This is to certify that the
dissertation entitled

Three Essays on Household Saving and Wealth

presented by

Kyeongwon Yoo

has been accepted towards fulfillment
of the requirements for the

Ph.D. degree in Economics

Major Professor's Signature

August 18, 2003

Date

THREE ESSAYS ON HOUSEHOLD SAVING AND WEALTH

By

Kyeongwon Yoo

A DISSERTATION

Submitted to
Michigan State University
in partial fulfillment of the requirements
for the degree of

DOCTOR OF PHILOSOPHY

Department of Economics

2003

ABSTRACT

THREE ESSAYS ON HOUSEHOLD SAVING AND WEALTH

By

Kyeongwon Yoo

This dissertation explores the impact of risk on household saving, portfolio decisions and evolution of non-land wealth with a panel of household data from rural China. It consists of three chapters.

In the first chapter, we develop a test of precautionary behavior in the consumption and saving decisions of rural agricultural households. We first present a constant relative risk aversion model of household consumption decisions in which consumption risk is explicitly related to yield risk. Next we discuss ways of using rainfall variance as a proxy for yield risk, and consider the possibility of using a GARCH model to estimate conditional rainfall variance. Finally, we test the empirical model using household panel data from rural China and find evidence of precautionary motives behind consumption and saving decisions. We estimate that roughly 11-12 percent of household savings can be attributed to a precautionary motive for households facing a median level of consumption risk.

Based on relatively recent panel data (1995 – 2000) in rural China the second chapter presents the empirical evidence that rainfall variability as a proxy for yield risk influences the portfolio composition of a household. We find support for an allocation toward liquid assets in response to more volatile rainfall variability. We observe that cash and deposits are important instruments for their precautionary wealth allocation, while it

is difficult to find the similar evidence for grain stocks. It may imply that financial instruments have played an important role in precautionary portfolio allocation while dramatic institutional changes of the post-reform period have been proceeding in contemporary rural China.

The composition and inequality of wealth in rural China is examined in the third chapter. We first document the evolution of rural households' non-land wealth during the period from 1986 to 2000. Our results show that financial and fixed productive assets have become more important in their weight in wealth composition, while housing assets have played a dominant role during this period. Based on various inequality measures we observe that the inequality of rural non-land wealth has worsened but there was improvement in these asset holdings across the period in rural China.

ACKNOWLEDGEMENTS

I would like to express my sincere appreciation to my advisor, John Strauss, for his guidance and advice. Without his encouragement and insightful comments this work would not have appeared in its present form. I have learnt lots of things from him during my stay at Michigan State. I owe special thanks to John Giles, who is in effect my second advisor and provided helpful comments and the data for my dissertation. I would also like to thank the other members of my committee, Professors Peter Schmidt and Jack Meyer, who provided valuable comments and suggestions.

For the completion of my dissertation, I am indebted to many people. I especially want to thank my friends at Michigan State for their invaluable support and friendship. Finally, I give special thanks to my family. I am too much indebted to my wife, Eunryeong, and my son, Hyunsol. Without their sacrifices and patience I was not able to complete this long journey. Thank for their love and support.

TABLE OF CONTENTS

CHAPTER 3

HOUSEHOLD NON-LAND WEALTH IN RURAL CHINA: COMPOSITION AND DISTRIBUTION FROM 1986 TO 2000

LIST OF TABLES

CHAPTER 3

LIST OF FIGURES

Chapter 1

PRECUATIONARY BEHAVIOR AND HOUSEHOLD CONSUMPTION DECISIONS: AN EMPIRICAL ANALYSIS USING HOUSEHOLD PANEL DATA FROM RURAL CHINA

1. Introduction

In recent years, considerable effort has gone into understanding the nature of precautionary responses to risk and uncertainty when households make consumption and savings decisions.[1] A micro-econometric literature attempting to identify the strength of precautionary motives generally confirms the prediction that income risk plays a role in determining the timing of consumption decisions, though this literature has also produced some confusion and anomalous results due to differences in empirical strategies.[2] In this paper we first extend an analytic framework developed by Blundell and Stoker (1999) to consider risks to income earned by rural households in the developing world, and then we develop an empirical test that avoids three common weaknesses found in the literature: (1) lack of an exogenous proxy for consumption risk; (2) lack of a mechanism for updating perceived risk as uncertainty is resolved; and (3) failure to control for the possibility that responses to risk may depend on household wealth.

If proxies for risk are endogenous with other household decisions or confounded with differences across households in the noise from income reports, then they may introduce serious bias into analyses of precautionary behavior. Jalan and Ravallion

---

[1] See Browning and Lusardi (1996), and Carrol (2001) for useful reviews of the literature. Deaton (1992) provides an important early exposition of the precautionary motive.

[2] Lusardi (1997) and Carroll (1994) suggest that the precautionary motive may explain a significant fraction of wealth accumulation. Carroll and Samwick (1997) estimate a wealth equation with direct measures of the variance of shocks to permanent and transitory income and find some evidence of a precautionary motive, but Jappelli and Terlizzese (1992) and Dynan (1993) both produce results suggesting that precautionary motives for saving are weak or non-existent. Ludvigson and Paxson (2001) suggest that approximation error is likely to be one important factor driving anomalous results.

(2001), for example, test whether households hold higher shares of their wealth in liquid form when they face higher risk, and find that only a small share of unproductive liquid wealth is held as a precaution against income risk. While Jalan and Ravallion (2001) employ a technically sophisticated approach to calculate income risk from a five-year panel, their measure of risk is likely to be endogenous for two reasons: time-invariant sources of uncertainty will be correlated with their measure of income variance, and they make no distinction between transitory income and measurement error. Furthermore, from what has become known as *Chamberlain's Critique*, we know calculating a consistent measure of risk from a six-year panel is particularly problematic.[3] Our approach to dealing with this problem in a short panel of six years is to use rainfall variability as an exogenous and observable proxy for yield risk rather than estimating it from the panel itself.[4]

Recent work in the consumption literature suggests that analyses of responses to risk should reflect the plausibility that perceptions of risk change as new information is revealed.[5] For this reason, use of conditional income variance with respect to time is preferable to the unconditional variance as a measure of income risk. One important characteristic of agricultural production is that it occurs over an extended period, and that

---

[3] Consistency of empirical estimates of variance in panel data analyses relies on a long time series of observations for each individual. See Chamberlain (1984) for the original exposition. Deaton (1992) and Browning and Lusardi (1996) also emphasize that if the panel used is short, then the usual orthogonality conditions used in regression analyses will not hold if there are common shocks and these impact households in different ways.

[4] We use twenty years of monthy rainfall data collected at 44 different local weather stations. Rose (2001) also uses rainfall variance as a proxy for yield risk when looking at how risk influences off-farm labor supply decisions and Chaudhuri (1999) shows that rainfall patterns provide good proxies for news and uncertainty and exploits these characteristics to test for forward-looking behavior in the ICRISAT villages. It should be noted that even in developed countries, farmers continue to be concerned with factors influencing production risk. A 1996 USDA survey, for example, indicates that producers are most concerned about decreases in crop yields or livestock output (production risk), and uncertainty in commodity prices. See Harwood et al. (1999).

[5] See Blundell and Stoker (1999), Chaudhuri (1999), and Behrman, Foster, & Rosenzweig (1997).

farmers are likely to adjust consumption as new information about yield risk is revealed over the crop cycle. New information revealed through rainfall allows farmers to update assessments of risk, and when combined with historical rainfall data, rainfall can be used to construct exogenous proxies for yield risk. In order to consider the possibility that farmers update expectations about future rainfall variability and respond to these changes, we also considered the possibility of using a GARCH model to estimate conditional rainfall variances for each of the surveyed villages.[6]

In addition to failing to allow for updates in risk perceptions with information revelation, important early research in the area either neglected to control for the impact of wealth and changes in expected wealth on perceptions of risk, or introduced the impact of changes to expected wealth in an ad hoc manner. Models using quadratic preferences (e.g., Campbell, 1987) or constant absolute risk aversion (e.g., Caballero, 1990) were tractable, but have unrealistic behavioral implications.[7] Blundell and Stoker (1999) provide an approach to working with constant relative risk aversion preferences in analysis of consumption decisions and the timing of income risk Banks, Blundell and Brugiavini (2001) show how to implement Blundell and Stoker (1999) empirically using quasi-panels of British household data, and find that cohort specific risk terms indeed have an impact on consumption growth. This paper extends the general approach outlined in Blundell and Stoker (1999) to an environment in which income risk is driven by yield risk in agricultural production.

[6] Use of historical rainfall information as an exogenous shock to agricultural production has a long history in the literature. Wolpin (1982) instruments income using information on historical regional rainfall in India and Paxson (1992) uses time-series information on regional rainfall to construct estimates of transitory income caused by rainfall shocks. Rosenzweig and Binswanger (1993) and Jacoby and Skoufias (1997) also use rainfall to proxy for risk and shock, respectively.

[7] The quadratic preferences model provides a solution in which households save in anticipation of negative shocks, but without any accommodation for risk (Campbell, 1987). Constant absolute risk aversion neglects the possibility that household expected wealth matters when considering responses to income risk.

Below, in Section 2, we first review the household panel data set and discuss the construction of variables important in our analyses. Next we discuss the characteristics of rainfall and the crop cycle in the villages of the panel dataset. In Section 3 we introduce a theoretical model based on Blundell and Stoker (1999), which we extend to consider risk of changes in household "full income," which includes yield risks faced in an agricultural environment. This model suggests that it is important to consider ways in which households update their assessments of consumption risk. Importantly, this updating may occur through changing estimates of the conditional variance of income, through updated household expectations of life-time wealth, and through current income realizations.

In the empirical analyses of Section 4, we first test whether the predicted conditional variance of rainfall innovations can be used as a proxy for conditional income variance and conclude that it does not matter whether we use unconditional or conditional variance of rainfall as a proxy for variance of full income. Our analyses still allows for updating of consumption exposure to income risk though changes in expected life-time wealth, changes in the value of grain yield, and changes in estimates of the household's full-income. We find that, during this period, 11 percent of saving for a household facing a median level of consumption risk can be attributed to precautionary motives. Further, we find that when households face an increase in scaled consumption risk equal to the average interquartile range, current period consumption is depressed by 6.3 to 8.2 percent when we use the 1986 -1991 panel, and by 8.0 to 9.1 percent when we use the 1995-2000 panel. In light of Banks, Blundell and Brugiavani's (2001) finding that a comparable change in consumption risk in British households would depress current period consumption by 0.6 percent, this result demonstrates the much stronger effect of precautionary motives in regions of the world where formal credit markets and other smoothing mechanisms are not well-developed.

2. Survey Data and Rainfall Variability in China

2.1 The RCRE Village and Household Surveys

The analyses of household consumption and saving decisions in the paper use village and household survey data provided by the Survey Department of the Research Center on the Rural Economy (RCRE) at the Ministry of Agriculture in Beijing. Annual village surveys from 44 villages of Shanxi, Jiangsu, Anhui and Henan provinces are used in conjunction with two panels of data from the same villages, spanning the periods 1986 to 1991 and 1995 to 2000, from roughly 3400 households per year.[8] Households are asked a range of questions regarding income from on-farm activities and household consumption, land use, asset ownership, savings, formal and informal access to and provision of credit, and transfers from both village members and friends and family outside the village. The household surveys are monitored by county agricultural research offices charged with collecting expenditure, income and labor allocation information on a monthly basis. A staff person from each office works with households to clear up inconsistencies in the survey.

In several of our empirical specifications we make use of village survey information to control for proximity to off-farm markets, local topographical

[8] RCRE has collected data from a panel of households from 1986 to 2002. Survey years are missing for 1992 and 1994, and we only have rainfall information through 1997.

characteristics, village irrigation infrastructure, and ownership structure of local enterprises. Location variables include distance to the nearest public road, and a dummy variable indicating whether the village is near a city. Indicator variables denoting village location on a plain or in mountainous or hilly areas provide information about local topography. Share of land in the village with irrigation allows us to control for the extent to which a village exposed to risk in dry seasons. We use share of village assets owned and controlled by private sector and share of gross revenue from collective and private enterprises, to control for the extent of village involvement in the local economy. Finally, share of gross revenue from non-agricultural activities and numbers of village laborers employed in local and distant labor markets may be used to control access to non-farm employment.

Household Consumption. Our measure of per capita consumption is the sum of current non-durable consumption and the calculated value of a stream of services from durable goods and housing. The first is non-durable consumption, and includes the value of household food consumption (both purchased and out of home-production), cooking fuel, clothing, education and health expenses, and sundry household items. In the calculation of both consumption and farm profits we must have estimated the value of grain produced and consumed by the household at market prices. RCREs survey values home production of grain at state quota prices, which were far below the market price for grain during the earlier panel. We followed the procedure outlined in Chen and Ravallion (1996) to adjust the values of both farm profits and household consumption so that nonmarketed grain, whether consumed or stored by the household, is valued at market prices.[9]

The second measure of consumption includes all current non-durable consumption, plus the consumption stream of services from durable goods and housing. In order to convert the stock of durables into a consumption flow, we assume that current and past investments in housing are consumed over a twenty-year period, and that investments in durable goods are consumed over a seven-year period.[10]

Household "Full Income." Our analyses use the estimated "full income" of the household in order to have a measure of income earning potential that is not biased by endogenous labor supply decisions. Full income is calculated as farm profits less the cost of all inputs including an estimate of household labor input, plus the annual value of household labor in the off-farm labor market.[11] Since we lack individual data, but know numbers of adult laborers with different levels of education, we predict local wage rates for households based on their education profiles. To calculate this value for a household,

---

[9] In their surveys RCRE has followed the definitions of the National Statistical Bureau (NSB) throughout the 1980s and 1990s (and in many areas they have hired the same county agricultural research officers charged with administering the NSB rural household survey). The NSB and RCRE data for the 1980s valued self-supplied consumption and the revenue from these activities at prices that are well below market-clearing levels. In 1992 (and in some areas beginning with the calendar year 1990), the NSB began using a new set of "imputed" prices that were significantly higher than the old set. However, the average imputed price for households' own consumption remained well below the market price, and, in fact, was only roughly equal to the quota price. By the late 1990s the market price did not difference much from the quota price. For this reason, measurement error in valuation of farm profits and consumption is still likely to be more of a problem in the early panel than during the later panel.

[10] Consumer durables, housing and production assets held by the household at the beginning of the year are reported in there original value, and only assets purchased during the current year are valued at current prices. In an attempt to correct for both likely depreciation, due to wear and tear, and appreciation, due to inflation, we assume that durable goods and housing were accumulated in an even stream between 1978, an early date used for the beginning of reform, and 1986 (or whenever the household entered the panel). We assume straight line depreciation of housing and durable goods over a 20 and 7 year periods, respectively, to depreciate the used portion of housing and durables, and then allow the remaining value to appreciate using a rural durable goods price index. Additional purchases of assets, additions to houses and purchases of durables are valued at current prices and can be measured more accurately.

[11] Our calculation follows in spirit the calculation used by Rosenzweig (1988b) and Jacoby and Skoufias (1997), but with adjustments due to the characteristics of the RCRE dataset. Farm profits are household revenue minus costs which include household labor.

we first exclude a household from the village, and then, using all other households in the village, we regress earnings divided by labor days in the off-farm labor market on share of household members in each of three education categories (elementary, lower middle school, upper middle school), adult sex ratio, share with a special skill, and year dummies to control for macroeconomic fluctuations. The coefficients from this regression are then used to predict the off-farm wage of the excluded household. This predicted off-farm wage is then used to value family labor time.[12]

Household Managed Land. Area of land managed by the household and number of household managed plots are the two measures of land available for the early years of the RCRE survey. From 1986-1991, households typically held long-term leases to land and were proscribed from trading or selling land use rights. During the 1990s, rental markets and informal exchange of land among related households started to appear as leases were officially extended from 15 to 30 years, but in these four provinces less than five percent of arable land was rented out by 2000. For this reason, we do not believe that year-to-year changes in household land area will be correlated with shocks experienced by the village or household.[13]

2.2 Historical Monthly Rainfalls and Rainfall Variability in China

[12] Estimates of full income may also be sensitive to estimates of available household labor time. We use the village average labor days per capita in each village and year as a local measure of each adult laborers annual labor time. We also make alternative assumptions of 250, 275, 300 and 325 labor days per year. Results of our analyses are robust to choice of this parameter.

[13] While it is well known in rural China (Benjamin and Brandt, 2002; Jacoby, Li and Rozelle, 2002) and specifically in the RCRE villages (Giles, 2002), that village leaders have engaged in land reallocations before the expiration of lease contracts, there were few adjustments before the 1990s and most later adjustments can be attributed to changing demographic characteristics of households within villages (Burgess, 2001).

In addition to the RCRE survey data, enumerators working with the authors collected twenty years of monthly rainfall data (January 1978 – December 1997) from county weather stations near each village. These historical rainfall data show considerable variation across the four contiguous provinces and even across counties within provinces (summary tables and figures of village rainfall characteristics are provided in Appendix A). We next provide more information about rainfall in China and discuss ways of using moments of its distribution in our analyses.

Rainfall Variability in China

Most annual precipitation in China comes during a summer rainy season, but the timing of this season in each location is not fixed. The duration of the rainy season varies from year to year, and hence variations in annual and seasonal rainfall can be quite large. High concentrations of torrential rainfall may not only cause insufficient utilization of rainwater during the rest of the year, but also result in soil erosion, floods, and water logging.

In North China (including Henan and Shanxi provinces), where annual precipitation is lower, torrential rains make up a considerable fraction of annual rainfall, and in some years, a few storms during the summer may amount to 80 percent of total annual precipitation. While annual rainfall is lower than southern and eastern coastal areas, floods, serious soil erosion, and water logging are frequent occurrences in North China. Precipitation from summer rainstorms, however, cannot be efficiently utilized in agriculture unless it falls in areas equipped with water conservation facilities. A considerable proportion of the annual rainfall is, therefore, not necessarily beneficial for agricultural production in China's semi-arid and semi-humid regions. Furthermore, scant precipitation in winter often develops into drought conditions. China's long history of drought and flood is related, in part, to a non-uniform seasonal distribution of the rainfall.

Rainfall and the Crop Cycle in the Survey Provinces

Our empirical test uses variability of rainfall as a proxy for yield risk and requires that we first determine which months of rainfall will be most important for agricultural producers. Since we have monthly precipitation for each village, alternative specifications will employ total precipitation during important months, as well as annual precipitation.[14]

The four provinces where our survey villages are located produce 41 percent of the wheat in China (Henan 20.4 percent, Jiangsu 9.9 percent, Anhui 7.9 percent and Shanxi 3.1 percent). Most wheat is grown in eastern China, and just 5 provinces (Henan, Anhui, Jiangsu, Hebei, Shandong) account for more than 70 percent of China's total wheat output, and winter wheat accounts for 90 percent of China's total wheat crop. Table A1, provided in Appendix A, shows that wheat is grown throughout the four provinces. While rice is major crop in southern Jiangsu and Anhui provinces, wheat is also one of the crops used in the two-crop-per-year and three-crop-per-year rotations for rice paddy. For the 1986-1991 period we do not have detailed information on crops cultivated by households, but we are comfortable with the assumption that wheat was a major crop in these areas.[15]

---

[14] We also performed our analyses using annual rainfall precipitation (January-December), but this did not affect our results much.
[15] The fact that these are the major grain crops in these regions is confirmed by examination of more detailed information in 1995-2000 surveys.

Winter wheat typically comes out of dormancy in March, at which time moisture requirements increase significantly.[16] Rainfall and supplemental irrigation are most important in the spring when most of the crop is in a drought-sensitive heading/flowering stage. Spring droughts are one of the more serious threats for the crop. Further, summer rainfall proves to be important for the following spring's crop development because rainfall during this season determines soil moisture, which is important during wheat planting in the following winter. For rice crops, the moisture and temperature sensitive heading stages occur in July and September.

From the crop cycle we infer that rainfall in March, July, and September will be important for crop (wheat/rice) cultivation, though this will depend somewhat on differences across varieties. We also performed regressions of household grain production on each month of rainfall to gauge the importance of the specific months of rainfall. These regression results confirm that more rain in March, July and September is in fact beneficial for grain production in the surveyed villages. We also find that when we add rainfall from July to November of the previous year to the regression, reflecting wheat crop cycle, spring rainfall becomes relatively less significant (particularly in Shanxi, Henan provinces) and more rain during this period of the previous year is also helpful for the current year's production. This is not surprising as precipitation during the latter half of the previous year is important for determining the moisture level during the winter period and affects the likelihood of a spring drought.[17] In consideration of the wheat and rice crop calendars, our analyses use the sum of rainfall for the months July-

---

[16] See the crop calendar in the Appendix A.

[17] Dr. Scott Swinton in the department of agricultural economics provides valuable suggestions on the crop cultivation and rainfall.

November as rainfall in these months is most closely related to crop production and yield risk.

3. Theory

The consumption growth equation behind our empirical model can be derived from a standard Euler equation for optimal consumption allocation across periods t and t+1:

$$(1) \qquad u_C(C_t) = \beta(1+r)E\{u_C(C_{t+1}) \mid \Omega_t\}$$

where u_C is the marginal utility of consumption, r is the real interest rate, and β is a discount factor less than unity.

We assume a constant relative risk aversion (CRRA) iso-elastic utility function:

$$(2) \qquad u(C) = \frac{1}{1-\lambda} C^{1-\lambda}$$

where λ is the coefficient of relative risk aversion and independent of lifetime wealth levels. From this we can derive the specific Euler equation associated with utility maximization:

$$(3) \qquad \beta(1+r)\left\{\frac{C_{t+1}}{C_t}\right\}^{-\lambda} = 1 + e_{t+1} \text{ where } E(e_{t+1} \mid \Omega_t) = 0$$

Taking logs and using a Taylor approximation for logs yields a linearized Euler equation:

$$(4) \qquad \Delta \ln C_{t+1} = \frac{1}{\lambda}\ln\beta + \frac{1}{\lambda}\ln(1+r) + \frac{1}{2}\frac{1}{\lambda}\sigma_{t+1}^2 + u_{t+1}$$

where $u_{t+1} = -\frac{1}{\lambda}\{e_{t+1} - \frac{1}{2}(e_{t+1}^2 - \sigma_{t+1}^2)\}$ so that $E(u_{t+1} \mid \Omega_t) = 0$

The conditional consumption shock variance, σ_{t+1}^2, is the variance of e_{t+1} conditional on information available at time t. From this we can separately identify three determinants of consumer behavior: an intertemporal substitution effect, a precautionary saving effect, and a life cycle effect reflected in the consumption path. The precautionary saving motive, captured in the third term of (4), predicts that increases in the expected variance of future consumption shocks will lead to higher observed consumption growth as households save more in period t.

Blundell and Stoker (1999) point out that the variance term in the equation (4) should not be replaced by the conditional variance of income because variance of the consumption shock subsequent to unexpected income changes depends on the amount of financial wealth held by a household and on the magnitude of current income relative to expected future income. Starting from their insight, we derive a modified version of Blundell and Stoker's model that explicitly introduces yield risk from agricultural production.

Since their insight is used in empirical study of precautionary saving by Banks, Blundell and Brugiavini (2001) we follow their derived specification with CRRA preference:

(5) $$\Delta \ln C_{t+1} = \frac{1}{\lambda} \ln \beta + \frac{1}{\lambda} \ln(1+r) + k m_{t+1} + u_{t+1},$$

where $m_{t+1} = \pi_{t+1} \sigma_{t+1}^2$ [18]

[18] Their specification is based on the below derived relation between consumption growth and risk with CRRA preference. $\Delta \ln C_{t+1} \approx k \pi_{t+1} \sigma_{t+1}^2 + u_{t+1}$, where the scaling term $\pi_{t+1} = Y_t^2 / (c\bar{W})^2$. See Banks et al. (2001) for further details.

Notice that the variance of income innovations conditional on the previous period t should be also scaled by the expected wealth in (5) following the insight of Blundell and Stoker (1999).[19]

An empirical question arises at this point. How should we estimate the conditional variance of income innovation or yield shocks? Banks, Blundell, and Brugiavini (2001) estimate the conditional variance of income innovations using an ARCH regression and exploiting synthetic panel data. Since we have a long time-series of rainfall data for each village, we use a similar approach to predict the conditional variance of rainfall and use this as a proxy for yield risk. We first test whether rainfall shocks show heteroskedasticity in most villages of the survey. If we cannot reject heteroskedasticity, then we could apply the GARCH model to predict values of conditional rainfall variance. Alternatively, if we reject heteroskedasticity of rainfall shocks, then predicting the conditional rainfall variance with a GARCH model will not yield any improvements over the unconditional rainfall variance.

In our empirical discussion below, we first review our tests of the plausibility of estimating conditional rainfall variances using GARCH, and determine that we should use unconditional rainfall variance. Next we discuss the empirical consumption growth model used to test for presence of a precautionary savings motive, and finally we review results of various specifications of model.

4. Empirical Strategy and Results

4.1 Do We Observe GARCH Effects in Village Rainfall Time Series?

[19] We also derive a modified version of Blundell and Stoker's model that explicitly introduces yield risk from agricultural production. See Appendix B for further details.

Since theory suggests using a proxy for the conditional variance of income, we first test the possibility of using a GARCH model to estimate the conditional variance of rainfall in each year. We thus perform autocorrelation, trend and heteroskedasticity tests with respect to rainfall data of 44 villages. The autocorrelation test confirms that neither annual (12-month) nor the July-November rainfall series show significant autocorrelation. Further, we confirm that there is no time trend to either rainfall series in each of the 44 villages. Finally and most important for using the GARCH model, we show that rainfall in most villages is not heteroskedastic, thus implying that variance of rainfall might not vary across the periods.[20] Even when performing GARCH estimation for each village, these tests are confirmed. Rainfall shocks are not persistent and tend to die out rather fast, meaning that forecasted rainfall variance converges and would not vary much over our sample period.[21] Predictions of conditional variance would not provide additional information across time for identifying a precautionary motive in the consumption growth equation, and thus we use the unconditional rainfall variance of rainfall for each village as our proxy for yield risk.[22]

Changes in consumption exposure to income risk are captured exclusively by a scaling term that controls for exposure to rainfall variation. Since the numerator of the scaling term is the value of household full income in period t, it also contains information about expectations of future grain yield and a possible source of information about changes in expected future income. Factors other than rainfall (e.g., expectations about

---

[20] We can reject the null of homoskedasticity at the 10 percent level in only 9 of 44 villages. See Appendix C.

[21] These results are summarized in Figure C1 of Appendix C.

[22] We calculate the sample variance of rainfall for each village, j, as

$$\sigma_j^2 = \left(\frac{1}{T-1} \sum_{t=1}^{T} (R - \bar{R})^2 \right)_j .$$

future prices, or changes in quota policy) are likely to have a more persistent effect on both future grain yields and future off-farm activities, and they are likely to be captured by this term.

4.2 Empirical Specification

The base specification for consumption growth is derived from our previous model and similar to those derived from the standard Euler equation models (Banks, Blundell and Burgavani (2001), Ludvigson and Paxson (2001), Chaudhuri (1999), Browning and Lusardi (1996)):

(6) $$\Delta \ln C_{it+1} = \alpha + \gamma Z_{it} + \phi m_{it+1} + \delta RS_{it} + \lambda' V_{it} + \pi D_{it} + u_{it+1}$$

where $\Delta \ln C_{it+1}$: Growth in non-durable consumption from period t to t+1.

