0.002*
	[0.002]	[0.001]	[0.002]	[0.001]	[0.002]	[0.001]
village income per person, log	-0.000*	-0.000***	-0.000*	-0.000***	-0.000*	-0.000***
	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
Observations	1515	1488	1515	1488	1515	1488

NOTE:
(1) Robust standard errors are in brackets. *** denotes significance at the 0.1% level, ** at the 1% level, * at the 5% level, + at the 10% level.
(2) LS is whether the village adopts large-scale land reallocation regime, instrumented by variables in Table 3.
(3) ill2 is whether having illness in the last two years; ill5 is whether having illness in the last five years; death is whether having death last year.
(4) All the first stage F-statistics are greater than the rule of thumb value of 10.

3 Unintended Consequences: One-child Policy in China

3.1 Introduction

From an international perspective, an interesting observation regarding wage situations in China is that the gender wage gap in urban areas appears to be relatively small compared to other developing countries (Gustafsson and Li, 2000; Meng and Kidd, 1996). By and large, gender wage gap tend to be larger in countries with market oriented wage setting and smaller in former central-planned economies. However, the causes of the gender wage difference in China are not well documented. Some researchers suggest that one important factor in explaining the gender wage gap is a reduction in wage discrimination. Liu et al. (2000) found that even though gender wage gap increases in absolute terms over the years, marketization actually reduces gender wage discrimination. Other studies have explored the improved situation in education and its impact on wage earnings. In general, however, the existing literature on gender aspects of earnings in China is rather limited.

This paper contributes to the gender wage literature by examining the role of the One-Child Policy (OCP) in altering women's education attainments and its implications in changing the gender wage gap in urban China. To my knowledge, this paper is the first analysis of the gender wage consequences of OCP. A related literature was Becker-Lewis quantity-quality (Q-Q) trade-off model (1976), which suggests that there is an inverse relationship between parental investment per child and family size.

The challenge in testing the idea is that it is difficult to find exogenous variation in family size to establish the causal relation between family size and human capital investment. Numerous studies in the past attempted to test the Q-Q model and yield different results (Hanushek, 1992). People from smaller families tend to have more schooling than those from bigger families.

However, this difference may not be due to the size of the family, but due to the differences in unobserved family characteristics such as parental education, entrepreneurship or other factors that also affect fertility and education. To address this omitted variable problem, numerous studies have used instrumental variables (IV). Angrist and Evans (2005) used multiple births and preferences for a mixed sibling-sex composition as IV to estimate the effect of family size on labor supply of mothers. Qian (2006) used twinning to evaluate the impact of an exogenous increase in the number of children on school enrollment.

This paper provides new evidence on the Q-Q tradeoff. The One-child policy (OCP) was introduced in 1979, which has been strictly enforced in urban areas but not so stringent in rural areas. The introduction of OCP is used as a natural experiment to analyze how the exogenous restrictions on fertility affect labor market decisions. I focus on the impact of OCP on children's education attainments and their subsequent wage earnings.

My baseline identification strategy uses a difference-in-difference (DID) approach to compare outcome for children born before and after 1979, and also between the treatment and the control group. I define the treatment group as *urban* households with only one child born between 1980 and 1989. Four control groups are defined. I firstly define two possible *rural* control groups using households with children born between 1980 and 1989. The first control group includes rural households with two children, and the second control group includes those with only one child. OCP affects the whole country in general, but the enforcement of the policy in rural areas has been looser. As a comparison, I then define two additional control groups using urban households which had children between 1970 and 1979. The first urban control group includes households who had two children, and the second urban control group includes households with one child.

Both rural and urban control groups have their own strength and weakness. The advantage of using rural OCP-cohort as the control group is that they were born at the same time period as the treatment group. However, they are subject to different social and economic environment from the urban cohort. If we use the urban before-cohort as the control group, the main disadvantage is that they were born at different time from the treatment group. Thus, we need to control for the time-specific factors that may contribute to the difference in education performance.

It is likely that the return to education is different for the treatment and control groups, and between treated individuals who responded to the treatment (compliers) and those who did not (non-compliers). In this case, it is inappropriate to use the simple linear regression models since they ignore the heterogeneity within the group. To explore this issue, I estimate the Local Average Treatment Effect (LATE).

Using data from the China Health and Nutrition Survey, I find significant treatment effects relative to both control groups. Using urban before-cohort as the control group, The OCP increases years of education for women by 1 to 1.5 years, and for men by 1.8 to 2.4 years. In terms of highest degree obtained, OCP significantly increases the probability of obtaining a university degree. The treatment effects are smaller for high school and junior technical school degrees. In LATE estimates for returns to education, female compliers who have received one more year of education due to OCP can experience 5.6 to 8.1 percentage points increase in wage earnings for an additional year of education and for male compliers this effect is not significant.

The following section describes the institutional background of OCP. Then I provide descriptive evidence in Section 3 on the correlations between OCP,

education attainments and wage income for urban workers. Section 4 presents the empirical strategy. Section 5 reports empirical results. Section 6 is conclusion.

3.2 Institutional Background

When the Communist Party came into power in 1949, they encouraged high fertility to rebuild the nation that had just emerged from WWII and the Civil War. The growth rate had been about 6% between 1949 and 1959 until the Great Famine, but it bounced back soon after. Banister (1987) showed that Chinese fertility rate exceeded six births per mother throughout the 1960s. No birth control measures were publicly encouraged during that time. In the 1970s, policy makers started to concern about the nation's ability to feed its people. The debate on whether the country could fall into a Malthusian population trap was widely popular among academics and the common public. The government initiated series of policies to slow down the population growth by encouraging households to have children later, with longer gaps between each birth, and have fewer children. The total fertility rate declined to as low as 2% at the end of 1970 ((Cai, 2010). In June 1979, One-Child Policy (OCP) was officially introduced at the second meeting of the fifth People's congress (Center for Population Studies, CASS, 1986). However, it is noteworthy that birth rate didn’t suddenly slow down only due to OCP. Even before OCP was introduced, the growth rate of population had a clear trend of slowing down (Qian, 2009).

Evidence from CHNS indicates that OCP has been strictly enforced in China. Since 1989, over 98% of the communities applied the OCP responsibility system and over 70% communities report that the success of the family planning policy is connected with economic rewards to the local cadres. However, the requirement of OCP was looser in rural area. In 2009, if the first child was

a girl, 82 rural communities (63% of all rural communities) allowed a second child while only 15 urban communities (22%) allowed a second child. The percentages were even higher in earlier rounds of the survey.

The costs of having a second child are prohibitive, for both urban and rural residents. Surveys in 1989, 1991 and 1993 recorded four forms of punishments for an additional child: fines, denied rations in food and other life necessities, denied social health welfare for the additional child, as well as losing work related benefits. If the couple has more children than what the policy allows, over 98% of communities say that they have to pay a fine. On average, one extra child will cost a rural family 1608 *yuan* in 1989 and 3216 *yuan* in 1993. In urban areas, these numbers are 2115 *yuan* in 1989 and 4459 *yuan* in 1993. The amount of the fines was sizable, accounting for over 50% of the household annual income.

About 20-30% of communities say that households will lose their grain, oil or other types of rations. This loss was small comparing to the possible loss related to work benefits. In 1993, over 70% of rural communities, and over 90% of urban communities report that individuals will lose work promotions and bonus. In addition, over 60% of rural communities and over 90% of urban ones punish non-compliers by denying their access to work-provided housing.

There are a few exceptions in the implementation of OCP. If the first child is handicapped, families could have a second child in almost all survey communities. Minority groups enjoy looser requirements as well. Nearly 70% of communities say that minority couples could have a second child if one or both parents are minority.

OCP has been criticized to have increased female infanticide, forced abortion and sterilization. One apparent consequence is that China's gender balance has become increasingly skewed (Hull, 1990). Realizing the negative impact

of OCP, some cities in recent years have adopted policies to loosen the impact of OCP. For example, if both couples are single child, they are allowed to have a second child upon approval. In 2009, over 60% of the rural communities and over 70% of urban communities allow couples who are both single child to have a second child.

3.3 Data

3.3.1 China Health and Nutrition Survey (CHNS)

The data for this analysis comes from the China Health and Nutrition Survey (CHNS), a longitudinal household survey conducted by the Carolina Population Center at the University of North Carolina, Chapel Hill and the National Institute of Food Safety at the Chinese Center for Disease Control and Prevention.[32] The survey was designed to present the economic and social transformations of China and how these changes are reflected in the health and nutritional status of the population. It follows a stratified, multistage, random cluster design. The first round of the survey was collected in 1989, with additional waves finished in 1991, 1993, 1997, 2000, 2004, 2006 and 2009. The CHNS data covers nine provinces: Liaoning, Shandong, Jiangsu, Heilongjiang, Henan, Hubei, Hunan, Guizhou, and Guangxi. [33] The first three provinces are from the eastern China, the following four from the middle and the last two from the west.[34]

---

[32] This research uses data from the China Health and Nutrition Survey (CHNS). We thank the National Institute of Nutrition and Food Safety, China Center for Disease Control and Prevention; the Carolina Population Center, University of North Carolina at Chapel Hill; the National Institutes of Health (NIH; R01-HD30880, DK056350, and R01-HD38700); and the Fogarty International Center, NIH, for financial support for the CHNS data collection and analysis files since 1989. We thank those parties, the China-Japan Friendship Hospital, and the Ministry of Health for support for CHNS 2009 and future surveys.

[33] Liaoning could not participate in 1997 so Heilongjiang was included in the survey to replace Liaoning. In the following waves, Liaoning came back and Heilongjiang stayed in the survey too.

[34] There have been some concerns on whether the survey is nationally-representative, but generally the selected communities demonstrate great variations over important demographic characteristics and can be confirmed by many studies. I want to thank Lauren Brandt for pointing out that the

To estimate the impacts of OCP on education attainments, I restrict the sample to individuals who have finished school at the time of the survey and started working. To estimate the OCP impact on wage earnings, I further restrict the sample to those who are full-time employed at the time of the survey and with wage income. The OCP-cohort (born between 1980 and 1989) includes 609 urban individuals and 1514 rural individuals, and the before-cohort (born between 1970 and 1979) includes 1436 and 3563 from urban and rural areas respectively.

The advantage of using CHNS is that it contains both urban and rural samples, and has detailed information of household income and parents' education. In the last round of survey in 2009, individuals in OCP-cohort were between 19 and 29 years and most of them have finished school and started working, which made the analysis of wage determination possible. In addition, the survey has a twenty-year time span from 1989 to 2009, which allows us to identify a relatively large before-cohort and OCP-cohort (discussed in the next section).

3.3.2 Descriptive Evidence: Education and Wage

Education attainments are measured with two outcome variables: years of education and the highest level of education obtained. Summary statistics for key outcome variables are reported in Table 1. Urban OCP-cohort has much higher education attainments than other groups: people have one to three more years of education on average and the percentage of people holding university and technical school degrees are 18 to 35 percentage points higher. One noticeable difference between the treatment group and the urban before-cohort is in terms of high school degree. There is much lower percentage of people with only a high-school degree in urban OCP-cohort than the before-group.

---

distribution of income shifts down for every age group after 2000 due to unconfirmed changes in the survey. More discussions see Ward and Shively (2011).

Although not officially documented, one explanation is that students actually do not gain practical skills through high school education. The purpose of high school education is to prepare for universities or higher level of technical schools.[35] Changes in the of university degree attainments are also consistent with this point. More than 25% of urban OCP-cohort has obtained the university degree, much higher than the 14% urban before-cohort and the 11% in rural OCP-cohort. Regarding monthly wage income, the OCP-cohort earns significantly higher wage than the before-cohort.

Figure 1 compares mean years of education by birth cohort for both urban and rural workers. The gender difference in education was narrowed after 1980. In fact, for urban cohort born between 1980 and 1985, the average education of women was higher than men, a reverse trend from before. The gender education gap in rural area was also narrowed but at a much small scale than the urban counterpart. As for the highest level of education obtained, Figure 2 and 3 present comparison for both urban and rural cohorts. In general, urban workers who were born after 1979 have higher education achievements than those who were born before 1979. The impact of OCP on rural area is small, especially for university degrees.

What's interesting is the trend in wage income for urban workers. Figure 4 reports log monthly wage using both raw data and residuals (detrending wage by the age factor). There is a clear convergence in gender wage after 1980. The rest of the paper attempts to explore whether OCP has contributed to the shrink of the gender wage gap and through which mechanism the impacts work.

[35] I would like to thank Professor Yao Yang for pointing this out.

3.3.3 Key Variables

3.3.3.1 Dependent Variables

Regarding education attainments, two measurements are used. One is the years of education that an individual has received. The other one is the highest degree one has obtained. Three qualifications are chosen for the empirical tests: college or university degree, [36] high school diploma and junior technical school degree. Junior technical school (*zhong zhuan*) is equivalent to a high school degree and usually requires three years of study, the same as high school. The number of observations of other qualifications such as senior technical school (*da zhuan*) or degrees beyond college is too limited for the estimation.

In wage equations, I use the log monthly wage as the dependent variable. A high percentage of rural workers are self-employed so they don't report a wage income. I only include rural individuals who work for local enterprises or as migrants and have wage income.

3.3.3.2 Explanatory Variables

Explanatory variables include characteristics on individual, household and community levels. Individual characteristics include a cubic polynomial in age as a way of detrending to separate age and cohort effects. [37] A gender dummy variable is also included.

The *hukuo* system in China has created large differences between urban and rural areas in terms of education and wage. There are differences in the

[36] CHNS did not distinguish the university degree from senior technical school degree, so in the rest of the analyses, university degree refers to both college graduates and senior technical school graduates.

[37] See Ichino and Winter-Ebmer (2004) for the importance of detrending to separate age and cohort effects.

costs of education—paid by households in the rural sector, public and subsidized in the case of households with urban *hukuo*. Controlling for presence of a high school and/or tertiary school in the community would control for one difference in costs or access to education.

Past studies have shown that intergeneration transfer may be particularly important for children's education and subsequent earnings (Chevalier, 2004). Years of education of parents are proxies for household wealth that may facilitate education and job search for children. The parental education also captures the urban-rural difference in access to education.

Returns to education might be a factor in accounting for educational demand. The difference in gender wage may explain the difference in gender return to education. I therefore include male-female wage ratio on the community level to account for the gender wage differential.

Social status may be of particular importance in accessing education and job search in China, especially in rural areas. Communist Party membership helps to identify households that have easier access to social resources. I therefore estimate main equations by adding a dummy variable indicating whether the household has a communist cadre. Cadres here refer to those who hold administrative positions in state-owned enterprises, government, the communist party, or the village.

In addition, three labor market measures on the community level are included: the percentage of farm labor, the percentage of migrants and the population growth rate of the community from 1989 to 2009. A higher percentage of farm labor may indicate lower education attainments due to the low and volatile income in agriculture. More migrants in the community may have mixed impacts on children. On the one hand, migrants may earn higher wage than local wage earners and thus can afford better quality of education for their children.

On the other hand, migrants are usually absent from home for a long time period in one year and a lack of parental company may decrease the education attainments for children. Population growth in a village may indicate job opportunities and access to health and education resources. Communities with population growth may be associated with higher wealth and therefore higher education and wage income.

3.4 Identification Strategy: Difference-in-difference

The paper has two goals. First, I will evaluate the impact of OCP on education attainments. Second, I will estimate the impact of changes in education due to OCP on individual's subsequent wage earnings. I use a differences-in-differences framework to compare the outcome before and after OCP was introduced, and also between the treatment group and the control group.

3.4.1 Treatment Group

I define the treatment group as *urban* households with only one child born between 1980 and 1989. CHNS has a relatively small sample size for the purpose of the study, so choosing a ten-year period after the introduction of OCP will cover a larger amount of observations. During the last round of survey in 2009, the youngest OCP-cohort members will be 20 years old and oldest ones 29 years old. The selection into treatment is based on birth cohort and thus is exogenous.

3.4.2 Rural Control Groups: Rural Households with OCP-Cohort

As discussed in the data section, OCP affects the whole country in general, but the enforcement of the policy in rural areas has been looser. In 1989, 69 out of 121 of rural communities allowed a second child if the first child was a girl, and only 13 urban communities allowed so. For households which had

children between 1980 and 1989, 68% of rural and 85% of urban households had only one child. Among all households with single child, 60% of rural children and 52% urban children were boys. Thus there is clearly a gender bias towards boys for rural households with single child.