Z_t : Area of land managed by the household

m_{it+1} : Scaled unconditional variance of rainfall ($= \pi_{it}\sigma_j^2$ where $\pi_{it} = \left(\frac{\tilde{Y}_{it}}{C_{it}}\right)^2$ & $\tilde{Y}_{it}$ is full income in period t.[23]

RS_{it} : Rainfall shock ($= | R_{it} - \bar{R}_i |$)

V_{it} : Vector of village variables such as village population, location, industry structure.

D_{it} : Province-year interaction dummies.

---

[23] In our empirical implementation we replace the expected wealth term (W) in the scaling factor by consumption in period t as in Banks, Blundell and Brugiavini (2001). Since this most likely introduces measurement error problems in estimation, particularly as a result of the measurement of home produced-home consumed goods, we will employ IV methods to control for measurement error. Use of wealth might be problematic because it is quite noisy and poorly measured. When we perform a kernel density estimation, we can find that the distribution of wealth is skewed and kurtotic.

The coefficient on scaled rainfall variance, ϕ, in (6) will be the focus of our estimation efforts, as a positive value indicates that household consumption is lower (and saving higher) in period t when households expect that future yield shocks will have a greater potential impact on the variability of consumption. Much effort in presenting alternative specifications will center on demonstrating the robustness of this coefficient to different potential sources of bias.

Other coefficients, however, are also of potential interest. Our model predicts that households will update their expectations of earnings after realization of a period t rainfall shock, and that the impact of this shock on local agriculture will depend on levels of moisture in the soil and the previous year's rainfall shock. The rainfall shock term is specified as the absolute value of the difference between rainfall in period t and the sample mean of rainfall across the period since we expect that both positive shocks (e.g. flood) and negative shocks (e.g. drought) will have unfavorable impact on the agricultural production and consumption.

In the first set of specifications, we estimate (6) without separately distinguishing heavy rainfall or drought conditions and we observe significant positive signs on the rainfall shock term (Table 2). In our first extension to the base specification, we interact the scaled rainfall variance term with the share of land that is irrigated in each village, and with dummy variables for provinces other than Shanxi. Since yield risk varies regionally, and depends on soil type, climate, and the use of irrigation, we would expect that rainfall variability will be more important for consumption and saving decisions in dry regions and where less of the land is irrigated. Thus we will expect that the interaction between share of village land with irrigation and the scaled rainfall variance term to carry a negative sign. When looking province by province, we also note from Appendix A that rainfall variability appears to be more pronounced in Shanxi than in most villages of other provinces. Given that Shanxi and Henan are more arid than Jiangsu or Anhui, we also expect to find that rainfall variance has a greater impact on savings and consumption decisions in these provinces.

We next explicitly introduce additional village level variables to control for omitted village specific factors that may be correlated with consumption risk related to yield variability. These variables include village population, the dummy indicating whether the village is in a mountainous or hilly area, a dummy variable for proximity to an urban area, share of irrigated land in the village, distance to the nearest public road, share of village assets owned and controlled by private sector in the village, cadre share of village population, total land area in a village, share of gross revenue from livestock production, share of gross revenue from non-agricultural activities, and share of gross revenue from collective and private enterprises.

Finally we introduce specifications that control for access to local and migrant employment opportunities. Under the assumption that off-farm employment can be used as an alternative means for smoothing yield shocks, we assume that the precautionary motive for saving may be mitigated if households expect that they might be able to find or expand off-farm employment subsequent to experiencing a serious yield shock. [24]

[24] These "measures of access to off-farm markets" are constructed as shares of the village with off-farm employment in either local or migrant labor markets in period t-1. These measures may be endogenous with expected growth of the local economy, and this fact is not considered when we introduce these terms. In addition, our rainfall shock term is specified as the difference in rainfall between period t and t-1. It is quite plausible that off-farm labor market participation in period t-1 is related to last years shock and our rainfall shock term. It might be better to use interactions of the scaled rainfall variance and the dummy variable for proximity to a city, or distance between the village and a major metropolitan area (e.g., the provincial capital, Beijing or Shanghai). Other village level variables may also suffer similar endogeneity problems.

We have not explicitly included household demographic information because the structure of the household may itself be determined by consumption smoothing considerations (Rosenzweig, 1988a; and Rosenzweig and Stark, 1989).[25] Measures of human capital, which could be constructed at the level of the household from information about numbers of individuals with different amounts of education, would also re-introduce demographic structure and potential biases in our statistical test. While not considered in this paper, it may be of use to consider specifications in which these variables are included and treated as predetermined but not strictly exogenous regressors.

4.3 Results and Robustness Checks

Table 2 summarizes results for different flavors of the base specification. Coefficients on the scaled rainfall variance term appear to provide strong evidence of precautionary behavior in the farm household's consumption decision. As exposure to weather risk increases, households depress current consumption in favor of future consumption. The sign on the irrigation interaction term is in the direction that we would expect, though not significant in some specifications[26] Interactions between scaled rainfall variance and dummy variables for Anhui, Jiangsu, and Henan provinces carry negative coefficients, suggesting that precautionary motives are stronger in Shanxi province. Given that Shanxi is more arid but also experiences greater rainfall variability, this result is consistent with our expectations.

---

[25] Kin based inter-household income transfers, 'exogamous' marriage migration and inter-household contractual arrangements are manifestations of income smoothing in an environment of spatially covariant risks.

[26] A large number of reservoirs and water diversion structures have been built and many tube wells have been installed, in order to supply water for the irrigation and flood control depends on the land drainage system or water pumping station in China. Refer to Xu and Peel (1991).

Robustness Checks

The regression models shown in Table 2 suffer from three potential problems. First, the village variables used are likely to be endogenous and may be biasing the coefficients on scaled rainfall variance terms. Second, use of household land and a household specific scaling term introduces the possibility that our results are biased by some source of unobserved heterogeneity. Third, the presence of period *t* consumption in the scaling term makes it more likely that errors in the measurement of this term will be correlated with errors in the measurement of the dependent variable.

Our approach to the first problem is to drop all village variables and estimate the model:

$$\Delta \ln C_{it+1} = \alpha + \gamma Z_{it} + \phi m_{it} + \lambda' V_{it} + u_{it+1} \tag{7}$$

where V_{it} are now a vector of village time dummies. This specification will controls for aggregate shocks to villages and all fixed village effects. Due to gaps in the time series we perform analyses separately on early and late six-year panels. Columns (1) in Table 3 show results of this regression and we observe coefficients on scaled rainfall variance similar to those in our base regressions.

Next, in order to control for possibility that measurement error of the scaling term may be correlated with the dependent variable, we estimate versions of growth model in (7) in which the scaling term is first instrumented with the period t-1 and t-2 values of the scaled term. To implement this we use Wooldridge's approach to first predicting $\hat{\pi}_{it}$ from the regression:

$$\pi_{it} = c + \beta_1 \pi_{it-1} + \beta_2 \pi_{it-2} + e_{it}$$

and then use $\hat{m}_{it} = \hat{\pi}_{it}\sigma_j^2$ as the instrumental variable in the IV estimation.[27] Columns (2) in Table 3 show results that are significant and carry a positive sign associated with a precautionary motive.

Unobserved differences in household discount factors due to unobserved life-cycle effects may introduce a source of unobserved heterogeneity that biases the coefficient on risk, and so we implement a first-differenced growth model:

$$\Delta\Delta \ln C_{it+1} = c + \gamma\Delta Z_{it} + \phi\Delta m_{it} + \lambda' V_{it} + \Delta u_{it+1}$$

and show results in columns (3). The first differenced scaled rainfall variance term picks up changes in risk associated with changes in the inverse of expected lifetime wealth, and suggests that once we control for individual heterogeneity, households appear more sensitive to risk.

Finally, we also control for measurement error biases as well using a first-differenced instrumental variables estimation. As in the IV level specification, the change in scaled unconditional rainfall variance is instrumented by first predicting $\Delta\hat{\pi}_{it}$ from

$$\Delta\pi_{it} = c + \gamma_1\pi_{it-1} + \gamma_2\pi_{it-2} + e_{it}$$

where

$$\Delta\pi_{it} = \left(\frac{Y_{it}}{C_{it}}\right)^2 - \left(\frac{Y_{it-1}}{C_{it-1}}\right)^2$$

and then using $\Delta\hat{m}_{it} = \Delta\hat{\pi}_{it}\sigma_j^2$ as the instrumental variable in FDIV estimation.[28]

[27] See Wooldridge (2001) and Wooldridge (2002) for discussion.

[28] Anderson and Hsiao (1982) first suggested that instruments of this type will be valid if m_{t-1} is correlated with Δm_t but not the error term.

Results from the FDIV estimation are shown in columns (4) of Table 3. Again, we see that households respond to changes in relative consumption risk by reducing current growth in their consumption.

One may at first be puzzled as to why coefficients of interest are significant, but differ dramatically between the early and late panels shown in Table 3. First, recall that the scaling term is $(y_{it} / c_{it})^2$. The downward trend in grain prices during the 1990s implies that the value of stored grain will be much lower in later periods, and that the scaling term will trend downwards. Further, over the 1990s households have invested considerably in housing, and given the 20 year amortization of new housing expenses, we expect the denominator of the scaling term to be increasing.

In order to interpret coefficients on the scaled rainfall variance term we predict the effect of scaled rainfall variance on consumption growth in Table 4 for different values of the scaled rainfall variance term. Overall, we see consistent evidence of precautionary saving over both the early and late periods. We find that, during this period, roughly 11 percent of saving for a household facing a median level of consumption risk can be attributed to precautionary motives.[29] Further, when households face an increase in scaled consumption risk equal to the average interquartile range, current period consumption is depressed by 6.3 to 8.2 percent in 1986 – 1991 and by 8.0 to 9.1 percent in 1995 -2000. In light of Banks, Blundell and Brugiavini's (2001) finding that a comparable change in consumption risk in British households would depress current period consumption by 0.6 percent, this result demonstrates the much stronger

[29] This calculation is based on strong restricted assumptions on the household's precautionary savings.

effect of precautionary motives in regions of the world where formal credit markets and other smoothing mechanisms are not well-developed.

While the identified precautionary motive appears stronger in rural China, as one might expect, one might still ask whether the magnitudes involved are economically meaningful. Estimated precautionary saving for a household facing median consumption risk during the 1995-2000 period was 19 Yuan RMB (in 1986 Yuan), and the 75th percentile of consumption risk, this value rose to 38.3 Yuan RMB (in 1986 Yuan).[30] On the face of it these magnitudes do not seem that large, yet we may place them in context by comparing them to average household expenses per capita on education and health care, which we also show in Table 4. Reducing current consumption by 4 percent at median levels of consumption risk leads to precautionary saving equal to nearly half the education-related expenditure of households spending resources on education during the 1995 to 2000 period, and for households above the 75 percentile of consumption risk precautionary saving per capita is equal to or greater than average education related expenses. Further, health care expenses, typically the cost of vaccines and medicines for households not facing a major crisis, are on average below the level of precautionary saving for households facing median levels of consumption risk. While we by no means make any claim that these expenditures are necessarily reduced in light of consumption risk, this simple comparison of magnitudes suggests that precautionary motives for reducing current expenditures may have real long term impact in some areas of rural China.

4.4 Potential Problems with Our Approach

[30]At 1986 exchange rates, this would be roughly $5 and $10, respectively.

Our model fails to consider some of the constraints faced by rural households in the developing world. By introducing yield risk in our model, we add one aspect of agricultural production, but other than this the model motivating our test is based on an exogenous income process and not endogenous agricultural income. Such standard intertemporal consumption models with exogenous income and credit constraints, though dynamic and perhaps suitable for the case where wage labor is the primary source of income, may not be relevant for analyzing rural households where income from farm production contributes significantly to total household income—although off-farm income is important source of household in contemporary China. As a next step, we will add risk to a dynamic model that explicitly considers these features in the spirit of dynamic household models presented in Behrman, Foster, and Rosenzweig (1997) and Saha (1994).[31]

How would a dynamic model help to inform our empirical analysis? And what would be the implications for our current empirical strategy? Chaudhuri (1999) suggests that the income process may be conditionally heteroskedastic when we introduce yield or price risk in an agricultural household production model, but that this added complication will not pose serious problems because even with a conditionally heteroskedastic income process, we would expect households to have the same behavioral response to risk. Still, we believe that our analyses would be stronger with formal derivation of a model incorporating both production and consumption behavior under uncertainty.

Finally, although off-farm earnings are a major source of income for many farmers in China, and may be used to stabilize farm household income, our model does

[31] Saha (1994) analyses a two-season agricultural household model of output and price uncertainty. Roe and Graham-Tomasi (1986) also introduce the risk into their dynamic household model. Chaudhuri (1999) exploit the inter-seasonal dimensions of household decisions to analyze the precautionary saving behavior.

not explicitly include this possibility. Risk mitigation arrangements such as off-farm labor supply and on-farm storage based on inter-seasonal framework could be appropriately analyzed by introducing price and yield uncertainty in the agricultural household's optimization problem (Saha, 1994; Rose, 2001).

5. Conclusion

Traditionally farming is a risky occupation in that the consequences of decisions or events are often not known with certainty until long after they occur. While there are many sources of risk in agriculture, ranging from price and yield risk to the personal risks associated with injury or poor health, our analysis focuses on farm household precautionary response to identifiable yield risk related to rainfall variance. While other forms of risk may indeed have a more important influence on farm household decisions, we use rainfall variance because it makes an ideal exogenous proxy for yield risk. One might argue that using conditional heteroskedasticity in income processes for identification of precautionary motives is appealing in that it allows us to control for risk associated with all income earning activities, but due to a lack of long panels of data, most analyses of the effects of income risk using this approach will be biased and/or suffer serious endogeneity problems. In rural agricultural environments, a relatively long time series of rainfall data can be an adequate proxy for yield risk. Since historical rainfall data is much less time-consuming to acquire, use of rainfall data is much less costly than execution of long panel household surveys with the explicit aim of studying precautionary behavior.

Given that we find evidence of economically significant evidence of precautionary behavior in household consumption decisions using rainfall as a proxy for risk, a risk that China's farmers are arguable better equipped to cope with than price risk or labor market risk, we take this as significant support for the existence of a precautionary motive in household consumption decisions in rural China. Precautionary behavior may have long term costs. Households with a strong precautionary motive may reduce education-related expenses for children or important preventive healthcare expenditures on vaccines. Further, given the growing inequality that we witness within and across regions in rural China, existence of a precautionary motive among households with lower permanent wealth may be part of the explanation for a rise in inequality if less affluent households more exposed to risk systematically depress consumption and spending for precautionary reasons rather making the relatively low investments necessary to diversify into such lucrative activities as raising livestock. Finally, our model suggests an important way in which a precautionary motive might interact with negative shocks to permanent wealth to produce persistently lower levels of consumption in future periods. A negative shock to permanent wealth will lead to a rise in the relative consumption risk faced by a household, which will then lead to a stronger precautionary motive.

Table 1. Descriptive Statistics

1. 1986 – 1991

Variables	1986	1987	1988	1989	1990	1991
Consumption per capita (yuan)	376.7	384.3	417.9	373.7	399.7	392.4
	(321.8)	(318.5)	(397.8)	(313.4)	(369.8)	(399.4)
Non-durable good consumption per capita (yuan)	277.8	284.5	290.9	284.3	297.9	292.1
	(134.8)	(134.1)	(150.4)	(141.2)	(157.1)	(157.1)
Full income per capita (yuan)	510.0	563.3	550.8	505.4	535.5	530.6
	(264.9)	(303.5)	(301.2)	(245.0)	(258.6)	(317.5)
Area of land per capita	0.07	0.07	0.07	0.07	0.06	0.06
	(0.05)	(0.06)	(0.05)	(0.05)	(0.05)	(0.05)
Village population	1662.1	1524.8	1545.6	1558.0	1603.6	1629.7
	(912.2)	(847.5)	(851.1)	(875.5)	(897.3)	(924.6)
1 if in mountains	0.23	0.24	0.23	0.24	0.23	0.23
	(0.41)	(0.42)	(0.42)	(0.42)	(0.42)	(0.42)
1 if in hills	0.30	0.31	0.33	0.28	0.32	0.30
	(0.46)	(0.46)	(0.47)	(0.45)	(0.46)	(0.46)
1 if in near city	0.11	0.10	0.10	0.12	0.10	0.10
	(0.31)	(0.30)	(0.30)	(0.32)	(0.30)	(0.30)
Distance to nearest public roads (Km)	2.36	2.71	2.68	2.72	2.68	2.68
	(3.41)	(3.63)	(3.61)	(3.64)	(3.61)	(3.60)
Irrigated share of land in village	0.42	0.49	0.48	0.48	0.50	0.51
	(0.34)	(0.39)	(0.39)	(0.39)	(0.39)	(0.38)
Share of assets in village owned or controlled	0.75	0.76	0.78	0.79	0.77	0.78
by private sector in village	(0.26)	(0.23)	(0.24)	(0.23)	(0.22)	(0.23)
Cadre share of village population	0.006	0.006	0.007	0.006	0.007	0.006
	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)
Village share of gross revenue from livestock	0.14	0.15	0.16	0.18	0.18	0.17
	(0.09)	(0.10)	(0.11)	(0.12)	(0.13)	(0.14)
Village share of gross revenue from non-agricultural act.	0.36	0.35	0.35	0.34	0.34	0.35
	(0.29)	(0.26)	(0.27)	(0.27)	(0.27)	(0.28)

Table 1 (cont'd).

Rainfall (July - November)	349	502	409	491	402	454
	(129)	(294)	(83)	(219)	(146)	(292)
Variance of rainfall (July - November, *1000000)	0.030	0.030	0.030	0.030	0.030	0.030
	(0.027)	(0.027)	(0.027)	(0.027)	(0.027)	(0.027)
Scaled variance of rainfall (*1000000)	0.083	0.118	0.114	0.102	0.101	0.106
	(0.136)	(0.213)	(0.208)	(0.165)	(0.168)	(0.333)

Notes: 1. Standard deviations in parentheses.
2. Scaled variance of rainfall =(full income/consumption)*rainfall variance

2. 1995 – 2000

Variables	1995	1996	1997	1998	1999	2000
Total expenditure per capita (yuan)	551.4	532.4	523.8	514.3	526.0	530.6
	(285.5)	(290.3)	(275.3)	(284.5)	(302.7)	(314.7)
Non-durable good expenditure per capita (yuan)	458.8	436.6	425.0	420.8	423.8	427.6
	(234.7)	(236.0)	(219.6)	(234.5)	(247.6)	(256.6)
Full income per capita (yuan)	394.1	413.4	442.8	410.5	417.3	431.9
	(221.6)	(232.1)	(243.8)	(236.0)	(268.0)	(271.9)
The area of land (mu)	0.05	0.05	0.05	0.05	0.05	0.05
	(0.04)	(0.04)	(0.04)	(0.04)	(0.04)	(0.04)
Village population	1583.0	1587.3	1586.8	1597.6	1543.2	1550.0
	(916.5)	(929.8)	(930.8)	(954.9)	(899.6)	(908.0)
1 if a village is located in mountains	0.24	0.24	0.23	0.24	0.23	0.23
	(0.43)	(0.43)	(0.42)	(0.43)	(0.42)	(0.42)
1 if a village is located in hills	0.33	0.33	0.35	0.34	0.34	0.34
	(0.47)	(0.47)	(0.48)	(0.47)	(0.47)	(0.47)
1 if a village is located in near city	0.11	0.11	0.13	0.14	0.17	0.13
	(0.31)	(0.32)	(0.33)	(0.34)	(0.38)	(0.33)
Average distance to nearest public road (Km)	3.15	2.57	2.73	2.82	2.54	2.65
	(5.26)	(3.40)	(5.06)	(5.29)	(4.24)	(4.26)
Village cadre share of population	0.007	0.007	0.006	0.006	0.006	0.006
	(0.005)	(0.004)	(0.004)	(0.003)	(0.004)	(0.004)

Table 1 (cont'd).

Total land area of village	4845.2	4899.6	4842.4	4876.1	4561.0	4600.8
	(5268.6)	(5280.7)	(5274.2)	(5449.2)	(4984.4)	(5017.1)
Scaled rainfall variance (*1000000)	0.020	0.027	0.030	0.027	0.028	0.031
	(0.033)	(0.043)	(0.052)	(0.044)	(0.044)	(0.053)

Notes: 1. Standard deviations in parentheses.
2. Scaled variance of rainfall =(full income/consumption)*rainfall variance
3. Some village variables are not available in the later survey.

Table 2. Summary of Estimation Results Using Village Variables

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Scaled Rainfall Variance	0.313	0.664	0.313	0.667	0.329	0.560	0.743	1.489
	(0.036)**	(0.065)**	(0.037)**	(0.066)**	(0.073)**	(0.110)**	(0.119)**	(0.278)**
(Scaled Rainfall Variance)* (Irrigated Share of Land in Village)					-0.039	0.267	-0.033	0.238
					(0.131)	(0.225)	(0.122)	(0.203)
(Province=Jiangsu)*(Scaled Rainfall Variance)							-0.310	-0.320
							(0.187)	(0.427)
(Province=Anhui)*(Scaled Rainfall Variance)							-0.505	-1.068
							(0.128)**	(0.294)**
(Province=Henan)*(Scaled Rainfall Variance)							-0.436	-1.047
							(0.125)**	(0.291)**
Land	0.068	0.085	0.068	0.090	0.071	0.067	0.051	0.031
	(0.100)	(0.166)	(0.100)	(0.166)	(0.101)	(0.168)	(0.101)	(0.168)
ln(Village Population)	0.044	0.065	0.044	0.065	0.043	0.069	0.043	0.069
	(0.013)**	(0.021)**	(0.013)**	(0.021)**	(0.013)**	(0.022)**	(0.013)**	(0.021)**
1 if in mountains	-0.007	0.009	-0.007	0.013	-0.007	0.013	0.016	0.061
	(0.020)	(0.033)	(0.020)	(0.033)	(0.020)	(0.033)	(0.020)	(0.034)
1 if in hills	0.014	0.063	0.014	0.064	0.014	0.063	0.025	0.087
	(0.011)	(0.021)**	(0.011)	(0.021)**	(0.011)	(0.021)**	(0.011)*	(0.021)**
1 if in near city	0.117	0.130	0.118	0.125	0.118	0.123	0.134	0.159
	(0.019)**	(0.037)**	(0.019)**	(0.038)**	(0.019)**	(0.038)**	(0.020)**	(0.039)**

Table 2 (cont'd).

Distance to Nearest Public Road (Km)	0.001	-0.001	0.001	-0.001	0.001	-0.002	0.001	-0.002
	(0.002)	(0.002)	(0.002)	(0.003)	(0.002)	(0.003)	(0.002)	(0.003)
Irrigated Share of Land in Village	0.006	0.003	0.006	0.006	0.010	-0.019	0.022	0.010
	(0.019)	(0.032)	(0.019)	(0.032)	(0.023)	(0.038)	(0.022)	(0.038)
Share of Assets in Village Owned or	0.158	0.150	0.158	0.145	0.158	0.144	0.187	0.207
Controlled by Private Sector in Village	(0.030)**	(0.050)**	(0.030)**	(0.050)**	(0.030)**	(0.050)**	(0.031)**	(0.053)**
Cadre Share of Village Population	5.380	7.131	5.384	6.895	5.395	6.820	4.816	5.847
	(1.745)**	(2.699)**	(1.753)**	(2.701)*	(1.753)**	(2.701)*	(1.771)**	(2.719)*
Total Land Area of Village	3.320	5.483	3.317	5.749	3.381	5.312	2.600	3.572
	(1.127)**	(1.731)**	(1.147)**	(1.758)**	(1.178)**	(1.801)**	(1.177)*	(1.794)*
Access to Health Insurance (Yes=1) in Village	-0.015	-0.046	-0.015	-0.048	-0.015	-0.045	-0.009	-0.029
	(0.015)	(0.024)	(0.015)	(0.024)*	(0.016)	(0.024)	(0.016)	(0.024)
Share of Village with Local Employment	-0.875	-0.185	-0.876	-0.167	-0.870	-0.206	-0.454	0.717
of period t-1	(0.594)	(0.916)	(0.594)	(0.914)	(0.593)	(0.913)	(0.601)	(0.930)
Share of Village with Migrant Employment	1.212	-1.890	1.212	-1.920	1.239	-2.101	0.732	-3.140
of period t-1	(1.163)	(1.885)	(1.163)	(1.886)	(1.168)	(1.887)	(1.180)	(1.901)
Village Share of Gross Revenue from Livestock	-0.137	-0.312	-0.137	-0.305	-0.143	-0.264	-0.140	-0.272
	(0.072)	(0.112)**	(0.072)	(0.113)**	(0.074)	(0.117)*	(0.074)	(0.116)*
Village Share of Gross Revenue from	-0.079	-0.166	-0.079	-0.165	-0.078	-0.175	-0.081	-0.180

Table 2 (cont'd).

Non-Agricultural Activities	(0.045)	(0.072)*	(0.045)	(0.072)*	(0.046)	(0.072)*	(0.046)	(0.072)*
Village Share of Gross Revenue from Collective & Private Enterprises	0.092	0.078	0.092	0.077	0.090	0.087	0.063	0.029
	(0.043)*	(0.076)	(0.043)*	(0.076)	(0.044)*	(0.077)	(0.044)	(0.077)
Rainfall shock ($\lvert R_t - \bar{R} \rvert$)			0.107	7.473	0.266	8.553	1.779	-5.352
			(4.316)	(6.912)	(4.279)	(6.885)	(4.302)	(6.845)
Constant	-0.407	-0.557	-0.407	-0.547	-0.404	-0.676	-0.439	-0.686
	(0.104)**	(0.170)**	(0.104)**	(0.170)**	(0.105)**	(0.174)**	(0.106)**	(0.174)**
Observations	7875	7875	7875	7875	7875	7875	7875	7875
R-squared	0.05	0.06	0.05	0.06	0.05	0.07	0.06	0.07

Notes: 1. Dependent Variable: Consumption Growth from Period t to t+1, non-durable consumption per capita for (1),(3),(5),(7); total consumption per capita for (2),(4),(6), (8). 2. Results are based on the data from 1986 – 1991. 3. Robust standard errors in parentheses 4. * significant at 5%, ** significant at 1% 5. All specifications include province*year dummies to control for aggregate shocks to the provincial economy. Their coefficients are jointly significant.

Table 3. Summary of Estimation Results Using Village-Year Dummy Variables

	1986 -1991				1995 -2000			
Regressors	OLS	IV	FD	FDIV	OLS	IV	FD	FDIV
Scaled rainfall variance	0.45	0.15	1.54	0.91	1.31	0.92	5.63	3.00
	(0.06)**	(0.07)*	(0.15)**	(0.15)**	(0.10)**	(0.21)**	(0.30)**	(0.45)**
Land	0.25	-0.16	0.01	0.01	0.25	0.08	0.01	0.01
	(0.07)**	(0.10)	(0.004)*	(0.004)	(0.08)**	(0.12)	(0.004)	(0.005)*
Obs.	10,646	5,584	7,956	5,594	14,779	8,618	11,571	8,616
R squared	0.18		0.24		0.09		0.17	

Notes: 1. Robust standard errors in parentheses 2. * significant at 5%, ** significant at 1% 3. All specifications include village*year dummy variables to control for aggregate shocks to the village economy and coefficients on village*year dummy variables are jointly significant. 4. Instrumental variables in IV/ FDIV estimation are based on the t-1 and t-2 periods of the scaling term.