One concern of using rural sample as the control group is that we do not know if OCP affects education in the rural area. So far, no official documents have identified OCP as an important factor on education attainments in rural China. As will be discussed later, CHNS data suggest that comparing to their urban counterparts, the education attainments of the rural OCP-cohort were affected to a much smaller extent due to OCP.

I define two possible *rural* control groups using households with children born between 1980 and 1989. The first control group includes rural households with two children, and the second control group includes those with only one child.

The advantage of using a rural control group is that it matches age groups of the treatment group. The rural OCP-cohort was born at the same period but not "treated", i.e. OCP was not enforced (no restriction on fertility), or was treated at a much lower level (allowing two or more children under certain circumstances).

One problem with using the rural sample as control group is that most rural residents are self-employed and only a small percentage is employed in the industrial sector and earns a positive wage. This may be a source of sample selection bias. Besides, rural and urban residents may have systematic differences in terms of education system, economic conditions, household characteristics and financial constraints. The difference-in-difference estimator will remove the time-invariant factors. In addition, I will include

important control variables as much as possible to control for the time-varying factors such as the cost of education or household income.

Mathematically, the outcomes for the urban and rural sample can be defined as:

$$O_U^1 = \alpha_U + T_{OCP} + X \quad , \qquad O_U^0 = T_{before} + X \tag{16}$$

$$O_R^1 = \alpha_R + T_{OCP} + X \quad , \qquad O_R^0 = T_{before} + X \tag{17}$$

where α_r is the OCP effect for rural population. Variables, O_R^1 and O_R^0 , are outcomes for rural population after and before the OCP policy, and O_U^1 and O_U^0 are outcomes for urban population. Variables, T_{OCP} and T_{before} , capture time specific effects that affects OCP-cohort and the before-cohort differently. Vector X includes all variables that affect everyone the same way.

On the assumption that X the same in urban and rural areas, the difference-in-difference estimator is:

$$(O_U^1 - O_U^0) - (O_R^1 - O_R^0) = \alpha_U - \alpha_R \tag{18}$$

The variable α_U is the OCP effect of interest. However, the result could be biased if α_R is big, i.e. OCP also has significantly large impact on rural groups. In that case, the empirical results will underestimate the OCP effect in urban areas.

3.4.3 Urban Control Groups: Urban Households with Before-Cohort

As a comparison, I define two additional control groups using urban households which had children between 1970 and 1979. The first urban control group includes households who had two children, and the second urban control group includes households with one child.

The advantage of using urban control groups is that both treatment and control groups live in the urban areas and are subject to similar economic changes and education systems. The difference-in-difference estimator will remove any systematic difference that may occur. According to equation (1), we obtain the difference between the two urban groups:

$$O_U^1 - O_U^0 = \alpha_U + \Delta T \tag{19}$$

where α_U is the policy effect on the treatment group. Variable, ΔT, is the difference between T_{OCP} and T_{before} , the time specific effects that affects OCP-cohort and the before-cohort differently. The value of ΔT has to be zero or small to ensure the validity of the difference-in-difference estimator. Otherwise, the empirical estimate may measure both the effect due to OCP and time specific factors.

3.4.4 Differences between Treatment Group and Control Groups

Children born between 1970 and 1979 are referred to as the "before-cohort", and those born between 1980 and 1989 as the "OCP-cohort". Assuming that one economy contains only one-child and two-child families, Figure 5 illustrates the treatment effect of OCP. After 1979, controlling for other variables, the trend of education for 2-child families should stay the same but the treatment effect for one-child families will be positive if the quality-quantity story holds.

To estimate the number of children born in each cohort, I mainly use the 1989 survey and use later surveys to correct for missing records. The 1989 survey picks up most of the 1970-79 cohort (10-19 years old) and some of the 1980-89 cohort (0-9 years old). Some households have missing records of children who were not home when the 1989 survey took place but those children came home in later rounds and entered the survey.

Table 1 presents comparisons of the treatment group and control groups in 2009 in which all members in the OCP-cohort have completed their education. Comparing to the rural control groups, the treatment group is largely statistically similar in the dimension of gender, age, and ethnicity. As expected, the treatment group is different from the rural control groups in several labor market characteristics. Education attainments of head and spouse as well as their children in the treatment group are significantly higher than their rural cohort. Higher percentage of the treatment group households has family members as cadres. The income levels of households in the treatment groups are significantly higher than the two-child rural households, but not significantly different from the one-child households. In addition, the value of productive assets (such as cars, computers or farming tools) and the non-productive assets (such as furniture, electronics and etc.) of the treatment group are much higher than the rural control groups.

The comparison between the treatment group and the urban control groups shows a different picture. All groups are similar in gender and ethnicity. Levels of incomes and assets of urban control groups are similar to the treatment group. The urban before-cohort on average have older heads and bigger families. Education attainments of parents in the treatment groups are much higher than the two-child urban before-group, but less different from the one-child urban before-group.

3.5 Main Results

3.5.1 OCP on Years of Education

When the dependent variable is years of education, I estimate the following equation:

$$EDU = \beta_0 + \beta_1(OCP * Urban) + \beta_2 OCP + \beta_3 Urban + \beta_4 X + \varepsilon \quad (20)$$

where OCP is a dummy variable for OCP-cohort who was born between 1980 and 1989. Dummy variable $Urban$ equals to one if living in urban area. The vector of covariates, X, includes a cubic polynomial in age, province dummies and other explanatory variables discussed in the previous section. The coefficient, β_1, on the interaction term, $OCP * Urban$, is the estimated effect of OCP when we use rural control groups.

If we only use the urban before-cohort as the control group, rural sample is dropped and equation (5) is reduced to:

$$EDU = \alpha_0 + \alpha_1 OCP + \alpha_2 X + \varepsilon \quad (21)$$

where coefficient α_1 is represents the policy effect.

Table 3a presents the results using total sample. Column [1], [2] use the total sample. Column [3] and [4] use only urban sample and column [5] and [6] use only rural sample as a comparison.

The results indicate significant treatment effects of OCP. The effect is bigger when we use urban before-cohort as control groups comparing to the rural OCP control group. I focus on the results in column [1] and [2] when we use the rural OCP-cohort as the control group. The coefficient on the interaction term (OCP-cohort*Urban) is the treatment effect. The result suggests that OCP, by reducing the number of children, has increased the years of education. Comparing to the two-child rural household, OCP increases children's education in the treatment group by 1.65 years on average. If we use one-child rural household as the control group, this number is smaller, 1.18 years. This result is as expected because quantity-quality tradeoff states that higher number of children will reduce the average education attainment.

Columns [3] and [4] show significant impact of OCP using urban before-cohort as control groups. The treat effects are also significant. If we use the one-child household as the control group, the OCP effect is bigger than the case when we use two-child household as the control group. It's counter intuitive because more children should indicate lower average education level according to the quality-quantity tradeoff theory. There may be other factors that we fail to take into account such as the huge institutional change before and after 1979 when OCP was introduced (I will discuss this in the next section).

Column [5] and [6] use rural sample as a comparison and show that that OCP also had positive impact on rural OCP-cohort though to a much smaller extent. Column [6] shows that if we use one-child rural before-cohort as the control group, then OCP has no significant treatment effect for the rural OCP-cohort. This result suggests that in rural area there is a tradeoff between children's quality and quantity. The education attainments between OCP-cohort and before-cohort are not statistically different for one-child households. However, if we compare rural OCP-cohort with the before-cohort that comes from two-child household, OCP does have a treatment effect for the rural sample.

Coefficients on other control variables are largely as expected. Parental years of education have significant positive impacts on children's years of education received, especially father's education. Having a cadre in the household will increase children's education from 0.65 to about one year. Having high school or tertiary school in the community do not seem to have significant impacts on urban children but will increase years of education by about 0.4 year on rural children.

In addition, among the unreported variables, higher amount of non-productive assets of the household, locating close to an open trade area, having a

higher population grow in the community will increase years of education. A higher percentage of farm labor decreases the education performance. A higher percentage of migrants in the community does not have significant impact for urban OCP-cohort but has a positive significant impact on the rural OCP-cohort.

Table 3b presents results using male and female sample separately. The results are largely consistent with the whole sample. We notice that OCP has bigger impact on males than females. Using two-child rural cohort as the control group, column [1] shows that OCP increases education by about 2.4 years for males and 1.5 years for females.