Table 4. The Predicted Effect of Precautionary Behavior in Saving

	(In 1986 RMB Yuan)	
	1986-1991	1995-2000
Per capita earned income of rural household (A)	460	637
Per capita expenditure of rural household (B)	338	461
Per capita saving (C=A-B)	122	176
The amount of predicted 'precautionary saving' based on the different scaled variance of rainfall		
75th percentile of scaled variance of rainfall (D)	0.08	0.08
Value of predicted 'precautionary saving' (E=D*B)	27.4	38.3
50th percentile scaled variance of rainfall (D)	0.04	0.04
Value of predicted 'precautionary saving' (E=D*B)	14.5	18.9
25th percentile of scaled variance of rainfall (D)	0.02	0.02
Value of predicted 'precautionary saving' (E=D*B)	7.8	9.2
Proportion of precautionary motive in saving (= predicted saving (E)/saving (C))		
At 75th percentile of variance of rainfall	0.22	0.22
At 50th percentile of variance of rainfall	0.12	0.11
At 25th percentile of variance of rainfall	0.06	0.05
Average education expenses per capita (for households with ed expense>0)	18.0	43.9
Average health care expense per capita	10.7	21.9

Notes: 1. The calculation is based on the estimates of FDIV method in Table 3.
2. The scaling term is defined as the squared value of (full income/consumption).
3. Consumption is total consumption.

Appendix A

Crop Production and Rainfall Variability

Table A1. Total Sown Areas of Farm Crops in 4 Provinces

(Units: 1000 hectares, %)

	Sown area of grain crops	Rice	Wheat	Corn
Shanxi	3128.1	6.1	951.2	822.8
Jiangsu	5994.4	2377.6	2341.4	439
Auhui	6030.6	2212.1	2137.6	512.2
Henan	8879.9	489.5	4927.3	1952.4
Shanxi	100.0	0.2	30.4	26.3
Jiangsu	100.0	39.7	39.1	7.3
Auhui	100.0	36.7	35.4	8.5
Henan	100.0	5.5	55.5	22.0

Source: *China Statistical Yearbook 1998.*

Table A2. Crop Calendar in China (Wheat/Rice)

January

- Wheat: Dormant

February

- Wheat: Dormant

March

- Early rice: Planting; Wheat: Vegetative

<u>April</u>

- Early & single rice: Planting; **Wheat: Heading***

<u>May</u>

- **Early rice: Heading***; Wheat: Filling

June

- Early rice: Maturing; Single rice: Vegetative; Wheat: Harvesting

<u>July</u>

- Early rice: Harvesting; **Single rice: Heading*;** Late rice: Planting

August

- Single rice: Maturing; Late rice: Vegetative

<u>September</u>

- Single rice: Harvesting; **Late rice: Heading***; Wheat: Planting

October

- Single rice: Harvesting; Late rice: Maturing; Wheat: Planting

November

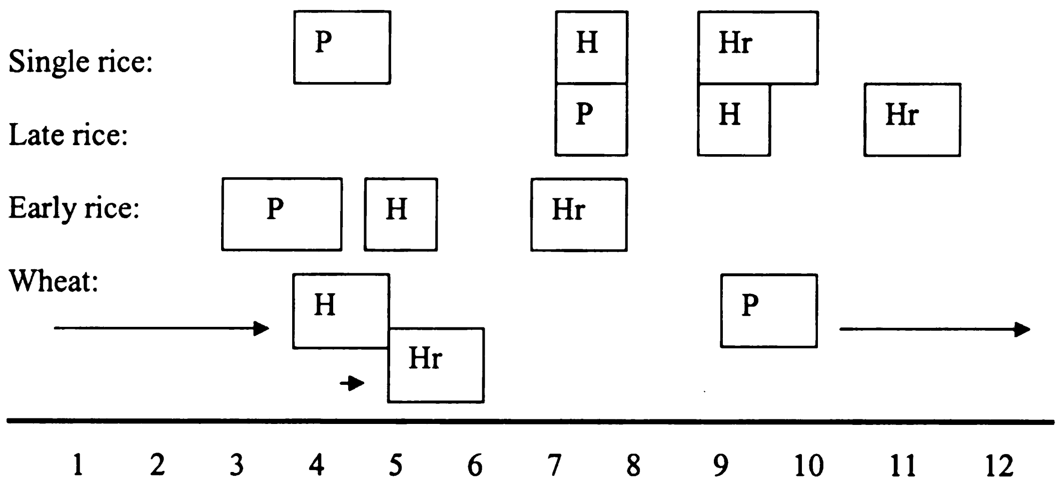
- Late rice: Harvesting; Wheat: Vegetative

December

- Late rice: Harvesting; Wheat: Dormant

Note: * Moisture/Temperature sensitive stage of development
Source: Production estimates and crop assessment division, FAS, USDA.

Figure A1. Crop Calendar (Rice/Wheat)



P: Planting, H: Heading, Hr: Harvesting

Table A3. Summary of Rainfall Data

(Unit=mm)

Number	Village ID	Average(village)	Average(province)
1	1401	369	Shanxi
2	1402	424	
3	1403	394	
4	1404	407	
5	1405	518	
6	1406	477	
7	1407	529	
8	1408	491	
9	1409	545	
10	1410	547	Shanxi = 470
11	3205	1013	Jiangsu
12	3206	1013	
13	3207	1024	
14	3208	1024	
15	3209	1102	
16	3210	1102	Jiangsu = 1046
17	3401	805	Anhui
18	3402	890	
19	3403	837	
20	3404	918	
21	3406	950	
22	3407	703	
23	3408	977	
24	3409	995	
25	3410	1285	
26	3412	1077	

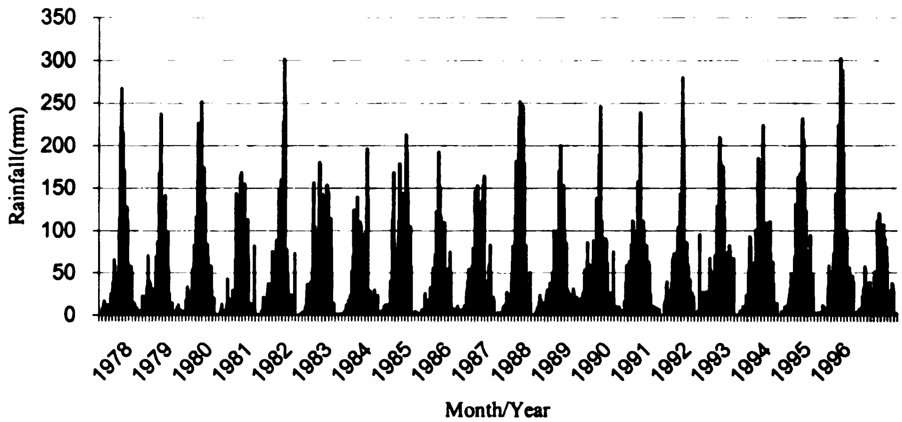
Table A3 (cont'd).

27	3413	1097	
28	3415	1632	
29	3417	1673	
30	3418	1867	Anhui = 1122
31	4101	590	Henan
32	4102	656	
33	4103	598	
34	4104	279	
35	4105	1312	
36	4106	805	
37	4107	727	
38	4108	643	
39	4109	858	
40	4110	914	
41	4111	783	
42	4112	514	
43	4113	560	
44	4114	627	Henan = 705

Source: Monthly village rainfall data from 1978.1 – 1997.12

Figure A2. Rainfall Pattern in Each Province (1978-1997)

Shanxi province (10 villages)



Jiangsu province (6 villages)

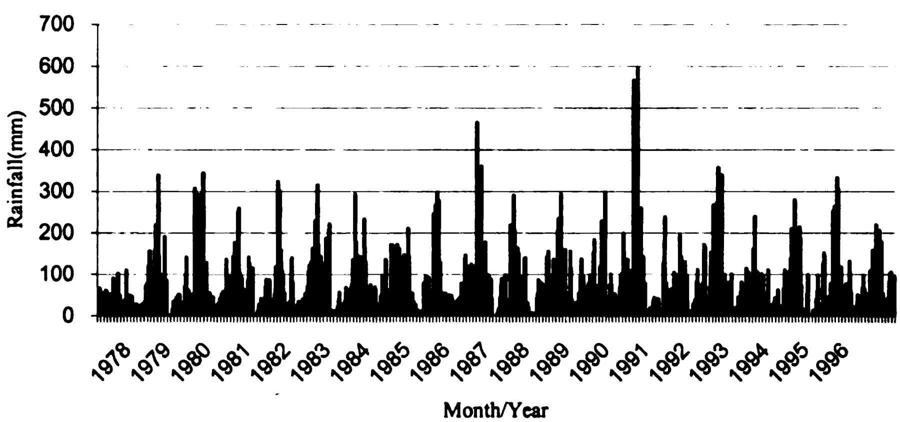
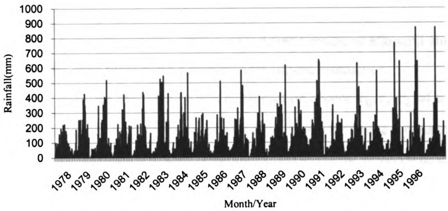
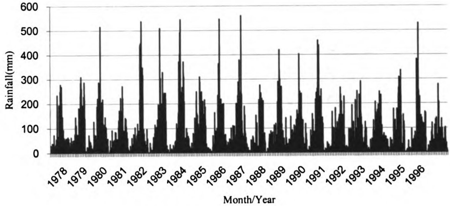


Figure A2 (cont'd).

Anhui province (14 villages)



Henan province (13 villages)



Appendix B

Consumption Growth and Yield Risk with CRRA Preferences

Starting from their insight, we derive a modified version of Blundell and Stoker's model that explicitly introduces yield risk from agricultural production.

The model analyzes the three-period consumption choice c_0, c_1, c_2 of a consumer over time periods t=0,1,2. For the purposes of tractability, we assume a constant relative risk aversion felicity function U_t with logarithmic preferences, $U_t(c_t) = \alpha_t \ln c_t$. The consumer's problem is:

$$\text{Max } \lambda_0 \ln(c_0) + \lambda_1 \ln(c_1) + \lambda_2 \ln(c_2)$$

where we normalize $\lambda_0 + \lambda_1 + \lambda_2 = 1$ and $\lambda_0 = \alpha_0, \lambda_1 = \frac{\alpha_1}{1+\delta_1}, \lambda_2 = \frac{\alpha_2}{1+\delta_2}$

subject to the budget constraint:

$$c_0 + \frac{c_1}{1+r_1} + \frac{c_2}{(1+r_1)(1+r_2)} = W + \frac{\varepsilon_1}{1+r_1} + \frac{\varepsilon_2}{(1+r_1)(1+r_2)}$$

where $\varepsilon_1 = y_1 - E_0 y_1$, $\varepsilon_2 = y_2 - E_0 y_2, W = A_0 + y_0 + \frac{E_0 y_1}{1+r_1} + \frac{E_0 y_2}{1+r_2}$.

W is expected wealth at period 0, which contains initial assets and the present value of expected income to be received over the three periods. $\varepsilon_1, \varepsilon_2$ are innovations in income that are unknown as of period of 0, ε_1 is revealed in period 1, and ε_2 is revealed in period 2. Thus it is natural to assume that information about expected innovations in income is updated in period 1.

The Euler equation for optimal allocation between period 1 and 2 is

$$\frac{\alpha_2}{c_2} = \frac{\alpha_1}{c_1}(1+\varepsilon_2)$$

From which we can derive consumption growth

$$\Delta \ln c_2 = -\ln \frac{\alpha_1}{\alpha_2} + \frac{1}{\alpha_2} \sigma_{2|1}^2 + \frac{\alpha_1}{\alpha_2} \frac{\varepsilon_2^*}{c_1}$$

where $\sigma_{2|1}^2 = \frac{Var(\varepsilon_2^* \mid \varepsilon_1)}{W^2}$, $\varepsilon_2^* = \varepsilon_2 - E(\varepsilon_2 \mid \varepsilon_1)$

Expected growth increases with the variance of updated income innovations conditional on the previous period, $\sigma_{2|1}^2$, and will be linear in the updated income innovation normalized by the previous wealth.

To add agricultural production to this model, assume that the households manage agricultural production like a competitive firm by hiring the needed labor inputs (from the market or the family), use their land, and selling their commodities as price-takers. Household income, in this case, would simply be agricultural profit. We introduce this assumption to rule out the endogeneity of labor supply decisions and income (In our empirical analyses, we will relax the assumption on household activity but still control for endogeneity of labor supply by using estimated measures of full income).[1] Thus, we define household profits as:

$y_t = p_t Q_t - w_{t-1} L_{t-1} = p_t f(L_{t-1}) \eta_t - w_{t-1} L_{t-1}$ where η_t is i.i.d with mean 1.

We assume that period *t* production depends on inputs in period *t-1*, and that there are no changes in price or wage during the period. Taking income as profit less the value of labor input and applying these to the income innovations of the previous model, we can show that income innovation terms based on crop production will be:

$$\varepsilon_1 = y_1 - E_0 y_1 = pQ_1 = pf(L_0)\eta_1$$

$$\varepsilon_2 = y_2 - E_0 y_2 = pf(L_1)\eta_2 - wL_1 - E_0(pf(L_1)\eta_2 - wL_1)$$

$$\varepsilon_2^* = \varepsilon_2 - E_1 \varepsilon_2 = y_2 - E_o y_2 - E_1\{y_2 - E_0 y_2\}$$

Since production is realized after input decisions are determined, the conditional variance of income subsequent to shock realizations in period 1 will be: $Var(\varepsilon_2^* \mid \varepsilon_1) = \pi \tilde{\sigma}_{2|1}^2$ with $\tilde{\sigma}_{2|1}^2 = Var(\eta_2 \mid \eta_1)$ and the scaling term $\pi = (\frac{pf(L_1)}{W})^2$.

[1] Although this assumption may be unrealistic in the real world. Chaudhuri (1999) suggests that it is not likely to change the relationship between the consumption and saving decisions, and yield risk under a more 'realistic' model specification.

If η, the yield shock is proxied by a rainfall shocks, it is plausible that the conditional variance of the rainfall shock will be an adequate proxy for the conditional variance of the shock, $\tilde{\sigma}^2_{2|1} = Var(\eta_2 \mid \eta_1)$.

Based on this derivation our analyses make use of two different measures of income: gross value of annual grain yield, and the estimated "full income" of the household. When we use the value of grain yields to reflect this model derivation we still have similar positive results.

Appendix C

Estimation of conditional variance of rainfall using GARCH model

A standard GARCH(1,1) model with no regressors in the mean and variance equations:

Mean equation: $R_t = c + \varepsilon_t$

Variance equation: $\sigma_t^2 = \omega + \alpha\varepsilon_{t-1}^2 + \beta\sigma_{t-1}^2$

We first should study the basic statistical features of the monthly rainfall data, in order to know if it is sensible to use the GARCH model with the rainfall data. For the proper specification of the mean equation in the model we have to test autocorrelation of the coefficients for the rainfall series as well as trend. If the rainfall has strong persistence then we can use the first difference of rainfall in the mean equation.

We did the below tests for each village using annual rainfall/selected months of rainfall (sum of July through November).

1. Autocorrelation test: test for mean equation specification

$R_t = \alpha + \rho R_{t-1} + \varepsilon_t$

Test $H_0 : \rho = 0$

All villages could not reject the null. Thus it implies that there is no serial correlation in the rainfall in these villages.

2. Trend test: test for whether time trend exist in the rainfall

$R_t = \alpha + \rho T + \varepsilon_t$

Test $H_0 : \rho = 0$

All villages could not reject the null. Thus it implies that there is no trend in the rainfall in these villages.

3. Heteroskedasticity test: $(R_{it} - \bar{R}_i)^2 = \alpha + \rho(R_{it-1} - \bar{R}_i)^2 + u_{it}$

Based on our mean equation specification ($\varepsilon_t = R_t - c$) this is the same as the ARCH(1) specification test.

$$\varepsilon_t^2 = \alpha + \rho\varepsilon_{t-1}^2 + u_t$$

Test $H_0 : \rho = 0$

Regression results show that 5 villages could reject the null at 10% level under ARCH(1) specification and 4 villages could additionally reject the null under ARCH(2) specification at 10% level.

4. GARCH specification test: test for whether GARCH (1,1) specification is appropriate for the data. Based on 1 and 2 results mean equation is specified like the below.

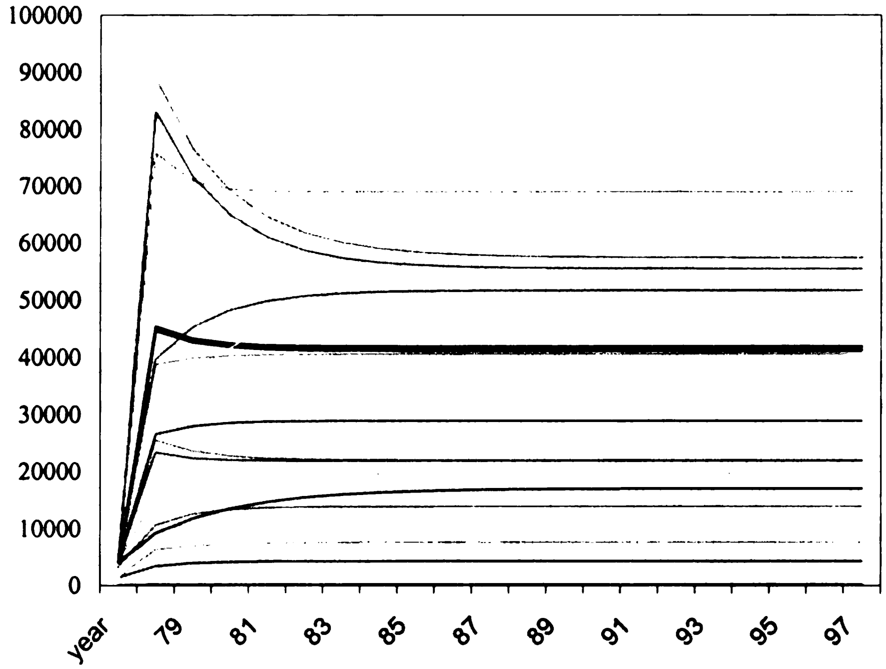
Mean equation: $R_t = c + \varepsilon_t$

Variance equation: $\sigma_t^2 = \omega + \alpha\varepsilon_{t-1}^2 + \beta\sigma_{t-1}^2$

Test $H_0 : \alpha = 0, \beta = 0$

16 villages among 44 villages could not reject the null. Most estimation shows that $\hat{\alpha} + \hat{\beta} < 1$ so it implies that the rainfall shock cannot persist long time.

Figure C1. Evolution of (Fitted) Conditional Variance of Rainfall



References

Anderson, T. W. and C. Hsiao (1982), "Formulation and Estimation of Dynamic Models Using Panel Data," *Journal of Econometrics*, Vol.18, pp.47-82.

Banks, J., R. Blundell and A. Brugiavini (2001), "Risk-Pooling, Precautionary Saving and Consumption Growth," *Review of Economic Studies*, 68 (4), pp. 757-779

Behrman, J., A. Foster, and R. Rosenzweig (1997), "Dynamic Savings Decisions in Agricultural Environments with Incomplete Markets," *Journal of Business & Economic Statistics*, Vol.15, pp. 282-292.

Benjamin, D. and L. Brandt (2002). ""Property Rights, Labour Markets, and Efficiency in a Transition Economy: The Case of Rural China," forthcoming, *Canadian Journal of Economics*.

Blundell, R. and T. Stoker (1999), "Consumption and the Timing of Income Risk," *European Economic Review*, March, 43(3), pp.475-507.

Browning, M. and A. Lusardi (1996), "Household Saving: Micro Theories and Micro Facts, *Journal of Economic Literature*," Vol.34 (Dec.) pp.1797-1855.

Burgess, R. (2001). "Land and Welfare: Theory and Evidence from China," mimeo, Economics Department, London School of Economics.

Caballero, R.J. (1990), "Consumption Puzzles and Precautionary Savings," *Journal of Monetary Economics,* Vol.25, pp.113-136.

Campbell, J. (1987), "Does Saving Anticipate Declining Labor Income? An Alternative Test of the Permanent Income Hypothesis," *Econometrica*, Vol.55, pp.1249-1273.

Carroll, C. (2001), "A Theory of the Consumption Function, With and Without Liquidity Constraints," *The Journal of Economic Perspective*, Vol.15, No.3, pp.23-46.

Carroll, C. (1994), "How Does Future Income Affect Current Consumption?," *Quarterly Journal of Economics*, pp.111-147.

Carroll, C. and A. Samwick (1997), "The Nature of Precautionary Wealth," *Journal of Monetary Economics,* Vol.40, pp.41-73.

Chaudhuri, S. (1999), 'Forward Looking Behavior, Precautionary Savings and Borrowing Constraints in a Poor, Agrarian Economy: Tests using Rainfall Data,' mimeo, Department of Economics, Columbia university.

Chen, S, and M. Ravallion (1996), "Data in Transition: Assessing Rural Living Standards in Southern China," *China Economic Review* v7, n1: 23-56.

Deaton, A. (1992), *Understanding Consumption*, Oxford Press.

Dynan, K. (1993), "How Prudent Are Consumers?," *Journal of Political Economy*, Vol.101(6), 1104-1113.

Giles, J. (2002), "Risk, Shock and Weak Property Rights in the Labor Allocation Decision of Rural Chinese Households," mimeo, Michigan State University.

Guiso L., T. Jappelli and D. Terlizzese (1992), "Earnings Uncertainty and Precautionary Saving," *Journal of Monetary Economics*, Vol.30, pp.307-337.

Harwood, J. et al. (1999), "Managing Risk in Farming: Concepts, Research, and Analysis," *Agricultural Economic Report*, No.774, USDA.

Jacoby, H., G. Li and S. Rozelle (2002) "Hazards of Expropriation: Tenure Insecurity and Investment in Rural China," *American Economic Review*. Forthcoming.

Jacoby, H. and E. Skoufias (1997), "Risk, Financial Markets, and Human Capital in a Developing Country," *Review of Economic Studies*, Vol.64, pp.311 – 335.

Jalan, J. and M. Ravallion (2001), "Behavioral Responses to Risk in rural China," *Journal of Development Economics,* Vol.66, pp.23-49.

Kochar, A. (1999), "Smoothing Consumption by Smoothing Income: Hour-of-Work Responses to Idiosyncratic Agricultural Shocks in Rural India," *The Review of Economics and Statistics*, Vol.81, pp.50-61.

Lusardi, A. (1997), "Precautionary saving and Subjective Earnings Variance," *Economic Letters* 57, pp.319-326.

Ludvigson, S. and C. Paxson (2001), "Approximation Bias in Linearized Euler Equations," *The Review of Economics and Statistics*, Vol.83(2), pp.242-256.

McKenzie, D. (2001). "Consumption Growth in a Booming Economy: Taiwan 1976-96," Yale University Economic Growth Center Discussion Paper No. 823.

Paxson, C. (1992), "Using weather variability to estimate the response of savings to transitory income in Thailand," *The American Economic Review*, Vol.82(1), pp.15-33.

Roe, T., and T. Graham-Tomasi (1986), "Yield risk in a Dynamic Model of the Agricultural Household," in Singh, I., Squire, L., Strauss, J. eds., *Agricultural Household Models: Extensions, Applications and Policy*, Johns Hopkins Univ. Press.

Rose, E. (2001), "Ex ante and Ex post Labor Supply Response to Risk in a Low-Income Area," *Journal of Development Economics*, Vol.64, pp.371-388.

Rosenzweig, M. (1988a), "Labor markets in Low-income Countries," Chenery,H., T.N. Srinivasan ed., *Handbook of Development Economics*, Vol.1, North-Holland.

Rosenzweig, M. (1988b), "Risk, Implicit Contracts and the Family in Rural Areas of Low Income Countries," *Economic Journal*, Vol. 98, pp. 1148-1170.

Rosenzweig M. and H. Binswanger (1993), "Wealth, Weather Risk and the Composition and Profitability of Agricultural Investments," *The Economic Journal,* Vol. 103, pp.56-78.

Rosenzweig M. and O. Stark (1989), "Consumption Smoothing, Migration, and Marriage: Evidence from Rural India," *Journal of Political Economy*, Vol. 97 (4), pp. 905-926.

Saha, A. (1994), "A Two-Season Agricultural Household Model of Output and Price Uncertainty," *Journal of Development Economics*, Vol.45, pp.245-269.

State Statistical Bureau (1998), *China Statistic Yearbook.*

Wooldridge, J.M. (2001), "Further Results on Instrumental Variable Estimation of Average Treatment Effects in the Correlated Random Coefficient Model," mimeo, Department of Economics, Michigan State University.

Wooldridge, J.M. (2002), Chapter 18: "Estimating Average Treatment Effects," in *Econometric Analysis of Cross Section and Panel Data*, MIT Press.

Woolpin, K. I. (1982), "A New Test of the Permanent Income Hypothesis: The Impact of Weather on the Income and Consumption of Farm Households in India," *International Economic Review*, Vol.23, pp.583 – 594.

Xu, G. and L. Peel (1991) ed., *The Agriculture of China*, Oxford University Press.

Young, Alwyn (2001). "The Razor's Edge: Distortions and Incremental Reform in the People's Republic of China," *Quarterly Journal of Economics* 115, no. 4 (November): 1091 - 1135.

Zeldes, S. (1989), "Optimal Consumption with Stochastic Income: Deviations from Certainty Equivalence," *Quarterly Journal of Economics*, Vol.104, pp.275-98.

Chapter 2

AN EMPIRICAL ANLAYSIS OF PRECAUTIONARY PORTFOLIO ALLOCATION

1. Introduction

Economic theory predicts that households facing substantial risks increase their savings, which are channeled into safe liquid assets in their portfolios. Although the issue of household portfolio composition has attracted considerable attention in the literature, most empirical work appears to focus on the presence of a precautionary saving motive on total wealth rather than the allocation of wealth. Moreover, the literature explaining the effect of risk on portfolios has generally studied financial risks that could be diversified against or are insurable in well-developed financial markets, or the literature has examined earnings risks, focusing on the implication of 'temperance'.[1]

This paper aims to provide empirical evidence of the effect of rainfall variability on farming household's portfolio allocation based on Chinese household panel data. Given the observation of substantial precautionary saving behavior in Yoo and Giles (2003) it may be a natural question; which assets are favored by the rainy-day motive? We test whether households facing more variable rainfall tend to hold more liquid assets and consider the importance of the precautionary motive on holdings of each liquid asset: including cash-in-hand, bank deposits, and grain stocks. Especially, we explore whether grain stock is still an important instrument for a precautionary portfolio allocation of

[1] Kimball (1993) introduced the concept of 'temperance', which is a theoretical explanation of precautionary portfolio allocation behavior. It implies that any risk that leads to an increase in precautionary saving reduces the demand for risky assets. It will be explained further in section 3.

households in a rapidly growing transitional economy where financial expansion is occurring.[2]

We present empirical evidence based on relatively recent panel data (1995 – 2000) of households and villages in rural China that rainfall variability, as a proxy for yield risk, influences the portfolio composition of households. We find strong support for an allocation toward liquid assets in response to greater rainfall variability. The result is in accord with the model that both the desire to moderate total exposure to risk and precautionary demand for liquidity contribute to portfolio choice.

We also observe that cash and deposits are important instruments for precautionary wealth allocation in rural households, while it is difficult to find similar evidence for grain stocks. This finding agrees with the noticeable increase in financial assets in rural areas, in both absolute terms and in the percentage of total wealth holdings in the recent years.[3] It may imply that financial instruments have been substituted for conventional physical assets in precautionary portfolio allocation, at the same time as dramatic institutional changes have occurred in contemporary rural China.[4]

The next section of this paper reviews the existing works literature on precautionary portfolio allocation. Section 3 introduces models that theoretically explain precautionary portfolio allocation behavior. We focus on the implications of demand for liquidity in this section. It is followed by a description of our main data source, Research

---

[2] Mckinley (1996) reports that farming households in rural China in a 1988 survey often did not hold any financial assets and implies that much of wealth is likely to take more concrete forms, such as grain stocks and other commodities.

[3] We find from our data that financial assets demonstrated a highest 9.3 percent rate of growth in the period (1995 – 2000) among wealth components and the proportion of financial assets in the total wealth has increased from 11.2 percent in 1995 to 15.1 percent in 2000. Refer to Chapter 3 of the dissertation for more detailed information.

[4] We also witness that the proportion of the fixed productive assets has decreased from 17.1 percent in 1995 to 15.1 percent in 2000 although the absolute amount of fixed productive asset holdings slightly increased. Chapter 3 of the dissertation documents in detail the evolution of composition in wealth in rural China.

Center on Rural Economy (RCRE) panel data and the empirical specifications. Our main findings are presented in Section 5, which highlights the role of risk-induced portfolio allocation. Finally, we summarize our results and their implications in Section 6.

2. Literature Review

Dreze and Modigliani (1972) first studied the effect of earning risk on consumption and portfolio choice and demonstrated using a two-period model that if income risk is perfectly uninsurable and markets are not complete, uninsurable risks could not only affect the level of wealth but also the composition of the portfolio. Kimball (1993) provides a more general framework to study the interaction between background risk and other undesirable risks. He shows that 'temperance', which is the desire to reduce overall risk exposure even if both risks are statistically independent, explains people's response to unavoidable risk by adjusting their portfolio to choose safer assets. Using simulations, Bertaut and Haliassos (1996) study the implications of a consumption capital asset pricing model with income and stock-holding risk, and they conclude that income risk lowers the demand for stocks and raises that for the secure asset at any level of wealth. Paxson (1990) shows that when a limit on borrowing is exogenous, this cost can be avoided by holding safer and more liquid assets, and it implies that the effect of borrowing constraints reinforces that of income risk.

The theoretical prediction that unavoidable income risk and demand for liquidity produced by the anticipation of liquidity constraints reduces the optimal investment in risky securities and increases the liquid assets lend themselves to empirical scrutiny. Although the effect of uncertainty on wealth allocation is clearly important, most empirical work on the precautionary saving motive focuses on the presence rather than the allocation of precautionary wealth and mostly on households in developed economies. Only a few concentrate on the impact of uninsurable income risk on portfolio composition and so far, these studies are primarily theoretical. Little empirical evidence has been produced to back these theoretical claims. Dicks-Mireaux and King (1982) find a small effect of pension wealth on household portfolio composition in Canada. Guiso et al. (1996) find evidence of a precautionary portfolio allocation in Italy, and Chakraborty and Kazarosian (1999), using the National Longitudinal Survey, find evidence of the presence and allocation of precautionary assets in the United States.

Although most empirical studies on precautionary wealth allocation have been based on households in developed economies, an important issue in development economics is whether rural households keep specific liquid assets (grain stocks and livestock) as buffer stocks to insulate their consumption from income fluctuations. Rosenzweig and Wolpin (1993) provide evidence that livestock sales and purchases are used as part of farm households' consumption-smoothing strategies. Udry (1995) provides evidence that consumption smoothing is effected through the sale or purchase of only those assets (mostly grain) not used in production. Fafchamps et al. (1998) indicate that livestock transactions play less of a consumption-smoothing role than is often assumed.

Compared to the previous studies that focused on liquid asset transactions in response to the risk, Jalan and Ravallion (2001) focus on precautionary portfolio decisions and find evidence using the surveys of rural China in 1986 – 1991 that liquid wealth, especially grain stocks, are held as a precaution against risk by farming households in rural areas. Rosenzweig and Binswanger (1993) also showed that Indian households hold a large amount of grain and other liquid assets based on the portfolio theory. Dercon (1998) also provides empirical evidence that in Tanzania, cattle are used as a liquid buffer which provides insurance against income shortfalls. In sum, although economic theory emphasizes the role of risk in household portfolio decisions, little empirical investigation has been done in the fast-growing transitional economies.

3. Theoretical Background[5]

The theory of portfolio choice relates asset shares to the expected value and degree of risk of asset returns. However, portfolio decisions may also be affected by types of uncertainty other than interest rates. In particular, uninsurable, non-diversified risks may induce prudent investors to reduce holdings of risky assets and also increase holdings of liquid assets in order to cut their overall exposure to risk.

Here we present existing theories to explain why rural farmers hold liquid assets among their wealth. First we introduce a prototype portfolio model.

Portfolio model.[6] We think about a simple two-period portfolio problem involving two assets, one with a risky return and one with a certain return. Since the rate of return on the risky asset is uncertain, we denote it by a random variable π. Let w be initial wealth, and let $i \geq 0$ be the dollar amount invested in the risky asset. For convenience we assume that the sure asset has a zero rate of return. In this case the second period wealth can be written as

$$W = i(1+\pi) + w - i = \pi \cdot i + w$$

---

[5] I thank Dr. Jack Meyer for helpful comments on this section.

[6] Refer to Varian (1992).

The expected utility from investing i in the risky asset can be written as

$$v(i) = Eu(w + \pi \cdot i),$$

and the first two derivatives of expected utility with respect to i are

$$v'(i) = Eu'(w + \pi \cdot i)\pi$$

$$v''(i) = Eu''(w + \pi \cdot i)\pi^2.$$

Note that risk aversion implies that $v''(i)$ is everywhere negative, so the second-order condition will be automatically satisfied.

When we solve the maximization problem of the expected utility function, $v(i)$ with respect to i and assume that $E\pi > 0$, the optimal investment will satisfy the first-order condition

$$Eu'(w + \pi \cdot i)\pi = 0$$

We investigate how the demand for a risky asset changes as the probability distribution of its return changes.

An interesting shift in the random variable is a mean-preserving spread that increases the variance of π but leaves the mean constant. We can parameterize such a change by writing $\pi + \lambda(\pi - \overline{\pi})$ which is a special case. The expected value of this random variable is $\overline{\pi}$, but the variance is $(1+\lambda)^2\sigma^2$, so an increase in λ leaves the mean fixed but causes an increase in the variance. A mean preserving spread of this sort reduces investments in the risky assets. Thus the model implies that the demand for risky assets will be reduced as the rate of the return becomes more uncertain.

Temperance. Pratt and Zeckhauser (1987) suggest that an unavoidable risk might lead an agent to reduce exposure to another risk even if the two risks are statistically independent. This tendency is called temperance. Although temperance cannot be measured as neatly as risk aversion or prudence, Kimball (1990) shows that just as decreasing absolute risk aversion implies that prudence is greater than risk aversion, decreasing absolute prudence implies that temperance is greater than prudence.[7] It means that any risk that leads to an increase in precautionary saving reduces an agent's demand for risky assets, both in absolute terms and as a share of total savings.

Precautionary Demand for Liquidity. Prudence and temperance lead to increased savings in terms of safe assets and, in the presence of unavoidable risk, even to an absolute shift out of risky assets. The precautionary demand for liquidity leads to increased holding of liquid assets in response to risk.[8] It is less restrictive compared to prudence and temperance in the sense that the precautionary demand for liquidity does not depend critically on the shape of the underlying utility function. It arises instead from convexity induced in the marginal value of a liquid asset (money) by liquidity constraints.

We consider a simple cash-in-advance model in which the level of cash balances must be chosen before the size of a random cash infusion δ is known.[9] Let the direct utility function be

$$u(c) + W = u(c) + w + \delta - c - \tau \cdot l,$$

where W is final wealth, c is immediate consumption, u(c) is concave utility function, w is initial wealth holding, τ is the cost of liquid asset holding and l is the initial liquid asset the household chooses to hold. It implies that the precautionary demand for liquidity can arise in response to uncertainty about temporary fluctuations in cash infusions and cash requirements.

[7] The corresponding measure of the convexity of marginal utility is absolute prudence defined as $-(u'''(\cdot)/u''(\cdot))$ while the Pratt-Arrow measure of absolute risk aversion is defined as $-(u''(\cdot)/u'(\cdot))$.

[8] Here liquid asset is implicitly assumed as the riskless asset.

[9] Refer to Svensson (1985) and Kimball (1992).

Given the direct utility function, the indirect utility function of a liquid asset is

$$V(l,\delta) = \underset{c}{Max}\ \ u(c) + w + \delta - c - \tau l \text{ s.t. } c \le l + \delta$$

The first-order condition for the optimal choice of c is

$$u'(c) - 1 = \lambda .$$

The Kuhn-Tucker condition for the Lagrange multiplier λ is

$$c < l + \delta \text{ and } \lambda = 0 \text{ or } c = l + \delta \text{ and } \lambda > 0 .$$

The envelope theorem indicates the marginal value of liquid asset is

$$V_l(l,\delta) = \lambda - \tau = \max(u'(l+\delta) - 1 - \tau, -\tau) .$$

Since the problem of choosing the optimal initial amount of the liquid asset,

$$\underset{l}{Max}\, E[V(l,\tilde{\delta})]$$

has the first and second order conditions

$$E[V_l(l,\tilde{\delta})] = 0 ,$$

$$E[V_{ll}(l,\tilde{\delta})] < 0$$

We use these conditions later to show that the demand for liquidity increases as cash infusions become more uncertain.

Figure 1 illustrates the marginal value of liquid asset graphically. Even if $u(c)$ is quadratic, so that the underlying marginal utility of consumption is linear, the marginal value of liquid asset is a convex function of $l + \delta$ because of the kink induced where the cash-in-advance constraint stops binding. If $u'(c)$ is itself convex, the cash-in-advance constraint interacting with the convexity of $u'(c)$ leads to a precautionary demand for liquidity even if the constraint is certain to bind, making the kink irrelevant.

Now let α be a parameter that represents a mean-preserving spread to the distribution of δ. The first order condition defines a choice function $l = l^{*}(\alpha)$. A change in α will affect the value of l^{*} and the value of $E[V_{l}(l,\tilde{\delta})]$ directly as well. Differentiating the first order condition with respect to α, we get

$$\frac{\partial l^{*}}{\partial \alpha} E[V_{ll}(l,\tilde{\delta})] + \frac{\partial}{\partial \alpha} E[V_{l}(l,\tilde{\delta})] \equiv 0$$

Since V_{l} is a convex function in $\tilde{\delta}$, $E[V_{l}(l,\tilde{\delta})]$ does not decrease as $\tilde{\delta}$ undergoes a mean-preserving spread. Thus the second term is not negative. Since $E[V_{ll}(l,\tilde{\delta})]$ is negative by the second order condition, $\frac{\partial l^{*}}{\partial \alpha} > 0$. Thus the convexity of the marginal value of a liquid asset as a function of $l + \delta$ means that a household will react to uncertainty relative to the size of the liquid asset infusion (δ) by increasing his or her initial liquid wealth holding (l). For instance, when a farming household expects its yields to become more uncertain due to the volatile rainfall distribution, their demand for liquid assets will increase.

Combined with temperance, the demand for liquid assets will magnify the effect of risk and uncertainty on household wealth allocation and leads households to increase their liquid assets away from risky ones. In this paper we focus on the precautionary demand for liquidity rather than temperance, which emphasizes the safeness or volatility of the asset. Estimating the share of liquid asset holding equation, our empirical specification presents evidence that households increase liquid assets in the face of exogenous rainfall variability.

4. Data and Empirical Specification

The analyses of household precautionary wealth portfolios in this paper use village and household survey data provided by the Survey Department of the Research Center on the Rural Economy (RCRE) at the Ministry of Agriculture in Beijing. Annual village surveys from 44 villages of Shanxi, Jiangsu, Anhui, and Henan provinces are used in conjunction with panel data spanning the period 1995 to 2000 from roughly 3,400 households per year.[10][11] Households are asked a range of questions regarding various asset ownership, savings, income from on-farm activities and household consumption, land use, grain stocks, formal and informal access to and provision of credit, and transfers from both village members and friends and family outside the village.[12] The household surveys are monitored by county agricultural research offices charged with collecting expenditure, income, and labor allocation information on a monthly basis. A staff person from each office works with households to clear up inconsistencies in the survey.

We provide more detailed information about the household asset holdings in the RCRE data through Tables D2 – D9 in the Appendix. Tables D2 and D3 provide information about the grain stock and production of the sample households at each year-end. They show that grain stocks were stable from 1986 to 2000 but grain production declines after it achieved the peak point in 1996. The summary statistics of the total value of production and non-production assets are presented in Table D4. Non-production

[10] RCRE has collected data from a panel of households from 1986 to 2002. Survey years are missing for 1992 and 1994, and we only have rainfall information through 1997. We use the first half of the panel in the analyses of this paper. We recently learned that the data for 1992 and 1994 were actually collected in these provinces but that the forms were archived because shortages in staff and funds made it impractical to enter the data.

[11] Table D1 in the Appendix presents the follow-up rates of the data set. It started with 4,152 households in 1995 and RCRE had followed 3,724 households for 6 years, so that its follow-up rate is 89.7%.

[12] The data are annual so we cannot identify intra-year risk. In a rural economy, one naturally expects there to be seasonality.

assets consist of housing and durable goods, but mostly (80%) they are housing assets. As the decline in fixed investments in agriculture have been widely discussed both in the media in China as well as in the academic literature (Brenner, 2001), our data also confirms both the fears of Chinese officials and predictions of researchers that present incentives are insufficient to promote fixed investment in agriculture. The growth rate of the production asset has drastically declined from 15.5% in 1996 to 2.9% in 2000. This phenomenon may partly relate to the return of the farming, and Table D5 provides the partial confirmation on this.

In Table D5 we show the household income and its composition from 1995 to 2000. The negative growth rate of farming income (on average –1 % across the period) may affect a household's time allocation and investment decision on production assets. Traditionally, household agricultural production contributes most of income to farm households, but the share of this income has decreased continuously from 73.4 % in 1995 to 64.3 % in 2000. Instead, the share of wage income has increased from 8.6% in 1995 to 14.9% in 2000.

Table D6 and D7 present a summary of financial asset holdings of the sample households in the period. Household bank deposits have increased a lot during the period and the average growth rate is 18%, but more than 50% of households in the sample report that they do not have any bank deposits. The households in the sample who have cash-in-hand hold 9 – 11 % of their annual income as cash. Households borrow a similar amount of money but their primary institutions for loans are not formal ones such as banks and rural credit cooperatives, but informal ones such as individuals who do not charge interest (refer to Table D7). It indicates an on-going process of financial deepening in the rural area or perhaps the uneven development of the Chinese rural financial system.

In this paper we define wealth as the sum of cash in hand, grain stock, bank deposits, value of productive farm assets, housing materials, and consumer durables, but we are not able to include land since it is difficult to evaluate appropriately value of land that rural Chinese households are allowed to use.[13] Liquid wealth is defined as cash-in-hand, grain holdings, and bank deposits of the household.[14] Table D8 presents the composition of the household non-land wealth holdings. On average, 29% of (non-land) wealth is held in liquid forms such as cash, deposits and grain stock. Housing is the most important element in a household wealth (46%). Productive assets accounted for 12% of wealth, consumer durables 13%. In comparison with the similar survey (1985 – 1990) that Jalan and Ravallion (2001) used, the most conspicuous change in our data (1995 – 2000) is the rapid increase in bank deposits, which reflects the financial deepening in rural areas (refer to Table D9).

Next we introduce the baseline specification for empirical analysis. We propose the empirical specifications below to test whether a household reacts to rainfall variability by increasing their share of liquid wealth holdings. The empirical specifications take the reduced form approach following the previous works.

---

[13] Since land is not owned privately by households and a rental market for land in rural China has not been well developed, most of studies that tried to include land in household's total wealth had imputed the value of user right to land. Brenner (2001) reports that land is one of the largest components of household wealth in rural China, but changes in average imputed values of user rights to land were smallest (1.8 % per annum from 1988 to 1995), although all components of wealth had increased. He points out that land exerts an equalizing effect on overall wealth distribution in rural China since user rights to land are fairly evenly distributed.

[14] Jewelry (especially gold) might also be an important liquid asset. Frankenberg, Smith, and Thomas (2003) report that many Indonesian households store some of their wealth in the form of gold and rural households used liquid wealth, particularly gold to smooth consumption. Since we do not have any information about jewelry in our data, we are not able to include this asset.

$$LS_{it} = \alpha + Z_{it}^{'}\gamma + \lambda L_{it} + \beta m_j + V_j^{'}\rho + D_t^{'}\pi + u_{it},$$

where LS_{it}: The share of liquid asset holding by the household i at time t

Z_{it}: Household demographics

L_{it}: Area of land managed by the household

m_j: Rainfall risk of village j (the coefficient of rainfall variation)

V_j: Village variables

D_t: Province-year interaction dummies.

Here we estimate the share of total precautionary liquidity wealth holdings as well as every component of conventionally assumed liquid assets such as cash-in-hand, deposits, and grain stocks.

If households hold more wealth in liquid form when they face a higher risk of rainfall, then β will be positive. The coefficient of rainfall variation, which is the variance of rainfall divided by the average rainfall in village j, is used for the proxy for exogenous aggregate risk measure. In estimating the above equation, the vector Z includes age and age squared of the household head, household composition, and education level of adult members in a household. L is the land area per capita that a household manages and V are geographic variables including features of topography of the communities in which the household resides, as well as socio-economic characteristics of the country in which the village of the household is located in. A time trend and province level fixed effect can be controlled by the interaction terms between the year and province dummies

Since the rainfall variability that we use does not vary across households within a village or over time, there may be other village-specific factors that affect the liquid wealth holdings. Hence, in our baseline empirical specifications we make use of many village variables to control for proximity to off-farm markets, local topographical characteristics, and village socio-economic infrastructure which might be correlated with liquid asset holdings and thus the estimates that we are interested in could be biased. Location variables include distance to the nearest public road, and a dummy variable indicating whether the village is near a city. Indicator variables denoting village location in city, suburb, or in mountainous or hilly areas provide information about local topography. We use annual net income per capita, a permanent village population, average education of a village, and various village infrastructures such as safe, sanitary water, TV, phones, and roads to control for the extent of village involvement and capability in the local economy. Finally, the share of full-time farming households in a village and the number of village laborers employed in local and distant labor markets may be used to control access to non-farm employment. Table D10 provides summary statistics of the variables we use in the regressions. We can find some characteristics of the typical household; they are mostly farmers (82%) and the size of households is 4 on average. The head of the household is approximately 45 years old and typically a secondary school graduate.

Next, we estimate the equation based on the above specification and as an extension of the baseline model we introduce an interaction term between rainfall variability and household characteristics (land holdings per capita). We also introduce the village-year dummies to control the village-specific factors across the period that may be correlated with rainfall variability.[15]

5. Empirical Results

In this section, we first introduce the results from our basic specifications. The baseline results are presented in Table 1. It shows that the estimated $\hat{\beta}$ is negative but insignificant in the share of total liquid wealth regression. When we do the same regressions in each liquid asset the results are somewhat different; especially, cash-in-hand and bank deposit regressions show $\hat{\beta}$ is positive as we expected, but it is still negative and significant for grain stock. When we introduce the interaction term between land and the rainfall variability as a proxy for idiosyncratic risk measure, the net effect of the rainfall risk is positive and significant in most regressions except grain stocks when it is evaluated at the mean of arable land per capita.[16]

It is most noticeable in the baseline regression results that the grain stock regressions provide counter-intuitive results. We suspect that this is mainly due to omitted variable problems. Although the geographic effects that we introduced in the regressions might pick up precautionary wealth effects of covariate risk, we cannot control every possible aggregate variable under the baseline specification. We introduce the village-time dummies to control these village-level covariate effects in order to better identify the precautionary portfolio effect of village rainfall variability although we can't directly estimate level effects but only through interactions.

---

[15] When we check the empirical densities of liquid wealth and its, liquid wealth holdings appear to have skewed and kurtosic distributions. When we can find there are some extreme values least absolute deviation (LAD) procedures might be preferable and could be applied. Although it is not a big issue because we get rid of gross outliers we also use the quantile estimation and the results are similar to OLS.

[16] Mean of arable land per capita is 1.369 in Table A10. Please refer to Table 1 for the detailed result.

Although we introduce some important village variables with province-time dummies in the baseline regressions, there might still be important missing variables in the regression. One of the possible important covariate risk variables may be the risk associated with grain prices. As Park (2001) argued, households are likely to store grains as an ex-ante hedge against consumption price risk.[17] In isolated markets, grain is likely to be expensive when the harvest is poor, and the household's added incentive to store grain is an ex-ante hedge against consumption price risk. If the grain price risk is strongly positively correlated with the rainfall variation, households tend to store more grain stock as they face more volatile rainfall. Since we do not have information on grain prices in our data, we introduced province time dummies to at least control for province-level price variation.

Next we extend our baseline estimation in order to introduce the village-time dummies instead of province-time dummies. When we introduce idiosyncratic risk as an interaction term between land and the coefficient of rainfall variation, we are able to introduce village-time dummies to control the aggregate village level variables such as consumption price variation. We expect that households who manage more land are likely to increase liquid wealth holdings in response to greater rainfall variation, since more land may be affected to a greater degree by rainfall variability and rainfall shocks.[18] Table 2 presents the new results with village-time dummies.

---

[17] There are several candidate explanations for the reason farmers in China hold grain stocks despite the relatively low production return of grain investment. According to Ke (2000), securing grain consumption is the most important motivation for high levels of grain storage in rural China. This attitude is partly attributed to changes in government's grain policies, market risks, and vulnerability to agroclimatic shocks. But Yang (1999) has argued that with the near realization of grain self-sufficiency after 1984, security motives for grain storage should be weaker.

[18] We here implicitly assumed that households with more land have greater exposure to agroclimatic variables for the identification. However, there is a possibility that transfers of land are correlated with these variables experienced by the households and it can contribute to bias. Severe weather shocks affect

Each liquid asset, except grain stocks, provides a positive coefficient of the interaction of an idiosyncratic risk with land but the regression result for total liquid assets still shows a negative sign of the coefficient. Since rainfall shocks could affect the liquid wealth decision especially grain stocks and the rainfall variability, we also introduce another interaction term between land and the lagged rainfall shock.[19] Share of total liquid wealth estimation results prove to be significant and provide the expected positive sign of the coefficients. Grain stock estimation results still show negative but insignificant ones when we introduce the rainfall shock variable. Results are reported in Table 3.

Aside from rainfall risk, we find a number of other factors that influence a household's composition of wealth. There are strong demographic effects on portfolio behavior. On the other hand, it is difficult to find from the results that education has a consistently strong effect. Households with more dependents tend to hold less liquid wealth; more arable land would not increase cash-in-hand or bank deposits, but would increase the grain stocks of the household. Liquid wealth holdings increase as household size increases and liquid wealth profiles show the inverted U shape with respect to age like the typical life cycle pattern of wealth accumulation. Based on our estimation the peak point of the cash holdings of a household is when the head of a household reaches

---

agriculture and contribute the decisions to transfer land to other households. But if we are able to assume that farmers know the distribution of rainfalls in their villages, not specific rainfall shocks it is likely that their current land holdings would not be varied much by the distribution of rainfall which is assumed here to be constant across the period.

[19] Since we only have the village rainfall data until 1997 number of observations is reduced when we introduced the rainfall shock. Thus we introduced the rainfall shock variables only in some of our regressions. Another issue on this interaction term is that the coefficient might be biased when it is likely that household land is endogenous with the rainfall shock if households respond to negative shocks by reducing land. Thus endogeneity of household land and the rainfall shock will mean that the coefficient of the newly introduced interaction term will be biased toward zero if land is adjusted in response to negative shocks.

an approximate age of 43 years. Conceivably they are more disposed toward engaging in emerging opportunities for money-based market transactions.

There are some caveats for interpretation of these results. First there is an inconsistency between the model and the empirical results that we provided. Although our major conclusions mostly depend on the empirical results of interaction terms between land and rainfall variability our model does not provide any specific implications on this. The positive coefficient of the interaction term would not necessarily imply the precautionary portfolio behavior of a household. Another issue related to estimation is potential measurement error. It may be a general issue in this type of empirical work since the wealth variables are notorious in measurement error problems in most household surveys.[20] Thus the interpretation of our empirical results should be very cautious and limited due to these major issues.

Since we have doubts about some of the explanatory variables being strictly exogenous, it is useful to test and correct errors for serial correlation.[21] We find fairly strong evidence of positive serial correlation. First- differencing the dependent variable might be a possible econometric solution for this. When we do first difference the dependent variables, nothing of interest is significant. We can calculate serial correlation-robust standard errors, and retain significant results (Refer to Table 3).

Our results appear to provide limited evidence on the precautionary portfolio behavior of a rural Chinese household, and especially cash-in-hand and bank deposits seem to be important assets for this purpose while grain stock regression would not

[20] Deaton (1989) notes that savings or wealth is even more difficult to measure in developing countries and the resulting data inadequacies are pervasive and have seriously hampered progress in answering the basic questions. Gersovitz (1988) points out that cash-in-hand is usually under-reported in most household surveys and these systematic reporting errors might cause the skewed distribution of their liquid wealth.

[21] Serial correlation in the error term happens when there is an unobserved time invariant factor.

provide the consistent and significant results through our estimations. Our empirical results on household portfolio behavior might provide some implications on current macroeconomic issues in China. We will briefly mention these as concluding remarks.

6. Conclusions

Accompanying recent financial deepening in rural China, financial assets that farming households keep have increased dramatically, both in absolute terms and as a percentage of total wealth holdings. With relatively recent panel data (1995 – 2000) we analyzed the issue of precautionary portfolio allocation and tried to answer the question: why the farming households in China hold substantial amounts of liquid assets in their wealth portfolio. [22]

Although economic theory emphasizes the role of risk in household portfolio decisions, which induces them to maintain high levels of relatively liquid wealth, little has been done to empirically investigate it under the fast-growing transitional economy. We provide limited empirical evidence of precautionary portfolio allocation in rural Chinese households and document that financial assets are one of their important instruments to cope with the uninsured aggregate risk in contemporary rural China. We imply that as the new available financial instrument emerges in rural areas the role of conventional instruments such as grain stocks may become smaller.[23] It is in accord with

---

[22] Although we could not specifically explain the increase in holdings of financial assets, one possible explanation will be macroeconomic phenomenon such as financial deepening rural areas.