An interesting observation is that for boys father's education is more important, while for girls mother's education is more important. Having a cadre in the household will significantly increase a boy's years of education but this effect is not significant for girls. In addition, having high school or tertiary school in the community will increase education only for girls in rural areas, but have no significant impacts for either urban girls or boys anywhere.

3.5.2 OCP on Highest Level of Education

The dependent variables in this section are whether the individual has a college degree, a higher diploma or a junior technical school degree. The regressions with binary outcomes are estimated with a logistic regression. Descriptive analysis suggests that the mean rate of outcome variable is low, thus the logistic model will perform better than a linear probability model. I use the following estimating equation:

$$Pr(y = 1) = l(\beta_0 + \beta_1(OCP * Urban) + \beta_2 OCP + \beta_3 Urban + \beta_4 X + \varepsilon) \quad (22)$$

where y is a dummy variable for the holding of the highest degree. The definition of other variables follows equation (5). The treatment effect is captured by β_1.[38] Similar to equation (6), when using the urban before-cohort as a control group, equation (7) will be reduced to

$$Pr(y = 1) = l(\alpha_0 + \alpha_1 OCP + \alpha_2 X + \varepsilon) \quad (23)$$

For the logistic models, I report the results in log odds ratios, which are interpreted as the log of relative odds of the outcome occurring for the treatment group relative to the control group.

Table 4 first presents results of equation (7) and (8) when the dependent variable is whether the individual holds a university degree. Observations with degrees higher than university qualification are excluded. Similarly, in estimations with high school and junior technical school, individuals with degree higher than high school and higher than junior technical school are excluded from the estimation respectively.

The sample size is too small to yield accurate estimates for males and females separately. The coefficients of interest remain significant but the R-squares are too low. Therefore, I only report results for the total sample.

Column [1] and [2] show that there is a clear OCP impact on the acquisition of university degree and high school diploma, but not on junior technical school degree. For the rural sample, OCP only has impact on the probability of getting a junior technical school degree. Past studies on human capital investment in rural China suggest that rural households are much more credit-constrained than urban residents in investing in education. It is more practical and financially affordable to get a technical degree and start to work early than to invest in a college degree (Yao, 2000).

[38] It is noteworthy that unlike in linear models, the coefficients on interaction variables in probit models are not the usual parameters of interest.

3.5.3 OCP on Wage Earnings

It is likely that the return to education is different for the treatment and control groups, and different between treated individuals who responded to the treatment (compliers) and those who did not (non-compliers). In this case, it is inappropriate to use the simple linear regression models since they ignore the heterogeneity within the group. To explore this issue, I estimate the Local Average Treatment Effect (LATE) proposed by Imbens and Angrist (1995, 1996). As the outcome of interest, I use log monthly wage in a Mincer type equation:

$$\ln W = \alpha_0 + \alpha_1(EDU * Urban) + \alpha_2 EDU + \alpha_3 Urban + \varepsilon \quad (24)$$

where $\ln W$ is the log value of monthly wage. Variable E is the education attainments either in term of years of education or highest level of degrees obtained. Vector X includes all other exogenous variables defined in previous estimations.

Education is by nature endogenous because individuals with higher ability would have had higher wage earnings given any level of education, as well as be more likely to have high levels of education. Simple least squares estimates would overestimate the returns to education. I use whether an individual belongs to the OCP-cohort as instrument. In the context of heterogeneous returns to education, this estimate by using OCP as instrument for education is an average of returns to education consisting of two types of averaging. It is firstly a weighted average of the return from gaining one more year of schooling. In addition, for any level of schooling, e.g. to moving from six to seven years of education, it is averaging over those people whose education would have been at least seven of schooling with OCP, and who would had less than seven years of education had OCP not been introduced.

Before presenting empirical results, we need to discuss assumptions required to interpreting the IV estimates as LATE estimator. Firstly, the instrument has to be as good as randomly assigned and does not directly affect the outcome. Whether an individual belongs to OCP-cohort is tied to an individual's day of birth, so more or less random. However, that alone does not make it valid as an LATE instrument. The exclusion restriction is the key assumption that has to be met. The restriction implies that for those whose education was not affected by OCP, there should be no change in subsequent wage earnings. For those whose education was affected by OCP, the only channel of increasing earnings should be the increase in education. There are a number of reasons why this could be violated. For example, with only one child, the household may decide to have the child work earlier if it is credit constrained. Entering the job market earlier will gain experience for the workers. Thus the early wage earning for them may be lower due to shorter years of schooling but their wage may increase faster in later years due to additional working experience. In that case, the empirical results may underestimate the OCP effect on wage.

There were huge institutional changes between the 1970s environment and the 1980s. In the 1970s, rural households were in collective farms and rural Township and Village Enterprises (TVE) or private enterprises were not allowed. In the 1980s, we have the household responsibility system, family specialization and trade in food, and the emergence of TVE enterprises employing underemployed agricultural workers. In the cities in 1970s, urban households are in state-owned enterprises with the *danwei* system, in which case there was little or no wage differentiation for education. Starting in the 1980s, we see the rise of non-state employers. Workers with more education are able to access higher wages in urban areas.

CHNS does not provide information on length of employments. Thus directly estimating the impact of OCP on individual decision of entering the job market is not possible. However, we could provide some evidence by estimating wage equations including an OCP-cohort dummy. Table 5 presents results of the reduced form estimation with and without years of education. When not including education in the estimation, the OCP effect is significant. After adding in the education, OCP effects become much smaller when we use rural OCP-cohort as control group in column [1] and [2]. For column [3] to [6], the coefficients on OCP-cohort became smaller. This estimation provides some evidence that OCP affects wage through education. However, this test should be treated with caution because it's possible that OCP variable also picks up other factors that are occurred at the same time such as changes in social institutions.

Table 6 reports the LATE estimates. To test the strength of the instruments, the first stage restricted F-statistics are presented in Table 6b. I focus on estimations with rural control groups. Female compliers, i.e. people who obtain one more year of schooling because of OCP, experienced 5.6 to 8.1 percent increase in wage earnings. For male compliers, this effect is not significant.

3.5.4 Parallel-trend Assumption

Identification of a DID estimator requires a parallel-trend assumption, which assumes the difference in the outcome between the treatment and the control group would be the same without the policy change. When many years of data are available, we can usually plot the series of average outcomes for treatment and control groups and see whether trends are parallel and whether there is a sudden change right after the reform for the treatment group. The CHNS data has a panel structure but the sample used in the paper is not a

panel. Therefore, to examine the parallel-trend assumption, I utilize the following two strategies. Firstly, I will check the assumption with the "placebo events" test (Duflo, 2001). Secondly, I will discuss the differences using alternative control groups (Gruber, 1996).

3.5.4.1 Comparing Different Control Groups

If DID estimates with the alternative controls is different from those with the original control, the original results are likely to be biased. In the paper, I used two sets of control groups: rural groups and urban groups. The empirical results differ in magnitudes but are consistent in significance.

3.5.4.2 Placebo Events

I use data for the prior period, 1960-69, and redo the DID comparing to period 1970-79. If this placebo DID is non-zero, then it is likely that my estimates comparing period 1970-79 and 1980-89 is biased as well.

The 1960-69 cohorts have some different characteristics comparing to later cohorts. Few people went to college or university and the enrollment in senior technical schools were rather limited as well. Most families had more than one child, in both urban and rural area. Having three or even more children were common. To be consistent with the previous tests, I use one-child and two-child families in control groups but this way limits the sample size. In addition, the calculation of the number of kids is a rough estimation. The reason is that the first round of CHNS was collected in 1989 and by then the 1960-69 cohorts were between 20 and 29 years old so many would have moved out of the household. Once moving out, their information was no longer tracked. Therefore, in the Placebo test, the sample size is much smaller than later tests.

Empirical results are reported in Table 7. Coefficients of interest are not significant, indicating no significant difference between control and treatment groups. [39]

3.6 Conclusion

The One-child Policy (OCP) reduced child births in urban areas tremendously for the following thirty years which has increased education attainments, especially for women. The policy provides a unique natural experiment to evaluate the impact of reducing family size on subsequent labor market consequences.

This paper uses a difference-in-difference framework to test the impacts of OCP on children's education and their subsequent earnings. The empirical results are by and large consistent with the Quality-Quantity tradeoff theory. Depending on the choice of control group, OCP contributes to between 1 to 1.5 more years of education for urban women, and 1.8 to 2.4 years for urban men. In terms of obtaining university degrees, OCP increased the likelihood to obtain university and high school degrees when using rural OCP-cohorts as control groups. When using urban before-cohorts as control groups, the likelihood of obtaining all three degrees are higher due to OCP. One interesting observation is that OCP has much bigger effects on obtaining high school degree than junior technical school degree. Although not officially documented, one possible explanation is that high school degree does not indicate any practice skill. It is only meaningful to finish high school if one intends to go to college.

In wage estimation equations, return to education is higher for urban women than men, which is consistent with findings in previous studies. One more

[39] Table 7 uses the whole sample with completed education, regardless of their wage income. If we restrict the sample to those with positive wage income, coefficients of interest are not significant either but the sample size is too small to give meaningful implications. Results are available upon request.

year of education will increase women's hourly wage earnings by 5.6 to 8.1 percentage points and have no significant impacts for men. The results suggest a higher return to education for women.

To my knowledge, this is the first paper to relate the impact of OCP on education and gender wage gap. We find positive effects of reduced family size on children's education and their subsequent wage earnings. In terms of policy implications, however, the contribution of OCP to social welfare is unclear. Reducing the number of children also indicates higher burdens of supporting parents per child. Given the imperfect capital and insurance markets, the expected benefits that a household could obtain may not be improved. The underlying mechanisms that relate family size to subsequent economic consequences need to be further explored.

References

[1] Angrist, Joshua D., Victor Lavy, and Analia Schlosser. *New evidence on the causal link between the quantity and quality of children*. No. w11835. National Bureau of Economic Research, 2005.

[2] Angrist, Joshua D., and Guido W. Imbens, and Donald B. Rubin. "Identification of causal effects using instrumental variables." *Journal of the American statistical Association* 91.434 (1996): 444-455.

[3] Angrist, Joshua D., and Guido W. Imbens. "Two-stage least squares estimation of average causal effects in models with variable treatment intensity." *Journal of the American statistical Association* 90.430 (1995): 431-442.

[4] Bailey, Martha J., Brad Hershbein, and Amalia R. Miller. *The opt-in revolution? Contraception and the gender gap in wages*. No. w17922. National Bureau of Economic Research, 2012.

[5] Banister, Judith. "Implications of the aging of China's population." *Changing family structure and population aging in China: A comparative approach* (1990): 268-308.

[6] Becker, Gary S., and H. Gregg Lewis. "Interaction between quantity and quality of children." *Economics of the family: Marriage, children, and human capital*. UMI, 1974. 81-90.

[7] Bound, John, David A. Jaeger, and Regina M. Baker. "Problems with instrumental variables estimation when the correlation between the instruments and the endogenous explanatory variable is weak."

Journal of the American statistical association 90.430 (1995): 443-450.

[8] Cai, Fang. "Demographic transition, demographic dividend, and Lewis turning point in China." *China Economic Journal* 3.2 (2010): 107-119.

[9] Gustafsson, Björn, and Shi Li. "Economic transformation and the gender earnings gap in urban China." *Journal of Population Economics* 13.2 (2000): 305-329.

[10] Hull, Terence H. "Recent trends in sex ratios at birth in China." *Population and Development Review* (1990): 63-83.

[11] Kaufman, Joan, et al. "Family planning policy and practice in China: A study of four rural counties." *Population and Development Review* (1989): 707-729.

[12] Liu, Pak-Wai, Xin Meng, and Junsen Zhang. "Sectoral gender wage differentials and discrimination in the transitional Chinese economy." *Journal of Population Economics* 13.2 (2000): 331-352.

[13] Mengtao, Gao, and Yao Yang. "Which Is the Main Reason for Income Inequality in Rural China: Physical Assets or Human Capital?[J]." *Economic Research Journal* 12 (2006): 71-80.

[14] Meng, Xin, and Michael P. Kidd. "Labor market reform and the changing structure of wage determination in China's state sector during the 1980s." *Journal of Comparative Economics* 25.3 (1997): 403-421.

[15] Meng, Xin, and Paul Miller. "Occupational segregation and its impact on gender wage discrimination in China's rural industrial sector." *Oxford Economic Papers* (1995): 136-155.

[16] Meng, Xin, and Robert G. Gregory. "The Impact of Interrupted Education on Subsequent Educational Attainment: A Cost of the Chinese Cultural Revolution*." *Economic Development and Cultural Change* 50.4 (2002): 935-959.

[17] Peng, Xizhe. *Demographic transition in China: Fertility Trends since the 1950s*. Oxford: Clarendon Press, 1991.

[18] Qian, Nancy. "Quantity-quality and the one child policy: The positive effect of family size on school enrollment in China." *Chapter in PhD thesis, Department of Economics, Massachusetts Institute of Technology* (2004).

[19] Qian, Nancy. *Quantity-quality and the one child policy: The only-child disadvantage in school enrollment in rural China*. No. w14973. National Bureau of Economic Research, 2009.

[20] Wang, Shing-Yi. "Credit Constraints, Job Mobility, and Entrepreneurship: Evidence from a Property Reform in China." *Review of Economics and Statistics* 94.2 (2012): 532-551.