[23] It has been argued that under a thin and particularly fragmented financial markets in many rural developing areas, physical asset accumulation may substitute for the store of wealth function of financial assets as well as a buffer stock in the face of income variability.

the recent argument that grain storage may be held as other risk concerns such as a price hedge, not in lieu of credit or other ex-post consumption smoothing mechanisms.[24]

Our empirical findings also have some implications on macroeconomic issues in China. While this paper provides one possible explanation of the rapid growth in financial asset holdings in rural China, it also sheds light on the question of how China has been able to combine a rapid expansion in monetary supply with only a moderate degree of inflation. Illustration of precautionary wealth portfolio behavior in this paper could provide microeconomic evidence for possible explanations of this macroeconomic puzzle in China. It implies that an increase in precautionary demands for liquidity of the rural households appears to be helpful for reducing inflationary pressure in a rapidly growing Chinese economy.

Our empirical findings may also provide some implications on the issue of poverty in developing economies.[25] As many development economists and politicians have pointed out, this rational portfolio behavior in the presence of uninsured risk can help perpetuate poverty in rural areas. Although the plausibility of the claim that precautionary portfolio behavior can cause poverty is not self-evident, it is problematic that the poor household might hold excessively large amounts of unproductive liquid assets. The precautionary desire to hold grain or liquid financial assets may prevent households from undertaking productive investments. Opportunities for investment in nonagricultural activity or housing, coupled with better functioning financial markets, have served to divert resources away from fixed investments. Understanding this aspect

[24] Refer to Park (2001) and Jalan and Ravallion (2001).
[25] Refer to Jalan and Ravallion (2001).

of household portfolio behavior may offer some insights into the issue of the decline in fixed investment of agriculture in China.

Figure 1. The Convexity of Marginal Value of the Liquid Asset

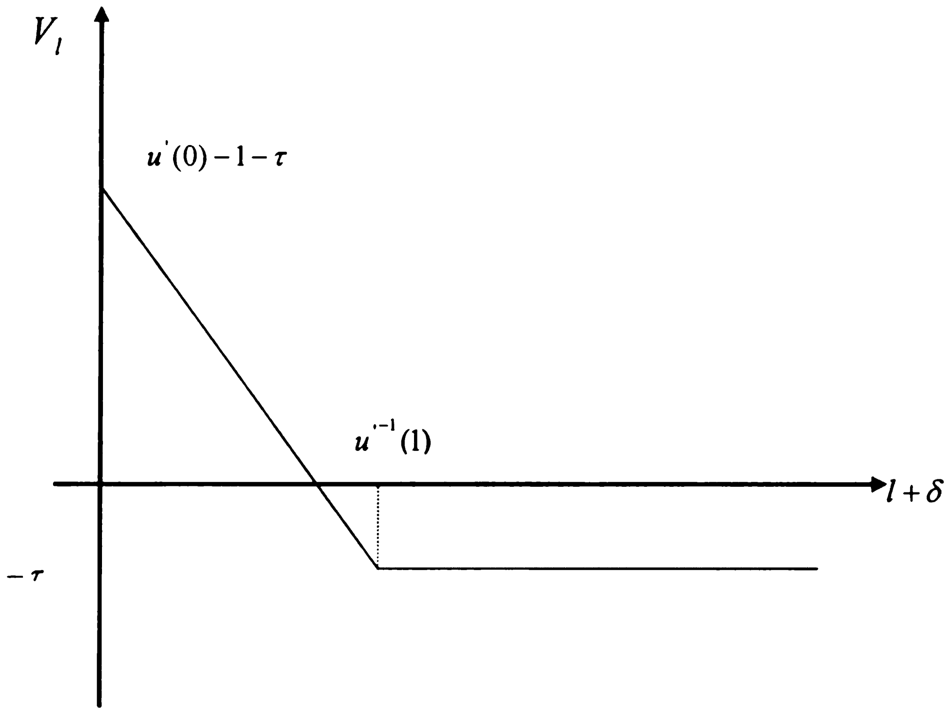


Table 1. Regression Results for Share of Liquid Wealth-holdings with Province-year Dummies

1. Share of Total Liquid Wealth

Variables	Share of Total Liquid Wealth				
Coefficient of rainfall variation	-0.0026	-0.0023	-0.0469	-0.0573	-0.0518
	(0.0085)	(0.0145)	(0.0122)**	(0.0214)**	(0.0228)*
Land*Coefficient of variation			0.0738	0.0899	0.0868
			(0.0151)**	(0.0280)**	(0.0282)**
Land* Rainfall shock					-0.0039
(=|Rainfall-Average of Rainfall|)					(0.0023)
Household size	-0.0098	-0.0081	-0.0095	-0.0079	-0.0079
	(0.0013)**	(0.0022)**	(0.0013)**	(0.0022)**	(0.0022)**
Age of household head	0.0006	0.0008	0.0005	0.0008	0.0008
	(0.0007)	(0.0012)	(0.0007)	(0.0012)	(0.0012)
Age squared of household head	-0.00001	-0.00001	-0.00001	-0.00001	-0.0000
	(0.00001)	(0.00001)	(0.00001)	(0.00001)	(0.0000)
Number of dependents	0.0041	0.0023	0.0044	0.0028	0.0027
	(0.0016)*	(0.0028)	(0.0016)**	(0.0028)	(0.0028)
Proportion of illiterates in household	-0.0206	-0.0251	-0.0212	-0.0260	-0.0260
	(0.0086)*	(0.0149)	(0.0086)*	(0.0148)	(0.0148)
Proportion of elementary school	0.0080	0.0027	0.0066	0.0008	0.0009
educated in household	(0.0081)	(0.0141)	(0.0081)	(0.0141)	(0.0141)
Proportion of secondary school	-0.0122	-0.0300	-0.0132	-0.0309	-0.0308
educated in household	(0.0080)	(0.0141)*	(0.0080)	(0.0141)*	(0.0140)*
Arable land per capita	0.0033	0.0117	-0.0193	-0.0150	-0.0150
	(0.0017)	(0.0030)**	(0.0049)**	(0.0088)	(0.0088)
Village located in hilly area (dummy)	-0.0125	-0.0576	-0.0133	-0.0570	-0.0557
	(0.0045)**	(0.0092)**	(0.0045)**	(0.0092)**	(0.0093)**
Village located in mountain area (dummy)	-0.1051	-0.1359	-0.0958	-0.1240	-0.1232
	(0.0056)**	(0.0117)**	(0.0060)**	(0.0124)**	(0.0125)**
Village located in a city suburb (dummy)	-0.0873	-0.0700	-0.0861	-0.0698	-0.0699

Table 1 (cont'd)

	(0.0053)**	(0.0093)**	(0.0053)**	(0.0093)**	(0.0093)**
Annual net income per capita in village	0.0001	-0.0001	0.0001	0.0001	0.0001
	(0.0000)**	(0.0001)	(0.0000)**	(0.0001)	(0.0001)
Number of people who migrated out among total residents	0.5726	2.0103	0.5692	2.0859	2.0710
	(0.1638)**	(0.3233)**	(0.1644)**	(0.3241)**	(0.3249)**
Permanent residents in a village	0.0011	-0.0020	0.0011	-0.0001	-0.0001
	(0.0005)*	(0.0003)**	(0.0009)	(0.00005)**	(0.0000)**
Full time farming households ratio in village	-0.0008	0.0304	0.0006	0.0365	0.0380
	(0.0058)	(0.0115)**	(0.0058)	(0.0116)**	(0.0120)**
Share of village cadre in village	-2.4294	-7.1025	-2.8005	-7.5288	-7.4251
	(0.5339)**	(1.0960)**	(0.5429)**	(1.1053)**	(1.1177)**
Share of rice among total sown area in village	-0.0870	-0.0179	-0.0902	-0.0305	-0.0308
	(0.0071)**	(0.0135)	(0.0071)**	(0.0140)*	(0.0140)*
Share of village wheat among total sown area in village	-0.1749	-0.1918	-0.1662	-0.1897	-0.1914
	(0.0104)**	(0.0181)**	(0.0107)**	(0.0181)**	(0.0181)**
Share of households with TVs	0.0685	-0.0753	0.0717	-0.0673	-0.0664
	(0.0107)**	(0.0162)**	(0.0107)**	(0.0164)**	(0.0164)**
Share of households with phones	-0.0405	0.3702	-0.0317	0.3356	0.3287
	(0.0097)**	(0.0923)**	(0.0098)**	(0.0936)**	(0.0939)**
Share of illiterate laborers among total laborers	-0.0546	-0.0398	-0.0409	-0.0328	-0.0390
	(0.0349)	(0.0707)	(0.0349)	(0.0707)	(0.0720)
Share of people graduate elementary school in village	-0.1455	-0.0144	-0.1474	-0.0230	-0.0258
	(0.0300)**	(0.0526)	(0.0300)**	(0.0529)	(0.0536)
Share of people who graduate secondary school in village	0.0753	0.1845	0.0911	0.2087	0.1975
	(0.0357)*	(0.0790)*	(0.0356)*	(0.0787)**	(0.0822)*
Share of households using safe and sanitary water	-0.0056	0.0336	-0.0112	0.0266	0.0273
	(0.0038)	(0.0074)**	(0.0039)**	(0.0077)**	(0.0078)**
Distance to the main concreted road (Km)	0.0031	0.0051	0.0029	0.0050	0.0050
	(0.0004)**	(0.0008)**	(0.0004)**	(0.0008)**	(0.0008)**

Table 1 (cont'd)

Rainfall shock of t-1		-0.0038		-0.0049	-0.0023
		(0.0019)*		(0.0019)*	(0.0029)
Constant	0.3338	0.3646	0.3407	0.3659	0.3696
	(0.0358)**	(0.0721)**	(0.0359)**	(0.0722)**	(0.0727)**
Observations	16611	5437	16611	5437	5437
R-squared	0.13	0.19	0.13	0.19	0.19

Notes: 1. Robust standard errors in parentheses
2. * significant at 5%, ** significant at 1%
3. All specifications include province*year dummies. Their coefficients are jointly significant.

Table 1 (cont'd).

2. Share of Cash-in-hand

Variables	Share of Cash-in-hand				
Coefficient of rainfall variation	0.0137 (0.0044)**	0.0132 (0.0067)*	-0.0091 (0.0065)	-0.0623 (0.0106)**	-0.0538 (0.0113)**
Land*Coefficient of variation			0.0380 (0.0075)**	0.0803 (0.0125)**	0.0756 (0.0126)**
Land* Rainfall shock (=|Rainfall-Average of Rainfall|)					-0.0029 (0.0009)**
Household size	-0.0027 (0.0006)**	-0.0040 (0.0009)**	-0.0026 (0.0006)**	-0.0039 (0.0009)**	-0.0039 (0.0009)**
Age of household head	0.0002 (0.0003)	0.0002 (0.0005)	0.0001 (0.0003)	0.0002 (0.0005)	0.0002 (0.0005)
Age squared of household head	-0.00001 (0.00001)	-0.00001 (0.00001)	-0.00001 (0.00001)	-0.00001 (0.00001)	-0.0000 (0.0000)
Number of dependents	0.0007 (0.0007)	0.0017 (0.0012)	0.0009 (0.0007)	0.0021 (0.0012)	0.0020 (0.0012)
Proportion of illiterates in household	0.0170 (0.0036)**	0.0029 (0.0060)	0.0167 (0.0036)**	0.0021 (0.0059)	0.0021 (0.0059)
Proportion of elementary school educated in household	0.0164 (0.0032)**	0.0141 (0.0056)*	0.0157 (0.0032)**	0.0123 (0.0056)*	0.0125 (0.0056)*
Proportion of secondary school educated in household	0.0040 (0.0031)	0.0024 (0.0054)	0.0036 (0.0031)	0.0016 (0.0054)	0.0017 (0.0054)
Arable land per capita	-0.0057 (0.0008)**	-0.0022 (0.0013)	-0.0173 (0.0026)**	-0.0260 (0.0042)**	-0.0261 (0.0041)**
Village located in hilly area (dummy)	0.0118 (0.0019)**	0.0105 (0.0039)**	0.0114 (0.0019)**	0.0110 (0.0039)**	0.0130 (0.0040)**
Village located in mountain area (dummy)	0.0115 (0.0022)**	0.0168 (0.0038)**	0.0162 (0.0023)**	0.0274 (0.0040)**	0.0288 (0.0041)**
Village located in a city suburb (dummy)	-0.0190 (0.0020)**	-0.0231 (0.0036)**	-0.0184 (0.0020)**	-0.0229 (0.0036)**	-0.0231 (0.0036)**

Table 1 (cont'd)

Annual net income per capita in village	-0.0001	0.0001	-0.0001	0.0001	0.0001
	(0.0000)**	(0.0000)	(0.0000)**	(0.0000)	(0.0001)
Number of people who migrated out among total residents	-0.5153	-0.0660	-0.5170	0.0015	-0.0215
	(0.0621)**	(0.1040)	(0.0623)**	(0.1061)	(0.1065)
Permanent residents in a village	-0.0001	-0.0001	-0.0001	-0.0001	-0.0001
	(0.0000)*	(0.0000)**	(0.0000)**	(0.0000)**	(0.0000)**
Full time farming households ratio in village	-0.0119	0.0127	-0.0111	0.0181	0.0205
	(0.0025)**	(0.0045)**	(0.0025)**	(0.0046)**	(0.0046)**
Share of village cadre in village	-0.1262	-1.3730	-0.3170	-1.7538	-1.5926
	(0.2743)	(0.4906)**	(0.2854)	(0.5025)**	(0.5104)**
Share of rice among total sown area in village	-0.0407	-0.0475	-0.0423	-0.0587	-0.0593
	(0.0034)**	(0.0061)**	(0.0034)**	(0.0062)**	(0.0062)**
Share of village wheat among total sown area in village	-0.0567	-0.0764	-0.0522	-0.0746	-0.0772
	(0.0038)**	(0.0074)**	(0.0039)**	(0.0074)**	(0.0075)**
Share of households with TVs	0.0074	-0.0420	0.0091	-0.0348	-0.0335
	(0.0054)	(0.0084)**	(0.0053)	(0.0083)**	(0.0083)**
Share of households with phones	-0.0252	-0.0101	-0.0207	-0.0410	-0.0518
	(0.0042)**	(0.0384)	(0.0043)**	(0.0381)	(0.0387)
Share of illiterate laborers among total laborers	0.0906	0.0179	0.0977	0.0242	0.0146
	(0.0173)**	(0.0295)	(0.0173)**	(0.0294)	(0.0296)
Share of people graduate elementary school in village	-0.0353	-0.0716	-0.0363	-0.0793	-0.0837
	(0.0144)*	(0.0248)**	(0.0144)*	(0.0247)**	(0.0247)**
Share of people who graduate secondary school in village	0.0840	0.0957	0.0922	0.1174	0.1000
	(0.0158)**	(0.0318)**	(0.0160)**	(0.0322)**	(0.0329)**
Share of households using safe and sanitary water	-0.0094	-0.0041	-0.0123	-0.0104	-0.0093
	(0.0016)**	(0.0033)	(0.0017)**	(0.0034)**	(0.0034)**
Distance to the main concreted road (Km)	-0.0011	-0.0005	-0.0012	-0.0006	-0.0006
	(0.0001)**	(0.0003)	(0.0001)**	(0.0003)	(0.0003)*
Rainfall shock of t-1		-0.0035		-0.0045	-0.0035
		(0.0007)**		(0.0007)**	(0.0013)**

Table 1 (cont'd)

Constant	0.0775	0.1530	0.0811	0.1541	0.1598
	(0.0166)**	(0.0309)**	(0.0167)**	(0.0308)**	(0.0308)**
Observations	16611	5437	16611	5437	5437
R-squared	0.09	0.09	0.09	0.09	0.09

Notes: 1. Robust standard errors in parentheses
2. * significant at 5%, ** significant at 1%
3. All specifications include province*year dummies. Their coefficients are jointly significant.

Table 1 (cont'd).

3. Share of Grain Stocks

Variables	Share of Grain Stocks				
Coefficient of rainfall variation	-0.0168	-0.0321	0.0342	-0.0044	-0.0209
	(0.0034)**	(0.0067)**	(0.0056)**	(0.0111)	(0.0117)
Land*Coefficient of variation			-0.0850	-0.0470	-0.0380
			(0.0086)**	(0.0174)**	(0.0176)*
Land* Rainfall shock					-0.0075
(=|Rainfall-Average of Rainfall|)					(0.0018)**
Household size	-0.0033	-0.0038	-0.0035	-0.0039	-0.0039
	(0.0006)**	(0.0011)**	(0.0006)**	(0.0011)**	(0.0011)**
Age of household head	-0.0005	0.0001	-0.0005	0.0001	-0.0001
	(0.0003)	(0.0006)	(0.0003)	(0.0006)	(0.0006)
Age squared of household head	0.00001	-0.00001	0.00001	-0.00001	-0.0000
	(0.00001)	(0.00001)	(0.00001)	(0.00001)	(0.0000)
Number of dependents	0.0059	0.0074	0.0055	0.0071	0.0072
	(0.0007)**	(0.0013)**	(0.0007)**	(0.0013)**	(0.0013)**
Proportion of illiterates in household	0.0191	0.0327	0.0198	0.0331	0.0333
	(0.0043)**	(0.0073)**	(0.0042)**	(0.0073)**	(0.0073)**
Proportion of elementary school educated in household	0.0089	0.0225	0.0106	0.0236	0.0232
	(0.0037)*	(0.0064)**	(0.0036)**	(0.0063)**	(0.0063)**
Proportion of secondary school educated in household	-0.0033	0.0056	-0.0022	0.0060	0.0059
	(0.0037)	(0.0063)	(0.0036)	(0.0063)	(0.0063)
Arable land per capita	0.0205	0.0272	0.0464	0.0412	0.0413
	(0.0010)**	(0.0021)**	(0.0028)**	(0.0055)**	(0.0055)**
Village located in hilly area (dummy)	-0.0148	-0.0287	-0.0138	-0.0290	-0.0329
	(0.0021)**	(0.0048)**	(0.0021)**	(0.0048)**	(0.0048)**
Village located in mountain area (dummy)	-0.0598	-0.0864	-0.0705	-0.0926	-0.0953
	(0.0031)**	(0.0062)**	(0.0033)**	(0.0066)**	(0.0067)**
Village located in a city suburb (dummy)	-0.0153	0.0019	-0.0167	0.0018	0.0021
	(0.0022)**	(0.0048)	(0.0022)**	(0.0047)	(0.0048)

Table 1 (cont'd)

Annual net income per capita in village	0.0000	-0.0000	0.0000	-0.0000	-0.0000
	(0.0000)	(0.0000)*	(0.0000)	(0.0000)*	(0.0000)**
Number of people who migrated out among total residents	0.2163	0.9419	0.2202	0.9024	0.9467
	(0.0661)**	(0.1655)**	(0.0651)**	(0.1654)**	(0.1658)**
Permanent residents in a village	-0.0000	-0.0000	-0.0000	-0.0000	-0.0000
	(0.0000)**	(0.0000)**	(0.0000)**	(0.0000)**	(0.0000)**
Full time farming households ratio in village	0.0504	0.0772	0.0487	0.0740	0.0695
	(0.0027)**	(0.0065)**	(0.0027)**	(0.0064)**	(0.0065)**
Share of village cadre in village	-3.1079	-4.7006	-2.6806	-4.4776	-4.7878
	(0.2530)**	(0.5860)**	(0.2515)**	(0.5892)**	(0.5958)**
Share of rice among total sown area in village	-0.0252	-0.0409	-0.0215	-0.0343	-0.0333
	(0.0037)**	(0.0071)**	(0.0036)**	(0.0071)**	(0.0071)**
Share of village wheat among total sown area in village	-0.0627	-0.1231	-0.0726	-0.1242	-0.1191
	(0.0058)**	(0.0110)**	(0.0060)**	(0.0110)**	(0.0110)**
Share of households with TVs	-0.0085	0.0187	-0.0122	0.0146	0.0119
	(0.0052)	(0.0071)**	(0.0052)*	(0.0073)*	(0.0074)
Share of households with phones	-0.0031	0.0194	-0.0133	0.0375	0.0581
	(0.0038)	(0.0420)	(0.0038)**	(0.0424)	(0.0431)
Share of illiterate laborers among total laborers	0.1142	0.0581	0.0985	0.0545	0.0729
	(0.0140)**	(0.0303)	(0.0138)**	(0.0300)	(0.0307)*
Share of people graduate elementary school in village	0.2310	0.2431	0.2332	0.2476	0.2562
	(0.0135)**	(0.0237)**	(0.0134)**	(0.0236)**	(0.0240)**
Share of people who graduate secondary school in village	0.3133	0.3407	0.2950	0.3280	0.3615
	(0.0168)**	(0.0361)**	(0.0163)**	(0.0351)**	(0.0373)**
Share of households using safe and sanitary water	-0.0123	-0.0050	-0.0059	-0.0014	-0.0035
	(0.0020)**	(0.0045)	(0.0021)**	(0.0046)	(0.0046)
Distance to the main concreted road (Km)	-0.0001	0.0023	0.0001	0.0024	0.0024
	(0.0001)	(0.0004)**	(0.0001)	(0.0004)**	(0.0004)**
Rainfall shock of t-1		-0.0051		-0.0045	0.0068
		(0.0014)**		(0.0014)**	(0.0015)**

Table 1 (cont'd)

Constant	-0.0694	-0.0451	-0.0774	-0.0458	-0.0567
	(0.0156)**	(0.0313)	(0.0155)**	(0.0311)	(0.0312)
Observations	16611	5437	16611	5437	5437
R-squared	0.27	0.33	0.28	0.33	0.33

Notes: 1. Robust standard errors in parentheses
2. * significant at 5%, ** significant at 1%
3. All specifications include province*year dummies. Their coefficients are jointly significant.

Table 1 (cont'd).

4. Share of Bank Deposits

Variables	Share of Bank Deposits				
Coefficient of rainfall variation	0.0005 (0.0063)	0.0166 (0.0055)*	-0.0721 (0.0093)**	0.0094 (0.0169)	0.0229 (0.0182)
Land*Coefficient of variation			0.1209 (0.0126)**	0.0566 (0.0240)*	0.0492 (0.0243)*
Land* Rainfall shock (=|Rainfall-Average of Rainfall|)					0.0066 (0.0021)**
Household size	-0.0038 (0.0010)**	-0.0002 (0.0017)	-0.0034 (0.0010)**	-0.0001 (0.0017)	-0.0001 (0.0017)
Age of household head	0.0009 (0.0006)	0.0005 (0.0009)	0.0009 (0.0006)	0.0005 (0.0009)	0.0006 (0.0009)
Age squared of household head	-0.00001 (0.00001)	-0.00001 (0.00001)	-0.00001 (0.00001)	-0.00001 (0.00001)	-0.0000 (0.0000)
Number of dependents	-0.0025 (0.0013)	-0.0067 (0.0021)**	-0.0020 (0.0013)	-0.0065 (0.0022)**	-0.0066 (0.0022)**
Proportion of illiterates in household	-0.0568 (0.0069)**	-0.0607 (0.0116)**	-0.0577 (0.0069)**	-0.0612 (0.0116)**	-0.0613 (0.0116)**
Proportion of elementary school educated in household	-0.0173 (0.0065)**	-0.0339 (0.0112)**	-0.0197 (0.0065)**	-0.0351 (0.0112)**	-0.0348 (0.0112)**
Proportion of secondary school educated in household	-0.0130 (0.0066)*	-0.0379 (0.0114)**	-0.0145 (0.0066)*	-0.0385 (0.0114)**	-0.0384 (0.0113)**
Arable land per capita	-0.0115 (0.0014)**	-0.0133 (0.0022)**	-0.0484 (0.0037)**	-0.0301 (0.0068)**	-0.0302 (0.0068)**
Village located in hilly area (dummy)	-0.0095 (0.0037)**	-0.0393 (0.0071)**	-0.0110 (0.0037)**	-0.0389 (0.0070)**	-0.0358 (0.0070)**
Village located in mountain area (dummy)	-0.0567 (0.0043)**	-0.0663 (0.0094)**	-0.0415 (0.0046)**	-0.0588 (0.0100)**	-0.0567 (0.0101)**
Village located in a city suburb (dummy)	-0.0530 (0.0045)**	-0.0488 (0.0073)**	-0.0510 (0.0045)**	-0.0487 (0.0073)**	-0.0489 (0.0072)**

Table 1 (cont'd)

Annual net income per capita in village	0.0001	0.0001	0.0001	0.0001	0.0001
	(0.0000)**	(0.0000)	(0.0000)**	(0.0000)	(0.0000)
Number of people who migrated out among total residents	0.8716	1.1344	0.8660	1.1820	1.1459
	(0.1300)**	(0.2580)**	(0.1300)**	(0.2588)**	(0.2593)**
Permanent residents in a village	0.0001	0.0001	0.0001	0.0001	0.0001
	(0.0000)**	(0.0000)**	(0.0000)**	(0.0000)**	(0.0000)**
Full time farming households ratio in village	-0.0393	-0.0595	-0.0370	-0.0557	-0.0520
	(0.0046)**	(0.0083)**	(0.0046)**	(0.0084)**	(0.0087)**
Share of village cadre in village	0.8022	-1.0290	0.1944	-1.2973	-1.0446
	(0.4316)	(0.8786)	(0.4374)	(0.8885)	(0.8958)
Share of rice among total sown area in village	-0.0211	0.0705	-0.0264	0.0626	0.0617
	(0.0050)**	(0.0093)**	(0.0050)**	(0.0097)**	(0.0096)**
Share of village wheat among total sown area in village	-0.0556	0.0077	-0.0414	0.0090	0.0049
	(0.0081)**	(0.0132)	(0.0083)**	(0.0133)	(0.0132)
Share of households with TVs	0.0696	-0.0521	0.0748	-0.0470	-0.0449
	(0.0082)**	(0.0135)**	(0.0082)**	(0.0136)**	(0.0137)**
Share of households with phones	-0.0122	0.3610	0.0023	0.3392	0.3224
	(0.0081)	(0.0726)**	(0.0081)	(0.0739)**	(0.0735)**
Share of illiterate laborers among total laborers	-0.2595	-0.1159	-0.2372	-0.1115	-0.1265
	(0.0285)**	(0.0573)*	(0.0284)**	(0.0569)	(0.0581)*
Share of people graduate elementary school in village	-0.3414	-0.1859	-0.3445	-0.1913	-0.1983
	(0.0240)**	(0.0405)**	(0.0240)**	(0.0408)**	(0.0413)**
Share of people who graduate secondary school in village	-0.3222	-0.2519	-0.2962	-0.2366	-0.2639
	(0.0292)**	(0.0634)**	(0.0290)**	(0.0622)**	(0.0648)**
Share of households using safe and sanitary water	0.0162	0.0428	0.0070	0.0384	0.0401
	(0.0028)**	(0.0053)**	(0.0029)*	(0.0057)**	(0.0057)**
Distance to the main concreted road (Km)	0.0043	0.0033	0.0040	0.0033	0.0032
	(0.0003)**	(0.0006)**	(0.0003)**	(0.0006)**	(0.0006)**
Rainfall shock of t-1			0.0048	0.0041	-0.0055

Table 1 (cont'd)

		(0.0015)**		(0.0015)**	(0.0024)*
Constant	0.3259	0.2568	0.3372	0.2576	0.2665
	(0.0295)**	(0.0586)**	(0.0295)**	(0.0586)**	(0.0590)**
Observations	16611	5437	16611	5437	5437
R-squared	0.16	0.20	0.16	0.20	0.20