Figures and Tables

Figure 1: Mean Years of Education by Birth Cohort

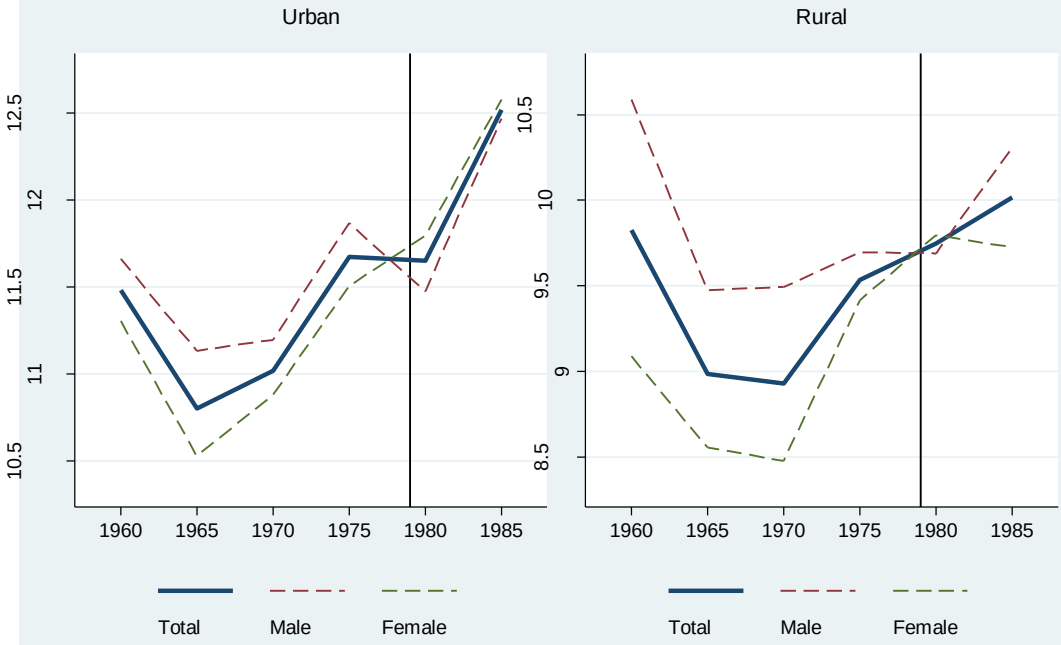


Figure 2: University Degree by Birth Cohort

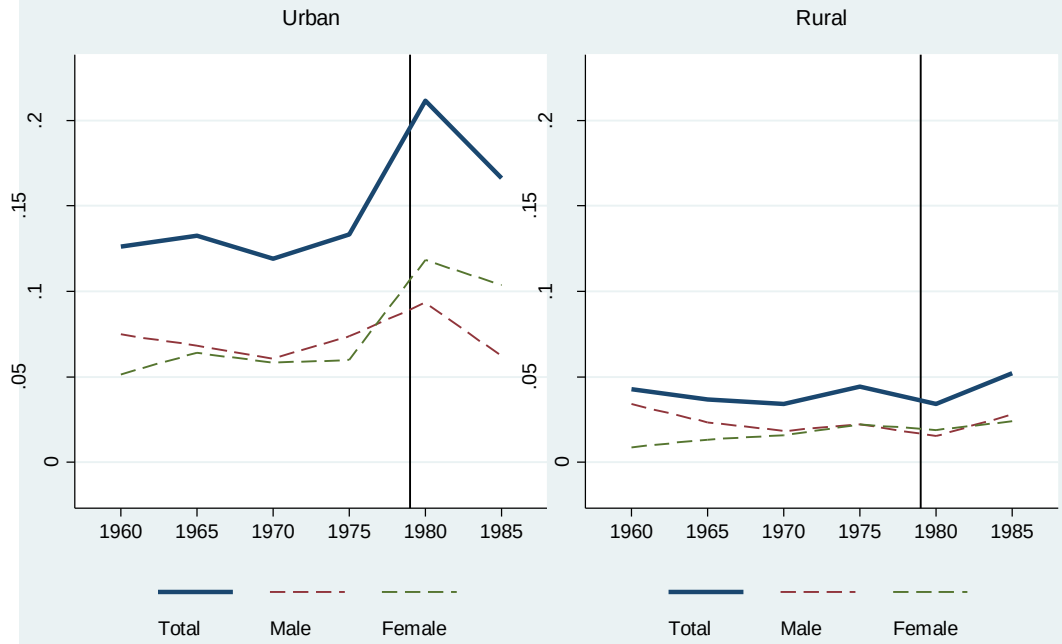


Figure 3: Junior Technical School Degree by Birth Cohort

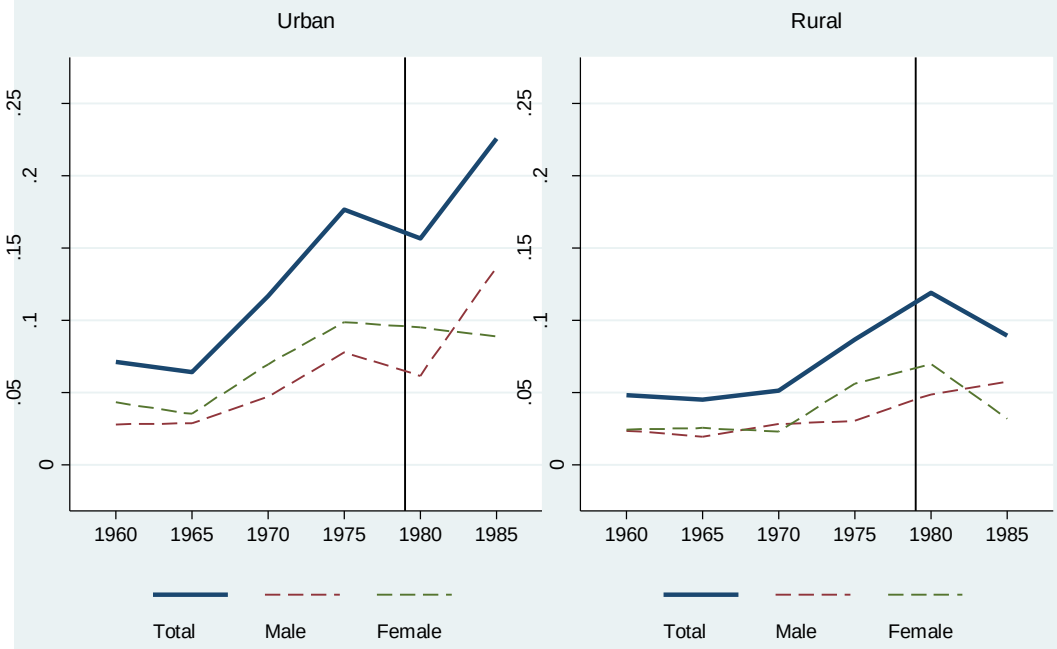


Figure 4: Log Monthly Wage for Urban Workers

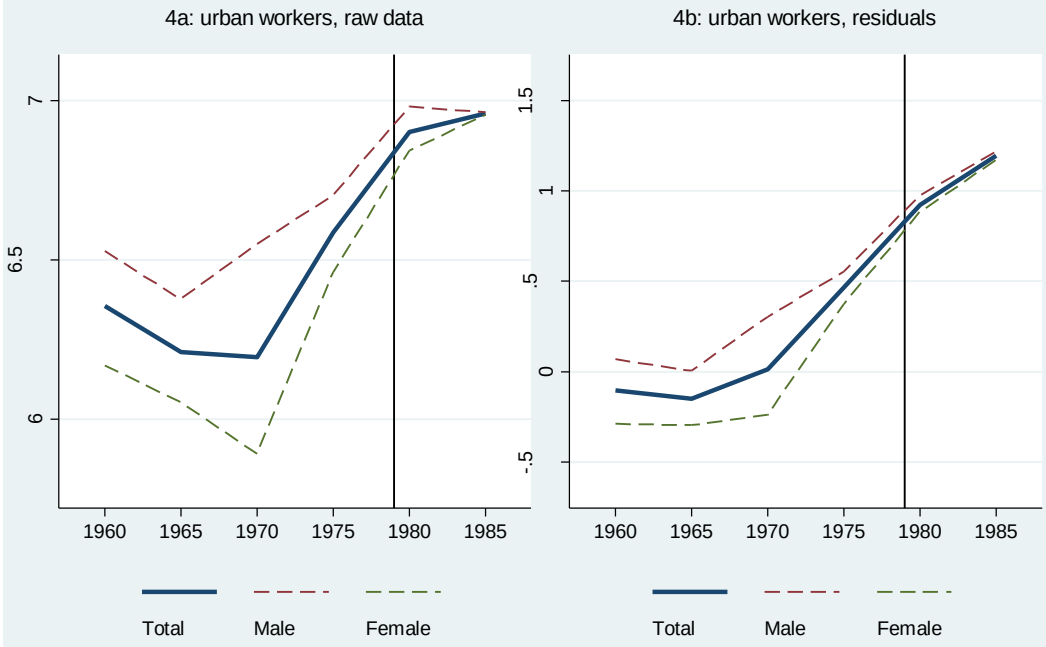


Figure 5: TREATMENT EFFECT OF OCP ON EDUCATION

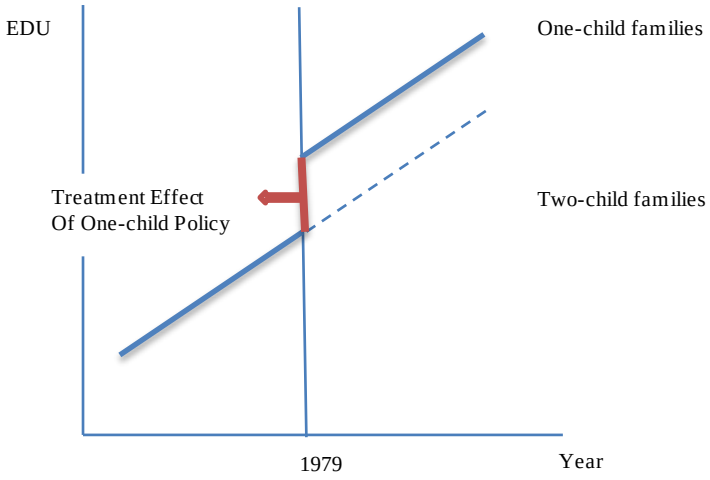


Table 1 SUMMARY STATISTICS OF HOUSEHOLDS IN 2009

	Treatment		Rural controls (OCP-cohort)				Urban control (Before-cohort)			
			Control 1: 2-child household		Control 2: 1-child household		Control 3: 2-child household		Control 4: 1-child household	
Demographic Variables										
Household size	3.51	[0.88]	5.02***	[1.27]	4.00***	[1.24]	5.73***	[1.86]	3.89***	[1.42]
Average age of household	45.29	[7.64]	43.92**	[8.71]	44.91	[8.62]	49.82***	[9.79]	51.06***	[10.48]
Percentage of males	0.48	[0.50]	0.46	[0.50]	0.49	[0.50]	0.48	[0.50]	0.48	[0.50]
If cadre in the household	0.13	[0.33]	0.06***	[0.24]	0.10*	[0.30]	0.18	[0.38]	0.20***	[0.40]
Age of head	51.55	[5.59]	51.14	[4.19]	49.92***	[6.44]	60.12***	[8.16]	57.97***	[11.79]
Head is minority	0.1	[0.31]	0.17***	[0.38]	0.1	[0.30]	0.20***	[0.40]	0.12	[0.33]
Education of head	10.27	[3.92]	7.94***	[3.58]	8.99***	[4.06]	7.13***	[5.38]	9.28***	[5.33]
Education of head's spouse	9.62	[4.15]	5.85***	[4.36]	7.21***	[4.22]	5.04***	[5.78]	8.44***	[5.32]
Education of children	14.74	[4.04]	10.84***	[3.51]	11.77***	[3.81]	11.53***	[4.50]	11.71***	[4.03]
Percentage of male children	0.55	[0.50]	0.67***	[0.41]	0.77***	[0.42]	0.87***	[0.30]	0.77***	[0.42]
Household's income and assets										
Net household income	42944.84	[43883.28]	33567.96***	[36089.67]	38717.19	[85824.63]	47407.34	[40611.69]	40983.42	[31435.59]
Household wage income	33514.89	[32800.54]	19783.24***	[17349.10]	26637.27***	[43355.59]	42594.54***	[36668.38]	27116.01***	[24352.86]
Value of productive assets	18846.79	[64832.88]	7089.57***	[27230.53]	10066.59***	[31475.79]	15653.66	[52636.32]	11431.15**	[30640.82]
Value of non-productive assets	11245.42	[10766.64]	6040.34***	[6265.93]	6550.73***	[6823.48]	12932.90*	[14922.40]	10190.97	[8201.68]
Observations	342		182		453		115		257	

Note:

(1) Standard deviations are reported in brackets. * denotes the level of significance on the equality of means between treatment and control group using t-tests; * denotes significance level at 10%, ** at 5% level, and *** at 1% level.

(2) Productive assets include farm tools, transportation vehicles, computers and etc. Non-productive assets include furniture, electronics and other consumptive investment.

Table 2 STATISTICS OF TREATMENT AND CONTROL GROUPS

	Treatment	Control 1	Control 2	Control 3	Control 4
Year of birth	1980-89	1980-89	1980-89	1970-79	1970-79
Hukou Status	Urban	Rural	Rural	Urban	Urban
Number of children in the household	1	2	1	2	1
Total number of boys in the group	179	194	279	136	164
Total number of girls in the group	163	170	174	94	93
Total number of households	342	182	453	115	257

Table 3a IMPACTS OF OCP ON YEARS OF EDUCATION: OLS

Sample	Urban and Rural		Urban		Rural	
Control group	Rural OCP-cohort		Urban Before-cohort		Rural Before-cohort	
	2-child HH	1-child HH	2-child HH	1-child HH	2-child HH	1-child HH
	[1]	[2]	[3]	[4]	[5]	[6]
OCP-cohort	1.018**	1.178**	2.780***	3.127***	0.948**	0.607
	[0.327]	[0.451]	[0.628]	[0.756]	[0.343]	[0.493]
OCP-cohort*Urban	1.645***	1.178*				
	[0.457]	[0.465]				
Urban	0.124	0.416+				
	[0.271]	[0.252]				
Male	1.263***	1.423***	1.203***	0.936**	1.566***	1.662***
	[0.191]	[0.171]	[0.324]	[0.329]	[0.208]	[0.198]
Father's education	0.203***	0.232***	0.244***	0.270***	0.190***	0.211***
	[0.033]	[0.030]	[0.065]	[0.064]	[0.033]	[0.034]
Mother's education	0.107***	0.210***	0.043	0.213***	0.161***	0.204***
	[0.031]	[0.029]	[0.052]	[0.057]	[0.033]	[0.033]
Have cadre in household	0.959*	0.658*	0.858	0.647	1.092*	0.537
	[0.386]	[0.303]	[0.549]	[0.531]	[0.434]	[0.400]
Have school in community	0.046	0.332	-0.178	0.756	0.408+	0.365
	[0.231]	[0.215]	[0.704]	[0.640]	[0.240]	[0.261]
Observations	1212	1428	453	456	927	972

NOTE:
(1) Robust standard errors are reported in brackets. *** denotes significance at the 0.1% level, ** at the 1% level, * at the 5% level, + at the 10% level.
(2) Unreported explanatory variables include a cubic polynomial in age, the value of household non-productive assets (furniture, electronics and other consumptive investment), community characteristics such as whether the community is close to an open trade area, the percentage of farm labor among all working age labor, the percentage of migrants, the population growth rate of the community from 1989 to 2009, province dummies, and a constant term.
(3) The variable "Have school in community" refers to either high school or tertiary school locating within the community.

Table 3b IMPACTS OF OCP ON YEARS OF EDUCATION: MALE VS FEMALE

Sample	Urban and Rural		Urban		Rural	
Control group	Rural OCP-cohort		Urban Before-cohort		Rural Before-cohort	
	2-child HH	1-child HH	2-child HH	1-child HH	2-child HH	1-child HH
	[1]	[2]	[3]	[4]	[5]	[6]
Male						
OCP-cohort	1.381**	2.337***	4.416***	4.560***	1.697**	1.458+
	[0.498]	[0.638]	[1.025]	[1.062]	[0.539]	[0.766]
OCP-cohort*Urban	2.440***	1.750**				
	[0.643]	[0.655]				
Urban	0.161	0.229				
	[0.373]	[0.351]				
Father's education	0.324***	0.421***	0.391***	0.448***	0.338***	0.389***
	[0.049]	[0.044]	[0.104]	[0.108]	[0.052]	[0.049]
Mother's education	-0.021	0.014	-0.082	0.011	0.022	0.015
	[0.041]	[0.036]	[0.060]	[0.085]	[0.045]	[0.040]
Have cadre	1.404*	1.155**	1.532*	0.721	1.404*	1.064*
	[0.544]	[0.415]	[0.713]	[0.634]	[0.612]	[0.532]
Have school in community	-0.264	0.401	-0.331	0.555	0.111	0.365
	[0.310]	[0.286]	[0.975]	[0.918]	[0.329]	[0.356]
Observations	532	647	197	192	427	455
Female						
OCP-cohort	0.599	0.396	1.640+	1.845	0.334	0.189
	[0.468]	[0.631]	[0.893]	[1.332]	[0.483]	[0.685]
OCP-cohort*Urban	1.506*	0.983				
	[0.684]	[0.721]				
Urban	0.156	0.833*				
	[0.412]	[0.367]				
Father's education	0.090*	0.044	0.008	0.045	0.051	0.029
	[0.043]	[0.038]	[0.078]	[0.095]	[0.044]	[0.043]
Mother's education	0.215***	0.370***	0.155*	0.372***	0.301***	0.367***
	[0.044]	[0.043]	[0.069]	[0.086]	[0.047]	[0.049]
Have cadre	0.644	0.499	-0.131	0.423	1.285*	0.521
	[0.509]	[0.484]	[0.698]	[0.824]	[0.654]	[0.644]
Have school in community	0.373	0.448	1.107	2.110+	0.717*	0.647+
	[0.353]	[0.326]	[1.170]	[1.158]	[0.354]	[0.377]
Observations	605	682	226	212	457	470

Note:

(1) Robust standard errors are reported in brackets. *** denotes significance at the 0.1% level, ** at the 1% level, * at the 5% level, + at the 10% level.
(2) Unreported explanatory variables include all explanatory variables in Table 3a and the gender wage ratio in the community.