Notes: 1. Robust standard errors in parentheses

2. * significant at 5%, ** significant at 1%

3. All specifications include province*year dummies. Their coefficients are jointly significant.

Table 2. Regression Results for Share of Liquid Wealth-holding with Village-year Dummies

Variables	Liquid W	Cash	Grain	Deposits
Land*Coefficient of rainfall variation	-0.0497	0.0212	-0.0821	0.0112
	(0.0161)**	(0.0067)**	(0.0394)*	(0.0125)
Household size	-0.0102	-0.0025	-0.0051	-0.0026
	(0.0012)**	(0.0005)**	(0.0006)**	(0.0010)**
Age of household head	0.00001	0.0002	-0.0008	0.0007
	(0.0007)	(0.0003)	(0.0003)*	(0.0005)
Age squared of household head	-0.00001	-0.00001	0.00001	-0.00001
	(0.00001)	(0.00001)	(0.000003)*	(0.00001)
Number of dependents	0.0041	-0.0002	0.0085	-0.0042
	(0.0016)*	(0.0007)	(0.0007)**	(0.0013)**
Proportion of illiterates in household	-0.0394	0.0070	0.0179	-0.0643
	(0.0086)**	(0.0032)*	(0.0043)**	(0.0066)**
Proportion of elementary school educated in household	-0.0124	0.0106	0.0118	-0.0348
	(0.0080)	(0.0030)**	(0.0037)**	(0.0063)**
Proportion of secondary school educated in household	-0.0309	0.0018	0.0005	-0.0332
	(0.0080)**	(0.0029)	(0.0037)	(0.0063)**
Arable land per capita	0.0365	-0.0124	0.0559	-0.0070
	(0.0054)**	(0.0022)**	(0.0033)**	(0.0036)
Constant	0.2663	0.0613	0.0823	0.1228
	(0.0178)**	(0.0077)**	(0.0089)**	(0.0137)**
Observations	16667	16667	16667	16667
R-squared	0.22	0.26	0.33	0.28

Notes: 1. Robust standard errors in parentheses

2. * significant at 5%, ** significant at 1%

3. All specifications include village*year dummies. Their coefficients are jointly significant.

Table 3. Regression Results for Share of Liquid Wealth-holdings with Rainfall Shock and Village-year Dummies

Variables	Liquid W	Cash	Grain	Deposits
Land*Coefficient of rainfall variation	0.0966	0.0579	-0.0014	0.0402
	(0.0471)*	(0.0170)**	(0.0298)	(0.0396)
	-	-	-	-
Land* Rainfall shock	0.0074	0.0014	0.0033	0.0028
(|rainfall-average of rainfall|)	(0.0024)**	(0.0008)	(0.0016)*	(0.0017)
Household size	-0.0062	-0.0032	-0.0035	0.0005
	(0.0026)*	(0.0010)**	(0.0013)**	(0.0021)
Age of household head	0.0009	0.0002	-0.0005	0.0012
	(0.0014)	(0.0006)	(0.0007)	(0.0011)
Age squared of household head	-0.00001	-0.00001	0.00001	-0.00001
	(0.00001)	(0.00001)	(0.00001)	(0.00001)
Number of dependents	-0.0019	-0.0004	0.0072	-0.0087
	(0.0033)	(0.0013)	(0.0016)**	(0.0026)**
Proportion of illiterates in household	-0.0359	-0.0028	0.0335	-0.0667
	(0.0173)*	(0.0063)	(0.0087)**	(0.0134)**
Proportion of elementary school educated in household	-0.0250	0.0042	0.0159	-0.0451
	(0.0162)	(0.0060)	(0.0074)*	(0.0130)**
Proportion of secondary school educated in household	-0.0565	-0.0042	-0.0004	-0.0520
	(0.0160)**	(0.0057)	(0.0072)	(0.0132)**
Arable land per capita	-0.0146	-0.0245	0.0291	-0.0192
	(0.0158)	(0.0060)**	(0.0106)**	(0.0120)
Constant	0.5325	0.0901	0.2603	0.1821
	(0.0487)**	(0.0159)**	(0.0330)**	(0.0312)**
Observations	5494	5494	5494	5494
R-squared	0.33	0.25	0.46	0.31

Notes: 1. Serial correlation robust standard errors in parentheses

2. * significant at 5%, ** significant at 1%

3. All specifications include village*year dummies. Their coefficients are jointly significant.

Appendix D

Table D1. Follow-up Rates of RCRE Survey

Year	Number of Households	Follow-up rates (%) of 1995 households	Changes
1995	4,152	100.0	-
1996	4,004	96.4	-3.6
1997	3,978	95.8	-0.6
1998	3,798	91.5	-4.3
1999	3,758	90.5	-1.0
2000	3,724	89.7	-0.8

Table D2. Grain Balance

	1995	1996	1997	1998	1999	2000
Grain Stock in year end (Mean)	895	1,118	1,145	1,193	1,197	1,186
Standard deviation	793	1053	1199	1151	1267	1366
Grain Stock in year end (Median)	724	877	860	916.5	863	864.5

Table D3. Grain Yield per Household

	1995	1996	1997	1998	1999	2000
Grain yield (Kg)	2,169	2,273	2,254	2,143	1,996	1,951
Of which, wheat	691	750	805	614	687	622
Of which, rice	874	882	901	906	743	800
Of which, corn	415	431	371	439	409	366

Growth rate (%)

	1995	1996	1997	1998	1999	2000
Grain Yield (Kg)		4.8	-0.8	-4.9	-6.9	-2.3
Of which, wheat		8.6	7.2	-23.6	11.8	-9.5
Of which, rice		1.0	2.1	0.6	-18.0	7.6
Of which, corn		3.9	-14.0	18.3	-6.9	-10.4

Table D4. Value of Production and Non-production Assets

	Mean	Median
Total value of production assets	3,470 (5,172)	1,000
Total value of non-production assets	14,946 (18,386)	8,850
Of which, Housing	11,839 (16,539)	6,500
Of which, Durable goods	2,785 (4,644)	1,500

Note: Figures in the parenthesis are the standard errors.

Table D4 (cont'd).

By year: 1995 – 2000

	1995	1996	1997	1998	1999	2000
Total value of production assets	2,760	3,187	3,444	3,706	3,809	3,921
Total value of non-production assets	11,382	12,748	14,223	15,675	17,257	18,417
Of which, Housing	8,521	10,071	11,291	12,511	13,894	14,771
Of which, Durable goods	2,040	2,401	2,694	2,973	3,202	3,406

Note: All values were deflated.

Growth rates (%)

	1995	1996	1997	1998	1999	2000
Total value of production assets	NA	15.5	8.1	7.6	2.8	2.9
Total value of non-production assets	NA	12.0	11.6	10.2	10.1	6.7
Of which, Housing	NA	18.2	12.1	10.8	11.1	6.3
Of which, Durable goods	NA	17.7	12.2	10.3	7.7	6.4

Table D5. Household Income

	1995	1996	1997	1998	1999	2000
Total income (mean value)	11,631	12,778	13,393	12,691	12,304	12,329
Of which, household business income	8,532	9,363	9,628	8,730	8,230	7,927
Of which, wage income	999	1,272	1,540	1,573	1,659	1,837
Others	817	843	877	996	1,027	1,154
Total income (%)	100.0	100.0	100.0	100.0	100.0	100.0
Of which, household management income	73.4	73.3	71.9	68.8	66.9	64.3
Of which, wage income	8.6	10.0	11.5	12.4	13.5	14.9
Others	7.0	6.6	6.6	7.8	8.3	9.4

Table D6. Cash/Deposits Balance

	Mean	Median
Total deposits	3,267 (8,197)	0
Total cash in hand	1,222 (2,441)	600
Total amounts of lending	343 (2,035)	0
Total amounts of borrowing	1,463 (7,320)	0
Of which, loans from banks and rural credit cooperatives	230 (3,135)	0

Note: Figures in the parenthesis are the standard errors.

Table D7. Cash/deposits Balance

	1995	1996	1997	1998	1999	2000
Total deposits	2,070	2,623	3,049	3,303	3,902	4,678
Total cash in hand	907	1,183	1,234	1,353	1,284	1,379
Total amounts of lending	284	354	356	317	376	369
Total amounts of borrowing	942	1,308	1,529	1,604	1,714	1,688
Loans from banks and rural credit cooperatives	219	278	269	259	180	175

Growth rates (%)

	1995	1996	1997	1998	1999	2000
Total deposits		26.7	16.2	8.3	18.1	19.9
Total cash in hand		30.4	4.3	9.7	-5.1	7.4
Total amounts of lending		24.7	0.6	-10.9	18.7	-2.0
Total amounts of borrowing		38.9	16.9	4.9	6.9	-1.5
Loans from banks and rural credit cooperatives		26.8	-3.2	-3.9	-30.6	-2.7

Table D8. Composition of Non-land Wealth

Variables	Mean	STD
Liquid wealth share	0.29	0.28
Of which, cash-in-hand	0.07	0.10
Of which, grain stock	0.11	0.11
Of which, deposits	0.11	0.17
Housing share	0.46	0.23
Fixed assets share	0.12	0.16
Durable share	0.13	0.11

Table D9. Share of Non-land Wealth

	1995	1996	1997	1998	1999	2000
Liquid wealth share	0.26	0.30	0.30	0.29	0.28	0.28
Of which, cash-in-hand	0.06	0.07	0.07	0.07	0.07	0.07
Of which, grain stock	0.11	0.13	0.12	0.11	0.09	0.08
Of which, deposits	0.09	0.10	0.11	0.11	0.12	0.13
Housing assets share	0.48	0.45	0.46	0.46	0.47	0.46
Fixed assets share	0.13	0.13	0.12	0.13	0.12	0.12
Durable share	0.13	0.13	0.13	0.13	0.13	0.14

Table D10. Descriptive Statistics of Variables

Variables	Obs.	Mean	SD
Coefficient of rainfall variation	19601	0.372	0.172
Household size	24734	3.981	1.523
Age of household head (/1000)	20120	0.045	0.012
Number of dependents	24734	1.492	1.189
Proportion of illiterates among adults in household	24058	0.184	0.278
Proportion of elementary school educated among adults in household	24059	0.354	0.323
Proportion of secondary school educated among adults in household	24059	0.366	0.330
Arable land per capita	24680	1.369	1.288
Village located in plains (dummy)	24539	0.431	0.495
Village located in hilly area (dummy)	24539	0.332	0.471
Village located in a city suburb (dummy)	24539	0.131	0.338
Village located near township (dummy)	24539	0.208	0.406
Village located in a mining area (dummy)	24539	0.045	0.207
Village located in mountain area (dummy)	24539	0.232	0.422
Annual net income per capita in village	24539	0.200	0.093
Permanent residents in a village	24539	1.571	0.915
Full time farming households ratio in village	24539	0.480	0.317
Share of cadre in village	24539	0.006	0.004
Share of wheat among total sown area in village	24539	0.325	0.237
Share of households with TVs	24539	0.853	0.169
Share of households with phones	24539	0.120	0.194
Share of illiterate people in village	24539	0.127	0.102
Share of people who graduated elementary school in village	24539	0.377	0.127
Share of people who graduated secondary school in village	24539	0.391	0.128
Share of households using safe and sanitary water	24539	0.663	0.450
Share of households using electricity	24539	0.985	0.103

References

Bertaut,C. and M.Haliassos (1996), "Precautionary Portfolio Behavior From a Life Cycle Perspective," International Finance Discussion Papers No.542, Board of Governors.

Brenner, M. (2001), "Reexamining the Distribution of Wealth in Rural China," in Riskin, C.,Z.Renwei, & Li Shi, ed., *China's Retreat from Equality: Income Distribution and Economic Transformation*, New York: M.E.Sharpe.

Chakraborty, A. and M. Kazarosian (1999), Portfolio Allocation of Precautionary Assets: Panel Evidence for the United States, mimeo.

Deaton, A. (1989), "Saving in Developing Countries: Theory and Review," Proceedings of the World Bank Annual Conference on Development Economics, World Bank, pp.61 – 96.

Dercon, S. (1998), "Wealth, risk and activity choice: cattle in western Tanzania," *Journal of Development Economics*, Vol.55, pp.1 –42.

Dicks-Mireaux, L. and M. King (1982), "Asset Holdings and the Life Cycle," *Economic Journal*, Vol.92, pp.247 – 267.

Dreze, H. and F. Modigliani (1972), "Consumption Under Uncertainty," *Journal of Economic Theory*, Vol.5(3), pp. 308 – 335.

Duncan, G.J. and D. Hill (1985), "An Investigation of the Extent and Consequences of Measurement Error in Labor Economic Survey Data," *Journal of Labor Economics*, Vol.3, pp.508 – 553.

Fafchamps, M., C. Udry and K. Czukas (1998), "Drought and Saving in West Africa: Are Livestock a Buffer Stock?," *Journal of Development Economics*, Vol.55, pp.273-305.

Feldstein, M. (1976), "Personal Taxation and Portfolio Composition: An Econometric Anlysis," *Econometrica*, Vol.44, pp.631-650.

Frankenberg, E., J.P.Smith and D.Thomas (2003), "Economic Shocks, Wealth, and Welfare," *Journal of Human Resources*, Vol.38(2), pp.280 – 321.

Gersovitz, M. (1988), "Saving and Development," *Handbook of Development Economics*, Vol.1, pp.381 – 424.

Guiso, L., T. Jappelli, and D. Terlizzese (1996), "Income Risk, Borrowing Constraints, and Portfolio Choice," *American Economic Review*, Vol.86(1), pp.158 – 172.

Jalan, J. and M. Ravallion (2001), "Behavioral Responses to Risk in Rural China," *Journal of Development Economics*, Vol.66, pp.23 – 49.

Ke, B. (2000), "On-farm Grain Stocks and Their Impact on Market Stability in China," in Yang, Y. and W.Tian ed., *China's Agriculture at the Crossroads*, MacMillan press.

Kimball, M. (1990), "Precautionary Saving in the Small and in the Large," *Econometrica*, Vol.58, pp.53 –73.

Kimball, M. (1992), "Precautionary demand for liquidity," *The New Palgrave Dictionary of Money and Finance*, edited by P. Newman, M. Milgate, and J. Eatwell, Vol.3, pp.160 – 161.

Kimball, M. (1993), "Standard Risk Aversion," *Econometrica*, Vol.61(3), pp. 589 – 611.

Park, A. (2001), *Risk and Household Grain Management in Developing countries*, mimeo, Department of Economics, University of Michigan.

Paxson, C. (1990), "Borrowing Constraints and Portfolio Choice," *Quarterly Journal of Economics*, Vol.105(2), pp. 535 – 543.

Pratt, J.W. and Zeckhauser,R.J. (1987), "Proper Risk Aversion," *Econometrica*, Vol.55, pp.143-154

Rosenzweig, M. and H. Binswanger (1993), "Wealth, Weather Risk and the Composition and Profitability of Agricultural Investments," The Economic Journal, Vol.103, pp.56 – 78.

Rosenzweig. M. and K. Wolpin (1993), "Wealth, Weather Risk and the Composition and Profitability of Agricultural Investments," *The Economic Journal*, Vol.103, pp.56-78.

Svensson, L.E.O. (1985), "Money and asset prices in a cash-in-advance economy," *Journal of Political Economy*, Vol.93, pp.914 – 944.

Udry, C. (1995), "Risk and Saving in Northern Nigeria," *American Economic Review*, pp.1287-1300.

Varian, H. (1992), *Microeconomic analysis*, 3rd edition, W.W. Norton and Company.

Yang, H. (1999), "Growth in China's Grain Production 1978 – 1997," *World Development*, Vol.27, No.12, pp.2137 – 2154.

Chapter 3

HOUSEHOLD NON-LAND WEALTH IN RURAL CHINA: COMPOSITION AND DISTRIBUTION FROM 1986 TO 2000

1. Introduction

China has been experiencing a great transition from a socialist economy to a market economy since the decollectivisation of agriculture and the introduction of market reforms. With the expansion of liberalizing reforms and the development of rural industry, China has achieved impressive growth in a relatively short period, and it is reported that a large number of people have been lifted out of poverty.[1] [2] However, as official economic indicators in China show dramatic growth and improvement (Table 2), disparities in income and wealth have also increased and have become a big concern to policy makers.[3]

Although the role of wealth and its distribution figures centrally in understanding the dynamics of economic development, relatively little is known about wealth of rural households in transitional economies. Also, in matters of agricultural policy much attention seems to be focused on income and little on the assets held by farmers, although distributions of asset holdings as well as income are considered to be among the key factors of China's economic security.[4] Hence, questions about the distribution of wealth

[1] As shown in Table 1, per capita rural income in 1978 was 134 yuan and became 2,253 yuan (17 times greater) while urban income is 18 times greater since 1978.
[2] China's official poverty statistics show a dramatic reduction of China's poor population from 250 million in 1978 to 32 million in 2000, although they underestimate rural poverty (Park and Wang (2001).
[3] Ravallion and Chen (1998) provide the different empirical results on this using household surveys for 67 developing countries over 1981 – 94. They suggest that changes in inequality have been uncorrelated with changes in average living standards and distribution improved as often as it worsened in growing economies.
[4] Refer to Draguhn and Ash (1999).

in rural China are relevant, and gaining adequate information on this issue is an urgent and important task.

This study is concerned with non-land wealth distribution and the asset position of farming households in contemporary rural China.[5] We will attempt to answer the following questions: 1. What are the levels and dynamic changes in composition of non-land wealth in rural areas? 2. Are there any dramatic changes in the composition of non-land wealth during the period from 1986 to 2000? 3. How much non-land wealth inequality is there in rural China? 4. How has inequality in rural China changed during this period? 5. How do components of wealth affect non-land wealth distribution?

As concern about the distribution of wealth in rural China is a relatively new phenomenon that has accompanied the dramatic institutional changes of the post-reform period, this study is particularly timely. Given the sharp rise in rural income inequality discussed in Khan and Riskin (1998) with possible links between income and wealth distribution posited, it is natural to wonder if growing inequality can be found in the distribution of household asset holdings in contemporary rural China. In this paper, we first describe the overall household non-land wealth composition and changes of the form in which wealth is held in rural China. Next, we document in detail the extent and determinants of wealth inequality over the years, based on various inequality measures. At the end of the chapter we briefly discuss whether low wealth households can accumulate non-land wealth over the period from 1986 to 2000 with the results of wealth dynamics.

[5] Growing income disparity between rural and urban residents is also an important issue, but we focus on the rural sector.

The paper will be structured in the following way: Section 2 provides background information on rural China and reviews past studies on income and wealth inequality in China. Section 3 briefly describes methods and data used in the study. In section 4, we examine the data in detail for differences in composition of household wealth holdings across the period. Section 5 presents main findings of wealth inequality and dynamic analysis of household's non-land wealth in rural China. Section 6 concludes the paper.

2. Historical Background and Studies on Rural China

2.1 Historical Background

It is worth noting that the issue of the distribution of wealth among households in rural China did not arise until after 1978, when a series of major economic and institutional reforms, beginning in the rural areas, were introduced. Prior to that time, most wealth, such as land, machinery, and equipment, was publicly owned. The main privately owned assets were housing assets, small tools, livestock, and individual use-rights to small plots. Most differences in household wealth were attributable to the number of each household's working members and their skills. Although the distribution was reported as being very equal, it didn't bring much growth to the rural economy since at that time, rewards were not linked to performance.[6]

From 1979 to 1984, the first phase of reform focused on decollectivizing agriculture by introducing the household responsibility system. This system distributed use rights of land to the farmers, although land could not be sold at the market. Land was

---

[6] Griffin and Saith (1982) reported that there was little income inequality in production brigades and teams during the period.

allocated to households on an equal basis, and farmers were allowed to keep the rest of their agriculture output after paying the quotas and taxes to the state. The household responsibility system allowed some farmers to become rich, as their efforts were directly linked to production performance. Grain production and rural incomes were increased rapidly in most regions of the country during this period.

The second phase of the reform started from 1985 with a changed focus away from the agriculture to the rural industrial sector. The structure of state taxes and prices was reformed, and an attempt was made to build a marketing and trading network. Efforts were made to develop non-farm enterprises—township and village enterprises (TVEs). TVEs are owned and operated by villages or townships and financed initially from surpluses generated within the community.

The new policy in this period, so called, "leave the land but not the countryside" was responded to with enthusiasm by Chinese farmers. As many farmers were transferred out of agriculture, farm production slowed down and the share of wage income increased substantially in rural households.

2.2 Studies on Income and Wealth Inequality in Rural China

Income Inequality in Rural China

Griffin and Saith (1982) measured rural income inequality and its determinants prior to the decollectivization period in China. They found little inequality in incomes in production brigades and teams, but discovered a greater disparity in distribution of assets across communes due to the structural factors of the quantity and quality of land. Rozelle (1994) analyzed the data from 1984 to 1989 and determined that evolving patterns of inequality were closely related to changing economic structures in rural China, and that interregional inequality was increasing in large part owing to the expansion of rural industry.

Hussain et al. (1994) showed that rural income inequality in 1986 was very low by international standards and that non-farming income was more unevenly distributed than farming income, which implies that income inequality rose with a shift in labor from farming activities to non-farming activities. Hare (1994) also found that non-agricultural income was less equally distributed than agricultural income.

Khan and Riskin (1998) analyzed the income distribution in China based on a 1995 survey and found that household production activities still contributed most to total rural income, while its share of total income decreased; yet wages, the second largest component of income, increased sharply. They reported that the main income sources for the wealthy were wages, non-farm entrepreneurship, and transfers from the state and collectives, while the main sources of income for the poor were farming and rental value of housing.

Contrary to Hussain et al. (1994), World Bank (1997) concluded that the Gini coefficient for overall inequality increased from 0.288 in 1981 to 0.388 in 1995 and greater opportunities for off-farm employment not only boosted income growth but also contributed to rising inequality. Yao and Zhu (1998) also supported this argument, providing the evidence that overall rural income inequality increased significantly from 1978 to 1996, although rural per capita incomes quadrupled.

More recently, Benjamin, Brandt, and Giles (2002) analyzed the evolution of income inequality in rural China using the same survey data that we use for this study.

They found that the Gini index for income inequality increased from 0.376 in 1987 to 0.440 in 1999 and reported that this rise was consistent with results using other rural surveys in China. They also suggested that the distribution of long-run living standards, which was reflected in current consumption, was less unequal than the distribution of income in any one-year.

Wealth Inequality in Rural China

There have been relatively few works on wealth distribution in rural areas compared to studies on income inequality. Until recently, poverty in China was mostly confined to the countryside, thus poverty has been a more urgent issue in rural China. Moreover, there have been some difficulties in obtaining reliable and extensive micro data on the ownership of livestock, agricultural tools and equipment, non-agricultural capital assets, housing assets, financial assets, and especially land, which is the most important asset in most rural economies. As a result, it is difficult to get accurate estimates of the distribution of total wealth. Here, we briefly review two studies that have been widely cited in the studies on distribution of wealth in rural China.

McKinley (1996) extensively researched rural wealth inequality in China in 1988. He argued that there was a relatively lower wealth inequality in rural China based on Gini index estimates, and land and fixed productive assets reduced inequality while housing and financial assets increased inequality. He suggested that land in China had the effect of reducing the total wealth inequality, while in other developing countries, a large proportion of rural households are landless and have very few other assets, resulting in a higher wealth inequality than income inequality.

More recently Brenner (2001) analyzed the wealth distribution in rural China using 1988 and 1995 surveys. He found that wealth distribution had worsened in 1995 compared to 1988, but continued to be remarkably equal in comparison to both rural income distribution in China and wealth distribution in other countries. He also argued that the source of growing divergence between wealth and income distribution is to be found in access to non-farm employment for household members, either through off-farm migration or local non-agricultural employment.

Both studies note that this relatively egalitarian distribution of wealth in rural China was primarily due to decades of land reform in rural China that, on the whole, have resulted in a more equal distribution of assets.[7] Although this might be the unique characteristic of wealth distribution in rural China we want to know the real situation of wealth distribution without land assets which might systematically play an equalizing role in the wealth distribution in rural China. We observe that the issues of income distribution and poverty in rural China have received relatively much attention in past studies and until recently, questions about wealth distribution in rural areas were not considered to be relevant and so urgent by the policy makers or researchers mostly due to these much lower inequality estimates of wealth distribution in rural China.

3. Valuation, Measurement, and Data

[7] Brenner (2001) reports that land in value terms continues to exert an equalizing effect on overall wealth distribution since 1988; land in physical units appears to have become more equally distributed since 1988, with the Gini coefficient for land distribution falls from 0.465 to 0.414, while the coefficient of variation falls from 2.96 to 0.83 in 1995.

3.1 Valuing Wealth

The valuation of wealth in money terms can take one of two broad approaches. The first values assets according to the price they would command if sold on the open market, and this can be labeled "realization" value. In the case of machinery, this would correspond to the salvage value that could be raised by sale; for land it would be its sale price. The second is to value the assets as they appear to the person who currently possesses and uses them if they remain in his control, termed "use" value or "shadow price." For machinery, use value could be the cost of acquiring a replacement machine. For land it might be considered the net income flow generated by the land and capitalized into a single figure – the "worth" of land as an income-generator.

The principle of wealth evaluation adopted here is similar to that of "use" value. Assets in our sample were valuated in terms of the original prices when purchased. Since we are not able to apply current market prices for assets, we use depreciated values for housing assets and durable goods based on specific assumptions. Current values of housing assets and durable goods are imputed by applying 20 years and 7 years depreciation rates, respectively.[8]

In the following analysis we use the Survey Department of the Research Center on the Rural Economy (RCRE) household surveys in the period from 1986 to 2000 to obtain estimates for wealth in rural areas. Wealth in this study is comprised of four principal components: housing assets, fixed productive assets, financial assets, and durable goods, all expressed in deflated value terms. Value of use rights to land is not included in our definition of wealth since a rental market for land in rural China seems

[8] When we use the original values or apply the different years of discounted rates for each asset the results would not change much.

slow to emerge and thus we only have to depend on the generated value.[9] Since the distribution of land would not change much and has played an equalizing role in the distribution of wealth in rural China during the period, we focus on 'actually available' asset holdings whose investments have not been constrained by the government after the post-reform period. Additional technical issues merit discussion such that the calculations of the inequality indices are performed on a per capita basis to take into account household size. Next we explain the inequality measures that we use in this paper.

3.2 Inequality Statistics

There are many ways to measure inequality, because inequality is a multi-dimensional concept. To investigate the inequality of wealth quantitatively, we focus on four measures: Theil inequality indices; the Gini coefficient; quantile ratio; and the concentration coefficient. Most of all, quantile ratios are straightforward indicators of inequality that are easy to interpret. They are insensitive to outliers either in the very top or very bottom tail of the distribution, but they do not reflect what happens in other parts of the distribution. To address this shortcoming, we also depend on Gini and Theil indices.

The Gini coefficient is used in this paper as one of our primary measures of inequality. This choice is based on its wide usage in other work, which facilitates comparison, as well as the fact that the Gini coefficient satisfies several desirable theoretical properties and at the same time is subject to fewer drawbacks than many other

[9] McKinley (1996) and Brenner (2001) both generated the value of use right to land based on the gross value of agricultural output.

competing measures.[10] The Gini coefficient is bounded between 0 and 1, with 0 indicating absolute equality and 1 indicating absolute inequality. The Gini coefficient is especially sensitive to changes in inequality in the middle of the distribution.