Table 4 IMPACTS OF OCP ON HIGHEST DEGREE RECEIVED: LOGIT

Sample	Urban and Rural		Urban		Rural	
Control group	Rural OCP-cohort		Urban Before-cohort		Rural Before-cohort	
	2-child HH	1-child HH	2-child HH	1-child HH	2-child HH	1-child HH
	[1]	[2]	[3]	[4]	[5]	[6]
University						
OCP-cohort	1.076	2.091**	2.966***	2.513***	1.436	2.905+
	[0.701]	[0.711]	[0.735]	[0.694]	[1.016]	[1.589]
OCP-cohort*Urban	1.249+	0.603				
	[0.670]	[0.563]				
Urban	0.192	0.756				
	[0.609]	[0.475]				
Male	0.2	0.694*	0.486	0.453	0.796	1.426**
	[0.308]	[0.286]	[0.412]	[0.340]	[0.499]	[0.552]
Observations	1212	1427	453	455	847	972
High school						
OCP-cohort	0.711+	0.422	1.514**	0.902	0.557	0.453
	[0.380]	[0.434]	[0.565]	[0.718]	[0.429]	[0.585]
OCP-cohort*Urban	0.821+	0.724				
	[0.462]	[0.448]				
Urban	0.271	0.034				
	[0.293]	[0.238]				
Male	0.138	0.670***	0.241	0.223	0.639**	1.014***
	[0.187]	[0.162]	[0.298]	[0.266]	[0.209]	[0.219]
Observations	1041	1225	339	338	851	887
Junior technical school						
OCP-cohort	0.946*	1.034	1.663*	2.417+	1.151*	0.303
	[0.457]	[0.674]	[0.830]	[1.418]	[0.584]	[0.636]
OCP-cohort*Urban	0.389	0.808				
	[0.595]	[0.576]				
Urban	1.108*	0.740+				
	[0.471]	[0.439]				
Male	0.33	0.39	0.575	-0.012	0.49	0.536+
	[0.268]	[0.259]	[0.466]	[0.485]	[0.362]	[0.326]
Observations	960	1061	302	270	748	711

NOTE:

(1) Robust standard errors are reported in brackets. *** denotes significance at the 0.1% level, ** at the 1% level, * at the 5% level, + at the 10% level.

(2) Unreported explanatory variables are the same as in Table 3a.

Table 5 TEST FOR EXCLUSION CRITERIA OF LATE ESTIMATION

Sample	Urban and Rural		Urban		Rural	
Control group	Rural OCP-cohort		Urban Before-cohort		Rural Before-cohort	
	2-child HH	1-child HH	2-child HH	1-child HH	2-child HH	1-child HH
	[1]	[2]	[3]	[4]	[5]	[6]
Without education						
OCP-cohort	0.867***	0.554***	1.036***	0.775**	0.833***	0.568***
	[0.133]	[0.140]	[0.198]	[0.243]	[0.147]	[0.164]
OCP-cohort*Urban	0.031	0.294*				
	[0.165]	[0.147]				
Urban	0.229+	0.104				
	[0.128]	[0.112]				
With education						
OCP-cohort	0.863***	0.550***	0.851***	0.561*	0.803***	0.575***
	[0.133]	[0.139]	[0.198]	[0.238]	[0.148]	[0.165]
OCP-cohort*Urban	-0.106	0.184				
	[0.173]	[0.153]				
Urban	0.2	0.105				
	[0.128]	[0.110]				
Education, years	0.047***	0.043***	0.063***	0.063***	0.036*	0.033*
	[0.012]	[0.011]	[0.017]	[0.018]	[0.016]	[0.015]
Observations	512	651	252	265	363	386

NOTE:

(1) Robust standard errors are reported in brackets. *** denotes significance at the 0.1% level, ** at the 1% level, * at the 5% level, + at the 10% level.
(2) Unreported explanatory variables are the same as in Table 3a.

Table 6a WAGE EQUATION FIRSTSTAGE

Sample	Urban and Rural		Urban		Rural	
Control group	Rural OCP-cohort		Urban Before-cohort		Rural Before-cohort	
	2-child HH	1-child HH	2-child HH	1-child HH	2-child HH	1-child HH
	[1]	[2]	[3]	[4]	[5]	[6]
All sample						
OCP-cohort	0.084	0.097	2.921***	3.403***	0.833	-0.213
	[0.572]	[0.798]	[0.867]	[0.978]	[0.618]	[0.843]
OCP-cohort*Urban	2.925***	2.554***				
	[0.725]	[0.724]				
Father's education	0.333***	0.403***	0.340***	0.497***	0.356***	0.350***
	[0.051]	[0.043]	[0.081]	[0.070]	[0.053]	[0.053]
Mother's education	0.110*	0.154***	0.067	0.185**	0.126*	0.135**
	[0.046]	[0.037]	[0.059]	[0.067]	[0.051]	[0.042]
Male						
OCP-cohort	0.151	0.847	4.445***	4.091**	0.885	0.581
	[0.884]	[1.037]	[1.111]	[1.389]	[0.910]	[1.150]
OCP-cohort*Urban	3.459**	2.604*				
	[1.100]	[1.085]				
Father's education	0.479***	0.564***	0.476***	0.620***	0.540***	0.532***
	[0.068]	[0.047]	[0.104]	[0.094]	[0.070]	[0.054]
Mother's education	-0.018	-0.004	-0.051	-0.01	0.01	0.002
	[0.057]	[0.035]	[0.059]	[0.077]	[0.063]	[0.037]
Female						
OCP-cohort	-0.032	0.026	1.608	2.343+	0.418	-0.666
	[0.731]	[1.094]	[1.300]	[1.222]	[0.781]	[1.185]
OCP-cohort*Urban	1.995*	1.002				
	[0.959]	[0.971]				
Father's education	0.164*	0.182**	0.12	0.332**	0.146+	0.087
	[0.068]	[0.065]	[0.122]	[0.100]	[0.080]	[0.087]
Mother's education	0.243***	0.372***	0.195+	0.395***	0.305***	0.351***
	[0.069]	[0.061]	[0.102]	[0.097]	[0.077]	[0.075]

Table 6b IMPACTS OF OCP ON WAGE: 2SLS

Sample	Urban and Rural		Urban		Rural	
Control group	Rural OCP-cohort		Urban Before-cohort		Rural Before-cohort	
	2-child HH	1-child HH	2-child HH	1-child HH	2-child HH	1-child HH
	[1]	[2]	[3]	[4]	[5]	[6]
Total						
Years of education	0.065**	0.049*	0.114***	0.061*	0.062+	0.026
	[0.022]	[0.019]	[0.034]	[0.026]	[0.033]	[0.030]
Male	0.483***	0.421***	0.514***	0.506***	0.494***	0.379***
	[0.081]	[0.072]	[0.110]	[0.102]	[0.118]	[0.100]
1st stage F-test	89.2	173.05	34.57	80.48	69.71	79.66
Observations	512	651	252	265	363	386
Male						
Years of education	0.029	0.033	0.077*	0.038	0.019	0.035
	[0.026]	[0.022]	[0.037]	[0.034]	[0.035]	[0.031]
1st stage F-test	62.54	161.37	28.65	61.3	72.86	101.03
Observations	269	382	133	142	210	240
Female						
Years of education	0.081*	0.056*	0.107+	0.076*	0.140**	-0.003
	[0.036]	[0.025]	[0.057]	[0.031]	[0.049]	[0.038]
1st stage F-test	34.54	73.64	10.09	35.44	24.72	35.17
Observations	243	269	119	123	153	146

NOTE:

(1) Robust standard errors are reported in brackets. Restricted F-tests are reposted. *** denotes significance at the 0.1% level, ** at the 1% level, * at the 5% level, + at the 10% level.

(2) Unreported explanatory variables are the same as in Table 3a.

Table 7 PARALLEL TREND TESTS IN EDUCATION: : DID 1960-69 VS 1970-79

Sample	Urban and Rural		Urban		Rural	
Control group	Rural OCP-cohort		Urban Before-cohort		Rural Before-cohort	
	2-child HH	1-child HH	2-child HH	1-child HH	2-child HH	1-child HH
	[1]	[2]	[3]	[4]	[5]	[6]
All sample						
OCP-cohort	0.788+	-0.214	0.381	-0.023	0.18	-0.427
	[0.404]	[0.435]	[0.842]	[0.782]	[0.550]	[0.480]
OCP-cohort*Urban	-0.262	0.362				
	[0.644]	[0.635]				
Observations	853	821	238	286	417	535
Male						
OCP-cohort	0.875	-0.563	0.01	-0.548	0.499	-0.381
	[0.571]	[0.660]	[1.217]	[1.367]	[0.839]	[0.774]
OCP-cohort*Urban	-0.496	0.396				
	[0.975]	[1.063]				
Observations	356	368	99	124	189	244
Female						
OCP-cohort	0.383	-0.433	1.283	-0.178	-0.303	-0.738
	[0.538]	[0.599]	[1.248]	[0.898]	[0.708]	[0.661]
OCP-cohort*Urban	0.267	0.165				
	[0.905]	[0.847]				
Observations	446	403	111	135	216	268