To compensate for one of the Gini's drawbacks – the insensitivity of the measure to redistribution to or from the tails as opposed to the center of the distribution – we have to include another common measure of dispersion, Theil indices, which are the generalized entropy class developed by Theil. Within that class we use the Theil entropy index,

$$E(1) = \frac{1}{N}\sum_{i=1}^{N}\frac{w_i}{v}\ln\left(\frac{w_i}{v}\right)$$

and the Theil mean log deviation index,

$$E(0) = \frac{1}{N}\sum_{i=1}^{N}\ln\left(\frac{v}{w_i}\right)$$

where there are N individuals indexed by i, their wealth is given by w_i, mean wealth is denoted by v.

Both measures are zero for perfect equality. For complete inequality (one person holds everything), E(0) goes to infinity while E(1) reaches Nln(N). The two Theil inequality measures differ in their sensitivity to inequality in different parts of the distribution. The entropy measure, E(1), is most sensitive to inequality in the top range of the distribution, while E(0) is most sensitive to inequality in the bottom range of the distribution.

[10] The Gini coefficient satisfies the properties of (1) symmetry, (2) scale independence, and (3) the Pigou-Dalton transfer principle, with its largest drawback being that it is not decomposable, for example to within-and between-group inequality. For a more detailed treatment of these theoretical properties and their implications, see Fields (2001).

To compensate for another shortcoming of the Gini, namely its non-decomposability, we make much use of the concentration coefficient and the Theil inequality decomposition. Inequality can be decomposed along two dimensions. One can decompose total inequality in equivalent wealth into the contribution of each component of wealth. This composition is usually performed for wealth inequality by the sources of wealth (housing, fixed, financial assets, durable goods, and so on). This decomposition can be performed using the Gini coefficient.

We measure inequality in total wealth by the Gini coefficient, and this in turn can be decomposed as the weighted sum of concentration coefficients for the various wealth components.[11] The weights are relative shares of wealth components in the total wealth, which sum up to 1. Therefore, the relationship between the two measures can be expressed as follows:

$$g = \sum_j \pi_j c_j \text{ and } \pi_j = \frac{v_j}{v}$$

where v_j, v are the means of wealth component j and total wealth, c_j is the concentration coefficient of wealth component j.

The concentration coefficient reflects the association between the wealth component j and the total wealth. It can assume values ranging from –1 to 1. Although the concentration coefficient does not provide a direct alternative to decomposition of the Gini, it does allow us to determine both the equalizing or disequalizing nature of various components of household worth as well as their contribution to overall inequality. If the

[11] Refer to Brenner (2001) and Kahn and Riskin (1998) for more detailed information on the concentration coefficient.

concentration coefficient of a wealth component were greater than the Gini coefficient of total wealth, this wealth component would be regarded as being disequalizing.

The second way of decomposing inequality is to decompose it into inequality within and between subgroups. Since the Gini coefficient does not lend itself well to decomposition by population groups, this decomposition can be performed using the Theil indices. Decomposition by population group allows us to look more closely at the causes of inequality.

3.3 The RCRE Data

Our analyses of the evolution of wealth composition and inequality use household survey data provided by the Survey Department of the Research Center on the Rural Economy (RCRE), at the Ministry of Agriculture in Beijing. A panel of household data spanning the period 1986 to 2000 that includes around 4,400 households per year in 4 provinces (Anhui, Henan, Jiangsu, Shanxi) is used for this study.[12]

The original intention of the RCRE survey was to collect annual data from the same households and villages from 1986 to 2000.[13] Given the relatively large number of households from each village and the lengthy span of the panel, the RCRE data allow us to study the evolution of wealth inequality as well as the changes in wealth composition during a period of changing access to markets in rural China. Households are asked a range of questions regarding various asset ownerships, savings, income from on-farm activities and off-farm employment, and household consumption, etc.

---

[12] The complete RCRE survey covers over 22,000 households in 300 villages of 31 provinces and administrative regions. Refer to Benjamin et al. (2002).

[13] RCRE reports that 80 percent of the households remain in the survey of the entire period. Much of the attrition is considered to correlate with gap in the survey (The RCRE did not conduct the survey in 1992 or 1994 as a result of funding difficulties).

4. Evolution of Wealth and its Components

Table 3 contains the basic results for level, composition, and real growth rate of overall household assets. Total non-land wealth per capita has increased by an 8 percent annual growth rate between 1986 and 2000 lower than the overall growth rate of per capita income, 12.6 percent, seen in Chen (2002). The overall growth rate of non-land wealth showed 8.7 percent in early period (1986 – 1991) compared to 7.3 percent in the later period (1995 – 2000). [14]

First, housing may in fact be a more accurate barometer of changes in wealth distribution than other rural assets. Rural households have not been constrained from investing in housing, and for many households, housing was one of their first spending priorities since 1980s. From Table 3, we are able to confirm that housing assets are the most important component in household non-land wealth, and it showed 8.1 percent of real growth rate on average. Rural households in China hold more than 50 percent of non-land wealth in forms of housing assets.

While investment in other assets such as land and fixed productive assets has been constrained, this has not been the case for housing. Houses were privately owned even during the collective era and remain so, with little prospect of collective ownership. Thus building a new house has been one of the first priorities for many rural families as soon as their income increases. It has represented a very conspicuous sign of a family's new wealth and prestige. Moreover, it has been an investment with little risk or uncertainty

[14] The RCRE did not conduct the survey in 1992 or 1994 as a result of funding difficulties. Matching households from 1991 to 1993 and 1993 to 1995 is complicated by these missing years of data. Thus Benjamin et al. (2002), used the same RCRE data set they suggested to construct sub-samples of balanced panels for early (1986 – 1991) and later (1995 – 2000) periods.

and one affording a highly valued immediate stream of very concrete, material services. This is in contrast to the situation in many other countries, where the richest rural households have secured their position mainly by accumulating stocks of land and other fixed productive assets.

Second and third most important components in overall wealth are the financial assets and the fixed productive assets. Rural households keep around 30 percent of non-land wealth in forms of fixed productive assets and financial assets. Fixed productive assets replaced financial assets as the second most important component in overall wealth, rising in importance from 13.7 percent in 1986 to 15.2 percent of the total in 2000. It has been frequently noted that rural China, like many other rural developing areas, has a thin and particularly fragmented financial market. It has been argued that in such a context, fixed asset accumulation may substitute for the store of wealth function of financial assets as well as a buffer stock in the face of income variability.

Although now in third position, financial assets have slightly declined in importance, falling from 17.2 to 15.1 percent of total non-land wealth during the period, while demonstrating the highest 9.3 percent rate of growth in the later period (1995 – 2000) among the non-land wealth components. Compared to the financial assets in the same period, the real growth rate of fixed assets recorded only 7.4 percent in the later period. It implies that the fast growth in household wealth was led by investments on the fixed productive assets in the early period (1986 – 1991) while the investments on financial assets became main instruments for households' wealth portfolios in more recent years. Compared to the other assets, durable goods have changed little, remaining at 13 percent of total worth during the period.

5. The Distribution of Wealth in Rural China

Turning to the distribution of assets, Table 4 displays the various measures of inequality calculated for household non-land wealth and its components. Considering first the overall distribution of non-land wealth, it is evident that it has worsened since 1986. The Theil index increased from 0.248 to 0.351, the Gini coefficient increased from 0.385 to 0.452 and the coefficient of variation increased from 0.79 to 1.12, with the change registering strong statistical significance.

Figure 1 plots Lorenz curves for the distributions of non-land wealth and its components between 1986 and 2000. The Lorenz curves confirm these results of the inequality measures.[15] Figure 2 also plots the percentiles of non-land wealth and its components across the period from 1986 to 2000. It shows that the real growth of non-land wealth in 90th percentile is faster than 10^{th} percentile. Now turning to the various components of wealth, several interesting findings emerge.

5.1 Housing Assets

Ever since the household responsibility system enabled the farmers in China to increase their income from 1978 on, total consumption expenditures of farm families have increased accordingly. Since the construction of farm housing was not controlled by the government, farmers used their greater income to improve their existing housing and

[15] We see in the Figure 1 that the 1986 Lorenz curve dominates the 2000 one. Additionally, Lorenz dominance test in Table 5 show first order Lorenz dominance of the 1986 distribution in rural China.

to build new houses on the land assigned to them. The construction of new housing increased according to the escalating demand.[16]

Thus housing assets are of key importance in understanding the distribution of wealth in rural China. From the table we could find a similar deteriorating trend in the distribution of housing assets. The Theil index increased from 0.265 to 0.448, the Gini coefficient increased from 0.386 to 0.505, and the coefficient of variation increased from 0.81 to 1.24. The concentration coefficients reported in Table 6 indicate that housing assets had an equalizing effect on overall non-land wealth distribution, although relative contribution decreased from 62 percent in 1986 to 51 percent in 2000.

5.2 Fixed Productive Assets

Turning to fixed productive assets, we have somewhat mixed results in Table 4. While the coefficient of variation increased from 2.02 to 2.55, most measures showed a decrease in inequality across the period; the Theil index decreased from 0.98 to 0.78, The Gini coefficient fell from 0.68 to 0.63.[17] Table 9 also provides figures supporting this; the ratio between the top 10th percentile and median value of fixed productive assets was 4.5 in 2000 compared to 5.9 in 1986. It implies that the distribution of fixed productive assets as a whole still tends to reflect transitional or mixed ownership patterns. The concentration coefficients reported in Table 6 indicate that fixed productive assets have reduced inequality, except in 1986.

---

[16] Chow (2002) observed the increase in quantity and the improvement of quality of the houses of farm families in 1980s. He reported that the per capita floor space of rural households was 8.1 square meters in 1978, 9.4 in 1980, 14.7 in 1985, 17.83 in 1990, 21.0 in 1995, and 22.45 in 1997.

[17] Lorenz curves of fixed productive assets distribution in Figure 1 show crossings at top 5 percent between 1986 and 2000 distribution. Thus if we measure the inequality by the top 5 % in the fixed asset productive assets we will judge 2000 distribution to be more unequal than 1986. In the most shares below the top 5 percent, the 2000 distribution appears to be more equal than 1986.

With regard to the effect of the various fixed assets on the distribution of total wealth, useful aspect of the division between traditional and modern fixed productive assets becomes readily apparent. Indeed, as the concentration coefficients for traditional assets demonstrate, these elements are the source, within total fixed productive assets, of the equalizing effect on overall wealth distribution, as their concentration coefficients are all lower than the Gini coefficient for total wealth in each year. Traditional assets showed a decreased inequality in Table 8. In sum, modern capital inputs continue to play a role in the unequal status of fixed productive assets and for overall wealth.

5.3 Financial Assets

Inequality in financial assets has increased during the period. There were rises in the Theil index, from 0.842 to 1.006 and Gini coefficient, from 0.661 to 0.703, and in the coefficient of variation from 1.76 to 2.02. While the concentration coefficients for financial assets have declined somewhat from 1986 to 1995 and increased in 2000, they are still much higher than the Gini coefficient for total wealth, indicating the continued unequal distribution of financial assets in rural China. Table 11 shows that the 90th percentile in financial wealth was 6.3 times compared to median financial asset value in 1986 and it widened into 7.7 times in 2000. Moreover, the contribution of financial assets to overall inequality increased from 20 to 24 percent between 1986 and 2000, due to the growth in these assets as a proportion of all wealth.

In Table 10, we present the various components of gross financial assets as a percentage of their total value along with their concentration coefficients. Turning to the results for 2000, deposits are the most important single component of financial assets, comprising 76 percent of all holdings. Next in importance is cash-in-hand, comprising 23 percent of the total, followed by investment with 1 percent.

This trend can be explained by the distinguishing feature of financial asset holdings and reflects uneven process of financial deepening in rural China. While the overwhelming majority of households own land, fixed productive assets, housing and durable goods, only half the rural population, on average, owns any financial assets. This is one reason why financial wealth is the most unequally distributed component of total wealth. Since financial assets account for about 15 percent of the total value of assets and the growth rate is the fastest among the component in later period (1995 – 2000), their significance lies much in their present impact on unequal distribution of wealth as in their indication of future directions of changes in the distribution.

5.4 Comparison of Wealth Inequality

Finally, even with this increase in inequality registered between 1986 and 2000, we can find that wealth distribution in rural China is still one of the most equal compared to the industrial countries, with the coefficient of variation and the Gini coefficient, relatively speaking, registering low values. How does inequality of wealth in rural China compare to inequality of wealth in other countries?

In Table 12, we report measures of wealth inequality based on household surveys for 8 countries as gathered from various studies by Davies and Shorrocks (2000) and add to it our estimates for rural China, although we could not include land in the definition of wealth in rural households. Although there are differences in methods and in definitions among the surveys and it is not the distribution of wealth in China as a whole, non-land wealth in rural China appears to be much less unequally distributed than that of other industrialized countries in Table 12.[18] It is also worth to note that the differences would be greater if land wealth included since land asset has been reported to have an equalizing effect on total wealth distribution in rural China.[19]

It will also be interesting to compare the inequality between the four provinces in our sample. Table 7 shows that Shanxi and Henan provinces contribute to increasing the inequality compared to the other two provinces, Jiangsu and Anhui, which have relatively higher average income. It also confirms regional disparities have increased since 1986.[20]

This completes our examination of the composition and the distribution of wealth in rural China in the period of 1986 - 2000. We found that financial and fixed productive assets have become more important in wealth composition, although the share of housing is decreased during the period. Based on our various inequality measures we found that the distribution of rural wealth appeared to remain relatively equal in comparison to wealth distribution in other countries. However, the results also showed that equality of non-land wealth has deteriorated during the period.[21]

5.5 Dynamic Analysis of Non-land Wealth

[18] It cannot be a rigorous comparison since our table only compares the results with the industrialized countries without information on their rural areas.
[19] Refer to Brenner (2001) and McKinley (1996)
[20] According to Yang (2002), the high inequality is attributable primarily to a large rural-urban income gap and growing inland-coastal disparity. He reports that the ratio of urban-rural income gap and consumption hovered between 2 and 3.5 since the inception of reform, a level much higher than the majority of countries in the world.
[21] Relatively equal distribution in rural China is of course possible because wealth might have been underreported. This is a problem common to almost all household surveys. Underreporting is usually most serious among the rich, who have innumerable avenues open to them to disguise the true dimensions of their wealth.

Although we appear to find evidence that inequality has been worsened from 1986 to 2000 it is not an answer for whether low wealth households can accumulate assets over the same time in rural China. In this sub section we try to answer this question.

A growing literature asks whether low wealth agents are trapped in poverty and recent finding suggests that optimal portfolio strategies are bifurcate so that wealthier households acquire a higher-yielding portfolio while poorer households acquire less remunerative one.[22] But this argument depends on the numerical simulation results and thus it needs an empirical analysis. In this context we briefly analyze whether this simulated results accord with the rapidly growing economy like China.

Table 13 and Figure 3 show the test result of first-order poverty dominance and cumulative density functions of non-land wealth distribution of 1986 and 2000. It graphically and statistically confirms that non-land wealth distribution of 2000 first-order stochastically dominates the distribution of 1986.

Since we have panel data of non-land wealth holdings of rural households we are able to do dynamic analysis of household wealth to exploit the characteristics of the panel data. Non-parametric regressions give a more detailed view of relationship between base year economic position and current one. The plots in Figure 4 are obtained by using a running line smoother, which locally estimates slopes between each point taking into account the nearest neighboring points. Figure 4 shows the smoothed relationship between non-land wealth per capita of 1986 and 2000. We also draw the 45 degree line for comparison; If the estimated line lies above the 45 degree line it implies that the current wealth position of these households improves compared to base year position of

[22] Refer to Zimmerman and Carter (2003).

1986. In the figure we observe that the households below 98 percentiles of 1986 non-land wealth distribution lie above the 45 degree line so it implies that most of the households improve in their wealth position. When we compare two different years between 1986 and 1991 and between 1995 and 2000 households below 96 percentile of the 1995 distribution experienced the improvement in their wealth position of 2000 although households below 63 percentile of the distribution enjoyed the improvement in 1991 (refer to Figure 5 and 6).

Moreover, Table 14 provides the evidence of empirical analysis using two stage least squares first difference estimation. Although the results may be contaminated by measurement error the dynamic analysis of wealth support the idea of improvement of non-land wealth position compared to the previous year.

6. Conclusion

Wealth has been considered a potent component among the factors that determine the position of the agricultural household within society. It is pointed out that wealth is important because it gives rise not only to income in a variety of forms but also because it provides security, freedom of movement, and economic and political power. The importance of wealth as a contributor to the economic welfare of farmers cannot be denied, yet it has not received enough attention among many researchers in the context of developing economies as well as developed ones.[23]

Here we are concerned with the economic attributes of non-land wealth in rural China which have been largely unexamined. In this paper, we first determined the composition and distribution of rural non-land wealth as well as the distribution of each

[23] Please refer to Hill (2000).

of its component – housing assets, fixed production assets, financial assets and durable goods during the relatively recent period from 1986 to 2000. We examined the effect that the distribution of each component has on the distribution of the total, focusing on which components of total worth have a disequalizing effect on the distribution of rural wealth.

Although our results show that the distribution remains relatively equal during the period compared to the other countries, we suggest that the increasingly uneven distribution of non-land wealth will be one of the most serious challenges, and the most embarrassing one for the Chinese policy makers. The Chinese government admits based on Chinese official statistics, which are more conservative, that by 2000 the Gini coefficient passed the 0.4 "warning light", and was averaging 0.40 – 0.43.[24] This warning sign is confirmed even with our rural households estimates.

In this paper, however, we also observe that there is an improvement in non-land wealth holdings of Chinese farming households from 1986 to 2000 while there is an argument for the poverty trap based on the simulated results. Our results show that 2000 of non-land wealth distribution first-order stochastically dominates the 1986 wealth distribution in rural China. This is supported by the smoothed relationship between the selected years as well as our tentative empirical results of dynamic panel regressions.

---

[24] *China Times*, June 20, 2001, p.3.

Table 1. Rural per capita Income and Growth Rate

Year	Rural per capita net income (Yuan)	Growth rate (%)
1978	133.6	
1979	160.2	19.9
1980	191.3	19.4
1981	223.4	16.8
1982	270.1	20.9
1983	309.8	14.7
1984	355.3	14.7
1985	397.6	11.9
1986	423.8	6.6
1987	462.6	9.2
1988	544.9	17.8
1989	601.5	10.4
1990	686.3	14.1
1991	708.6	3.3
1992	784	10.6
1993	921.6	17.6
1994	1221	32.5
1995	1577.7	29.2
1996	1926.1	22.1
1997	2090.1	8.5
1998	2162	3.4
1999	2210	2.2
2000	2253.4	2.0

Source: China Statistical Yearbook

Table 2. Major Economic Indicators (1985 – 2000)

Indicators	Amount				Growth Rates			
	1985	1990	1995	2000	1990	1995	2000	85-00
Population (10, 000 persons)	(A)			(B)				(B)/(A)
Population at the Year-end	105,851	114,333	121,121	126,583	8.0	5.9	4.5	19.6
Rural	80,757	84,142	85,947	80,739	4.2	2.1	-6.1	0.0
National Accounting (100 million yuan)								
Gross National Product	8,989	18,598	57,495	88,190	106.9	209.1	53.4	881.1
Gross Domestic Product	8,964	18,548	58,478	89,404	106.9	215.3	52.9	897.4
Total Investment	3,386	6,444	23,877	32,255	90.3	270.5	35.1	852.6
Fixed Assets	2,641	4,732	20,301	32,624	79.2	329.0	60.7	1135.3
Price Indices (preceding year=100)								
General Retail Price Index	109	102	115	99	-6.2	12.4	-14.2	-9.5
General Consumer Price Index	109	103	117	100	-5.7	13.6	-14.3	-8.1
General Farm and Sideline Products Purchasing Price Index	109	97	120	96	-10.3	23.1	-19.6	-11.2
Agriculture								
Cultivated Areas (1,000 hectares)	96,846	95,673	94,971	NA	-1.2	-0.7	NA	-1.9
Labor Force of Farming, Forestry, Animal Husbandry and Fishery (10, 000 persons)	30,352	33,336	32,335	32,798	9.8	-3.0	1.4	8.1
Gross Output Value of Farming, Forestry, Animal Husbandry and Fishery (100 million yuan)	3,620	7,662	20,341	24,916	111.7	165.5	22.5	588.4
Output of Grain (10,000 tons)	37,911	44,624	46,662	46,218	17.7	4.6	-1.0	21.9

Table 2 (cont'd).

Family								
Total Number of Households (10,000 households)	23,804	27,738	31,676	34,837	16.5	14.2	10.0	46.3
Average Household Size in Rural Areas (person)	5.1	4.8	4.5	4.2	-5.9	-6.3	-6.7	-17.6
Housing								
Per Capita Net Floor Space of Urban Residents (sq.m)	5.2	6.7	8.1	10.3	28.8	20.9	27.2	98.1
Per Capita Net Floor Space of Rural Residents (sq.m)	14.7	17.8	21.0	24.8	21.1	18.0	18.1	68.7
People's Livelihood								
Per Capita Annual Disposable Income of Urban Households (yuan)	739	1,510	4,283	6,280	104.3	183.6	46.6	749.8
Per Capita Net Income of Rural Residents (yuan)	398	686	1,578	2,253	72.4	130.0	42.8	466.1
Outstanding Amount of Saving Deposits in Urban and Rural Areas (100 million yuan)	1,623	7,120	29,662	64,332	338.8	316.6	116.9	3864.8

Source: China Statistical Yearbook

Table 3. Mean, Composition, and Growth Rate of Household Assets (1986 – 2000)

	Mean values (yuan)				Percent of total				Real growth rate (%, per annum)		
	1986	1990	1995	2000	1986	1990	1995	2000	1986 to 2000	1986 to 1991	1995 to 2000
Total wealth	5505.7	7812.8	9839.2	13762.5	100.0	100.0	100.0	100.0	8.0	8.7	7.3
Housing assets	3071.1	4249.1	5652.8	7802.0	55.8	54.4	57.5	56.7	8.1	8.3	7.3
Fixed prod. assets	754.2	1118.1	1739.1	2086.2	13.7	14.3	17.7	15.2	9.1	9.8	7.4
Financial assets	944.9	1393.8	1100.2	2072.5	17.2	17.8	11.2	15.1	7.4	9.2	9.3
Durables	735.5	1071.1	1352.5	1845.6	13.4	13.7	13.7	13.4	8.0	9.4	6.1

Table 4. Distribution of Household Assets (1986 - 2000)

	Theil index				Gini coefficient				Coefficient of variation				Quantile ratio (25/75)			
	1986	1990	1995	2000	1986	1990	1995	2000	1986	1990	1995	2000	1986	1990	1995	2000
Total wealth	0.248	0.305	0.322	0.351	0.385	0.422	0.431	0.452	0.794	0.993	0.935	1.129	0.379	0.342	0.351	0.324
Housing assets	0.265	0.347	0.405	0.448	0.386	0.442	0.475	0.505	0.811	0.936	1.047	1.241	0.393	0.317	0.310	0.286
Fixed prod. assets	0.980	0.803	0.748	0.778	0.680	0.638	0.621	0.629	2.024	2.084	1.946	2.549	0.111	0.186	0.169	0.176
Financial assets	0.842	0.909	1.006	1.006	0.661	0.681	0.703	0.703	1.761	2.122	2.008	1.948	0.105	0.076	0.074	0.067
Durables	0.522	0.565	0.562	0.638	0.518	0.548	0.554	0.591	1.087	1.332	1.327	1.604	0.210	0.198	0.223	0.169

With Rural Population Weights

	Theil index				Gini coefficient				Coefficient of variation				Quantile ratio (25/75)			
	1986	1990	1995	2000	1986	1990	1995	2000	1986	1990	1995	2000	1986	1990	1995	2000
Total wealth	0.232	0.296	0.328	0.332	0.374	0.417	0.435	0.443	0.784	0.988	0.957	1.043	0.397	0.354	0.351	0.333
Housing	0.239	0.320	0.404	0.427	0.371	0.429	0.474	0.496	0.807	0.912	1.049	1.208	0.418	0.336	0.325	0.295
Fixed assets	0.874	0.738	0.717	0.707	0.654	0.618	0.612	0.606	1.834	2.047	1.943	2.168	0.132	0.206	0.181	0.191
Financial assets	0.853	0.957	1.053	1.038	0.666	0.696	0.716	0.712	1.755	2.214	2.157	1.939	0.104	0.073	0.080	0.067
Durables	0.503	0.548	0.567	0.606	0.514	0.544	0.556	0.580	1.092	1.310	1.348	1.468	0.236	0.207	0.224	0.175

Notes: 1. Rural population weights are applied. 2. Computation for the table above was performed using "DAD: A Software for Distributive Analysis/Analyse Distributive", copyrighted by Jean-Yves Duclos, Abdelkrim Araar, and Carl Fortin.

Table 5. Test for First-order Lorenz dominance (1986 and 2000)

	Difference	Standard error
0.1	0.006	(0.0008)
0.2	0.014	(0.0016)
0.3	0.022	(0.0024)
0.4	0.029	(0.0034)
0.5	0.037	(0.0045)
0.6	0.045	(0.0055)
0.7	0.053	(0.0068)
0.8	0.057	(0.0112)
0.9	0.053	(0.0039)

Notes: Computation for the table above was performed using "DAD: A Software for Distributive Analysis/Analyse Distributive", copyrighted by Jean-Yves Duclos, Abdelkrim Araar, and Carl Fortin.

Table 6. Decomposition of Wealth Inequality by Sources

	Concentration coefficient				Relative contribution				Share			
	1986	1990	1995	2000	1986	1990	1995	2000	1986	1990	1995	2000
Total wealth	0.385	0.422	0.431	0.452	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Housing assets	0.357	0.385	0.428	0.446	0.62	0.48	0.56	0.51	0.67	0.52	0.56	0.52
Fixed prod. assets	0.390	0.414	0.422	0.416	0.11	0.16	0.20	0.18	0.11	0.17	0.20	0.20
Financial assets	0.507	0.525	0.485	0.515	0.20	0.28	0.15	0.24	0.15	0.22	0.14	0.21
Durables	0.381	0.387	0.388	0.399	0.07	0.08	0.09	0.07	0.07	0.09	0.10	0.07

Notes: 1. Estimates are based on Gini inequality decomposition.
2. Computation for the table above was performed using "DAD: A Software for Distributive Analysis/Analyse Distributive", copyrighted by Jean-Yves Duclos, Abdelkrim Araar, and Carl Fortin.

Table 6 (cont'd)

With Rural Population Weights

	Concentration coefficient				Relative contribution				Share			
	1986	1990	1995	2000	1986	1990	1995	2000	1986	1990	1995	2000
Total wealth	0.374	0.417	0.435	0.443	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
Housing	0.341	0.376	0.427	0.437	0.606	0.477	0.553	0.507	0.665	0.529	0.563	0.515
Fixed assets	0.376	0.384	0.415	0.389	0.122	0.149	0.192	0.174	0.121	0.162	0.201	0.198
Financial assets	0.519	0.547	0.516	0.526	0.204	0.289	0.165	0.255	0.147	0.220	0.139	0.215
Durables	0.383	0.396	0.401	0.392	0.069	0.084	0.090	0.064	0.067	0.089	0.097	0.073

Notes: 1. Rural population weights are applied. 2. Estimates are based on Gini inequality decomposition.
3. Computation for the table above was performed using "DAD: A Software for Distributive Analysis/Analyse Distributive", copyrighted by Jean-Yves Duclos, Abdelkrim Araar, and Carl Fortin.

Table 7. Decomposition of Wealth Inequality Across Provinces

	Theil index				Relative Contribution			
	1986	1990	1995	2000	1986	1990	1995	2000
Total	0.238	0.325	0.332	0.349	1.00	1.00	1.00	1.00
Shanxi	0.235	0.343	0.352	0.385	0.32	0.29	0.28	0.29
Jingsu	0.141	0.153	0.093	0.136	0.04	0.02	0.01	0.03
Anhui	0.192	0.271	0.321	0.332	0.22	0.32	0.39	0.37
Henan	0.282	0.402	0.361	0.366	0.41	0.36	0.31	0.29

With Rural Population Weights

	Theil index				Relative Contribution			
	1986	1990	1995	2000	1986	1990	1995	2000
Total	0.232	0.296	0.328	0.332				
Shanxi	0.221	0.350	0.327	0.371	0.109	0.134	0.110	0.125
Jingsu	0.193	0.217	0.322	0.249	0.234	0.222	0.285	0.215
Anhui	0.196	0.244	0.270	0.295	0.201	0.191	0.202	0.208
Henan	0.224	0.340	0.337	0.348	0.349	0.402	0.361	0.376
Between group inequality	0.025	0.015	0.014	0.025				

Notes: 1. Estimates are based on Theil inequality decomposition.
2. Computation for the table above was performed using "DAD: A Software for Distributive Analysis/Analyse Distributive", copyrighted by Jean-Yves Duclos, Abdelkrim Araar, and Carl Fortin.

Table 8. Fixed Productive Assets (Closer look)

	Composition				Concentration coefficient			
	1986	1990	1995	2000	1986	1990	1995	2000
Fixed productive asset	1.00	1.00	1.00	1.00	0.390	0.414	0.422	0.416
Draught/meat/parenting animals	0.27	0.22	0.19	0.15	0.070	0.106	0.098	0.012
Large/medium production tools	0.06	0.06	0.06	0.06	0.065	0.090	0.164	0.161
Other machinery for agriculture	0.05	0.10	0.11	0.15	0.397	0.359	0.333	0.207
Industrial machinery	0.07	0.10	0.12	0.12	0.631	0.675	0.664	0.637
Transportation machinery	0.27	0.29	0.31	0.30	0.683	0.665	0.600	0.571
Factory/agricultural production building	0.28	0.24	0.21	0.23	0.416	0.380	0.389	0.469

Note: Computation for the table above was performed using "DAD: A Software for Distributive Analysis/Analyse Distributive", copyrighted by Jean-Yves Duclos, Abdelkrim Araar, and Carl Fortin.

Table 9. Percentiles of Fixed Productive Assets (1986 – 2000)

Percentiles	1986	1990	1995	2000
50	300.0	505.6	794.6	963.3
60	476.0	687.0	1086.2	1325.5
70	670.0	942.4	1506.9	1902.3
80	1015.0	1327.7	2258.9	2816.4
90	1760.0	2454.8	3626.7	4390.2

Table 10. Financial Asset Holdings (Closer look)

	Composition				Concentration coefficient			
	1986	1990	1995	2000	1986	1990	1995	2000
Financial asset	1.00	1.00	1.00	1.00	0.507	0.525	0.485	0.515
Deposits	0.49	0.51	0.68	0.76	0.606	0.597	0.550	0.582
Cash	0.48	0.43	0.29	0.23	0.394	0.398	0.312	0.242
Investment	0.04	0.06	0.02	0.01	0.647	0.845	0.737	0.741

Note: Computation for the table above was performed using "DAD: A Software for Distributive Analysis/Analyse Distributive", copyrighted by Jean-Yves Duclos, Abdelkrim Araar, and Carl Fortin.

Table 11. Percentiles of Financial Assets (1986 – 2000)

Percentiles	1986	1990	1995	2000
50	385.0	498.5	373.6	721.9
60	591.0	794.8	610.3	1164.3
70	884.0	1239.7	944.2	1870.5
80	1391.0	1979.3	1548.8	3102.5
90	2414.0	3493.1	2711.8	5522.7

Table 12. Comparison of Inequality in Household Wealth Distribution in Various Countries

Country	Year	Gini coff.
USA	1983	0.79
France	1986	0.71
Germany	1988	0.69
Canada	1984	0.69
Italy	1987	0.6
Korea	1988	0.58
Japan	1984	0.52
Sweden	1985	0.5
Rural China	1986	0.37
	1990	0.42
	1995	0.43
	2000	0.44

Notes: 1. The source is from Davies and Shorrocks (2000) except the estimates of China.
2. Estimates of rural China are based on our calculation with rural population weights.

Table 13. Test for First-order Stochastic Dominance between 1986 and 2000

1st order	Difference	Standard Error
1,000	0.170	(0.0095)
2,000	0.241	(0.0105)
3,000	0.190	(0.0089)
4,000	0.153	(0.0074)
5,000	0.110	(0.0061)
6,000	0.081	(0.0049)
7,000	0.057	(0.0041)
8,000	0.041	(0.0034)
9,000	0.031	(0.0029)
10,000	0.023	(0.0025)
11,000	0.019	(0.0022)
12,000	0.014	(0.0019)

Note: Computation for the table above was performed using "DAD: A Software for Distributive Analysis/Analyse Distributive", copyrighted by Jean-Yves Duclos, Abdelkrim Araar, and Carl Fortin.

Table 14. Dynamic Analysis of Household's Non-land Wealth: Two Stage Least Squares First Differenced Estimation (FDIV)

1. Identifying variables: land and wealth

	Without village-time dummies				With village-time dummies			
	Sub sample (1986 - 1991)		Sub sample (1995 - 2000)		Sub sample (1986 - 1991)		Sub sample (1995 - 2000)	
	log(wealth)t-log(wealth)t-1							
Variables	coeff.	std.err.	coeff.	std.err.	coeff.	std.err.	coeff.	std.err.
log(wealth)t-1 -- log(wealth)t-2	0.232	0.042	0.283	0.065	0.227	0.040	0.300	0.062
Share of elementary edu. -Share of elem. edu. of t-1 period	0.043	0.018	0.003	0.019	0.054	0.018	0.010	0.019
Share of midd. edu. -Share of midd. edu. of t-1 period	0.048	0.019	-0.086	0.020	0.060	0.019	-0.077	0.020
Share of hig. edu.- Share of hig.edu. of t-1 period	0.097	0.030	-0.104	0.031	0.103	0.030	-0.090	0.031
Share of skilled labor - share of skilled labor of t-1 period	0.129	0.022	0.018	0.042	0.127	0.022	0.032	0.042
constant	0.059	0.005	0.045	0.005	0.052	0.012	0.051	0.013
AR(1) of the residual term	0.043	0.004	0.036	0.007				
First stage regression								
	Sub sample (1986 - 1991)		Sub sample (1995 - 2000)		Sub sample (1986 - 1991)		Sub sample (1995 - 2000)	
	log(wealth)t-1 -- log(wealth)t-2							
Share of elementary edu. -Share of elem. edu. of t-1 period	0.004	0.027	-0.072	0.031	0.013	0.029	-0.067	0.031
Share of midd. edu. -Share of midd. edu. of t-1 period	-0.018	0.030	-0.059	0.031	-0.010	0.030	-0.053	0.031
Share of hig. edu.- Share of hig.edu. of t-1 period	0.093	0.050	-0.032	0.047	0.096	0.051	-0.025	0.047

Table 14 (cont'd)

Share of skilled labor - share of skilled labor of t-1 period	-0.058	0.037	-0.047	0.063	-0.045	0.037	-0.021	0.063
Land of t-2	-0.001	0.011	-0.039	0.010	-0.002	0.011	-0.038	0.010
log(wealth) of t-2	-0.213	0.016	-0.148	0.017	-0.221	0.016	-0.155	0.017
constant	0.103	0.005	0.059	0.005	0.075	0.019	0.018	0.020

2. Identifying variables: land

	Without village-time dummies				With village-time dummies			
	Sub sample (1986 - 1991) log(wealth)t-log(wealth)t-1		Sub sample (1995 - 2000) log(wealth)t-log(wealth)t-1		Sub sample (1986 - 1991) log(wealth)t-log(wealth)t-1		Sub sample (1995 - 2000) log(wealth)t-log(wealth)t-1	
Variables	coeff.	std.err.	coeff.	std.err.	coeff.	std.err.	coeff.	std.err.
log(wealth)t-1 -- log(wealth)t-2	0.029	0.186	-0.097	0.141	0.048	0.178	-0.065	0.137
Share of elementary edu. -Share of elem. edu. of t-1 period	0.037	0.017	-0.005	0.018	0.049	0.018	0.000	0.018
Share of midd. edu. -Share of midd. edu. of t-1 period	0.038	0.020	-0.096	0.018	0.052	0.020	-0.087	0.018
Share of hig. edu.- Share of hig.edu. of t-1 period	0.085	0.030	-0.113	0.028	0.094	0.030	-0.099	0.029
Share of skilled labor - share of skilled labor of t-1 period	0.116	0.024	0.016	0.038	0.115	0.024	0.033	0.038
constant	0.078	0.018	0.072	0.010	0.066	0.018	0.074	0.014
AR(1) of the residual term	0.052	0.004	0.050	0.010				

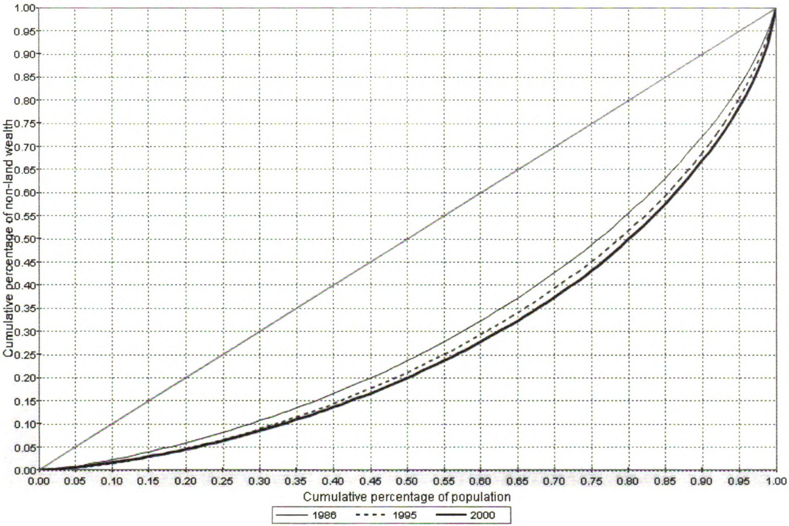
First stage regression

Table 14 (cont'd)

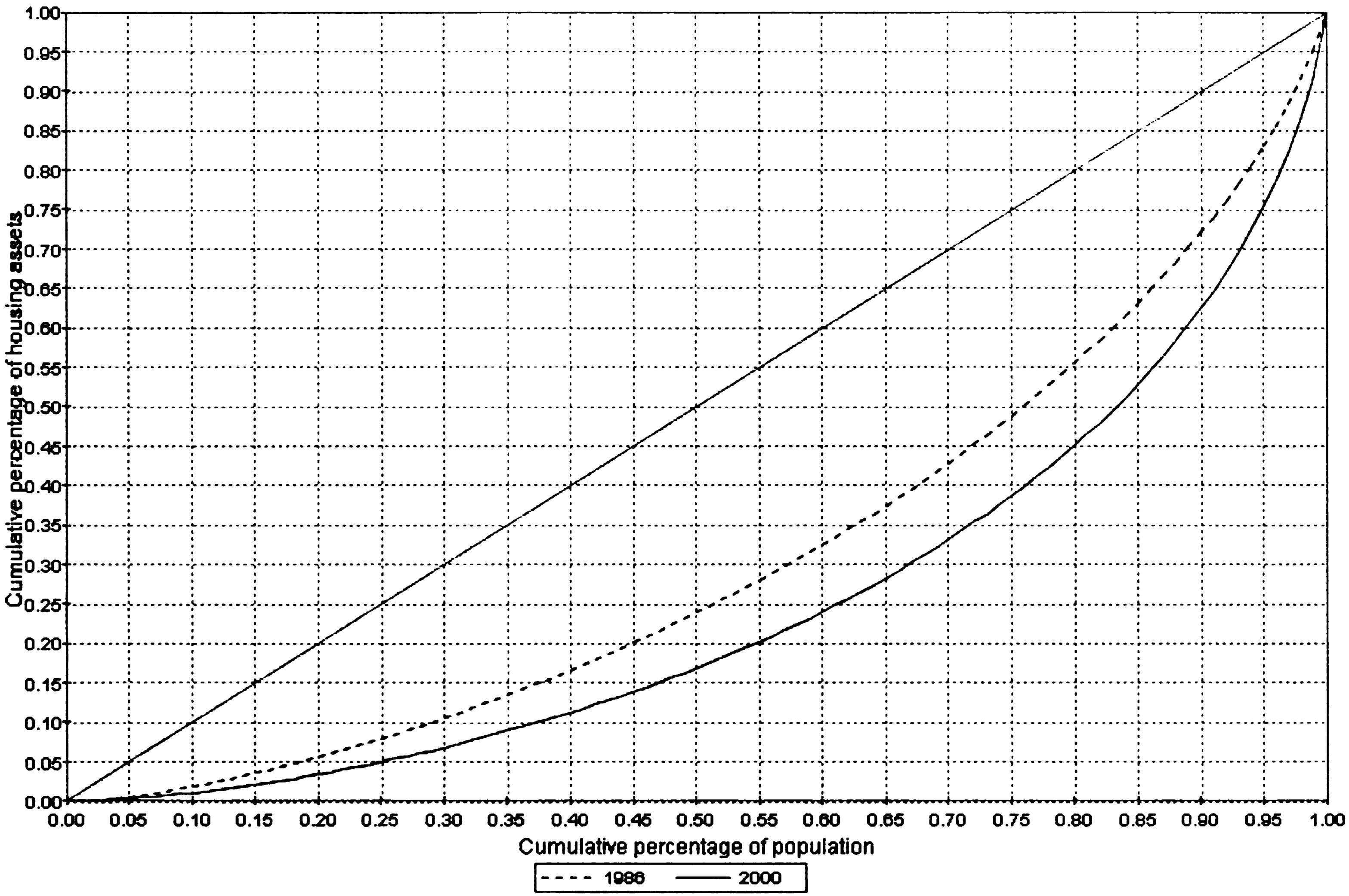
	Sub sample (1986 - 1991) log(wealth)t-log(wealth)t-1		Sub sample (1995 - 2000) log(wealth)t-log(wealth)t-1		Sub sample (1986 - 1991) log(wealth)t-log(wealth)t-1		Sub sample (1995 - 2000) log(wealth)t-log(wealth)t-1	
Share of elementary edu. -Share of elem. edu. of t-1 period	0.005	0.028	-0.076	0.031	0.015	0.029	-0.0709	0.0312
Share of midd. edu. -Share of midd. edu. of t-1 period	-0.024	0.031	-0.063	0.031	-0.014	0.031	-0.0563	0.0313
Share of hig. edu.- Share of hig.edu. of t-1 period	0.074	0.051	-0.026	0.048	0.079	0.052	-0.0177	0.0480
Share of skilled labor - share of skilled labor of t-1 period	-0.061	0.037	-0.057	0.064	-0.048	0.038	-0.0360	0.0637
Land of t-2	-0.034	0.011	-0.064	0.010	-0.036	0.011	-0.0640	0.0100
constant	0.088	0.005	0.046	0.005	0.067	0.019	0.0030	0.0198

Figure 1. Lorenz Curves of Non-Land Wealth and its Components (1986 – 2000)

1. Lorenz Curves of Non-land Wealth



2. Lorenz Curves of Housing Assets



3. Lorenz Curves of Fixed Productive Assets

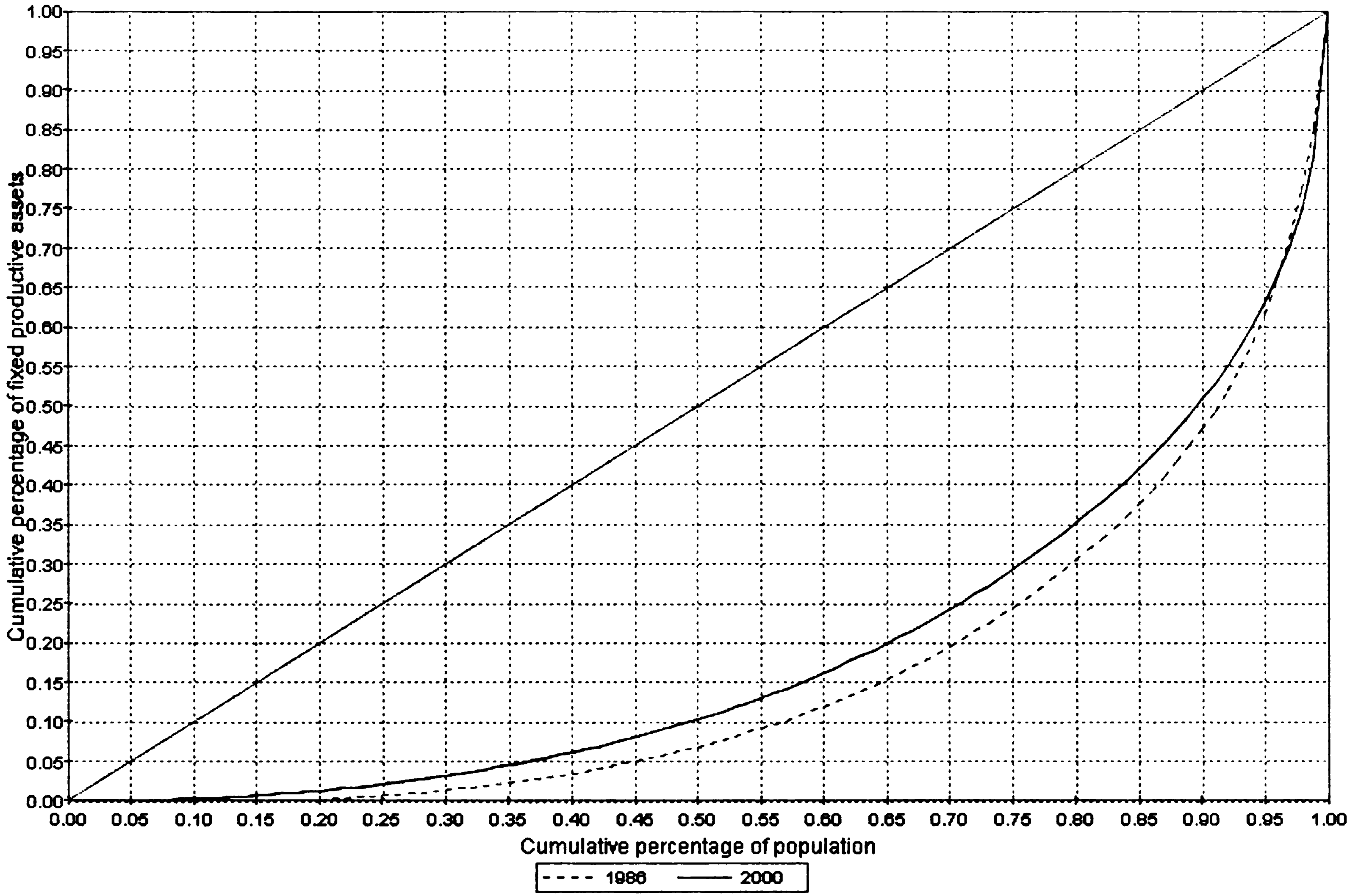
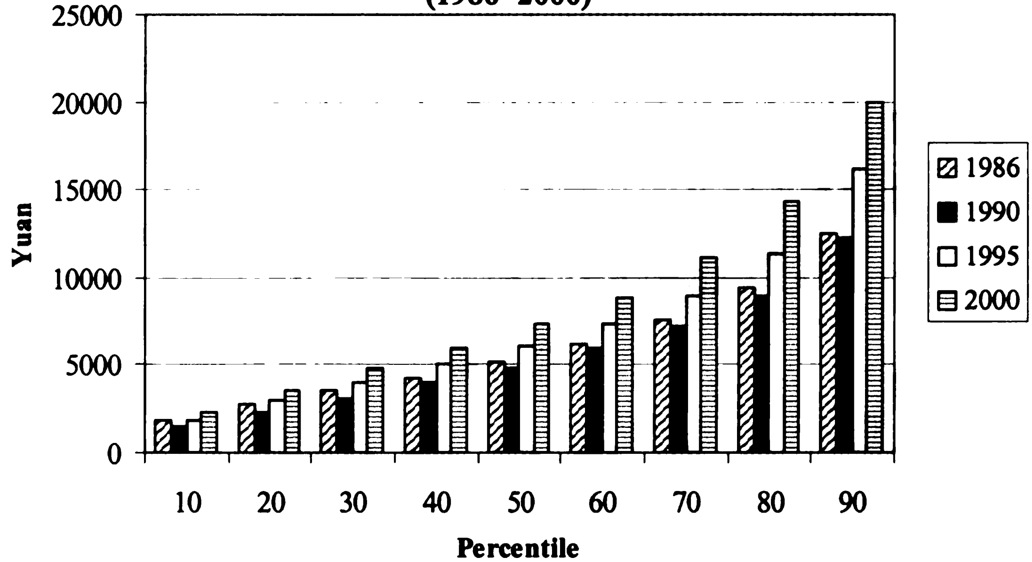
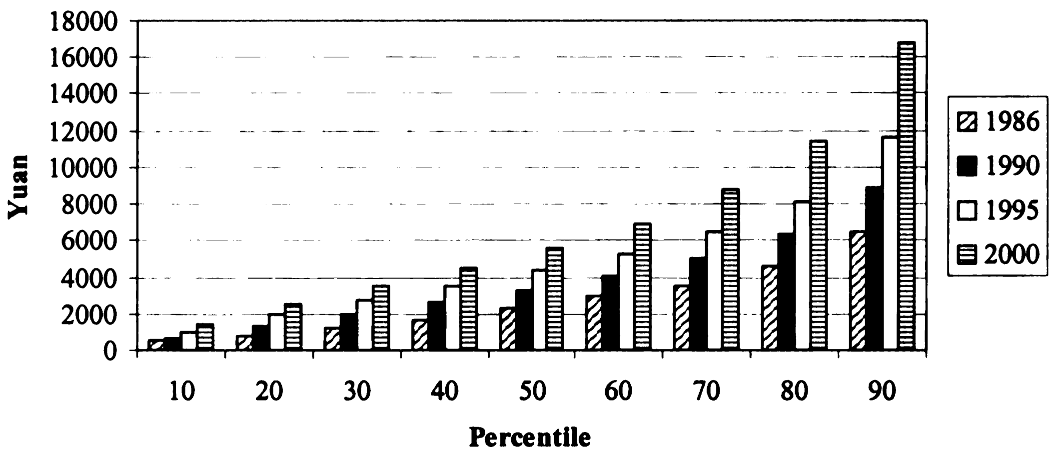


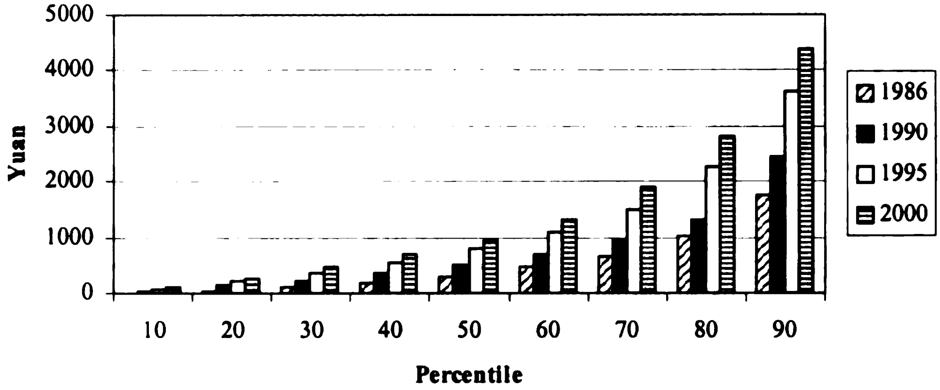
Figure 2. Percentiles of Non-land Wealth and its Components (1986 -2000)



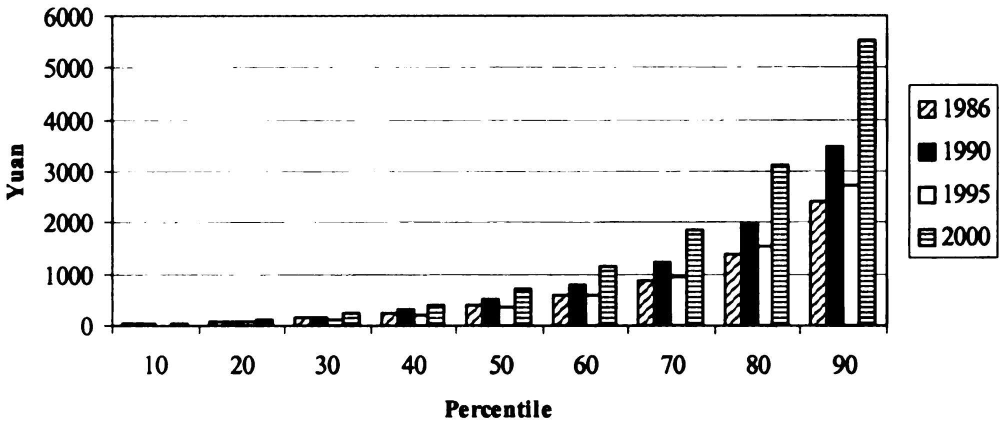
Housing assets



Fixed productive assets



Financial assets



Durable goods

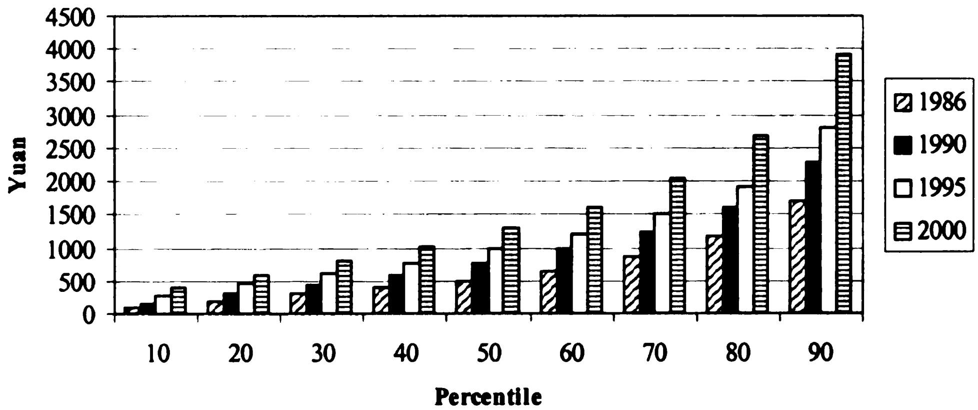


Figure 3. First-order Poverty Dominance

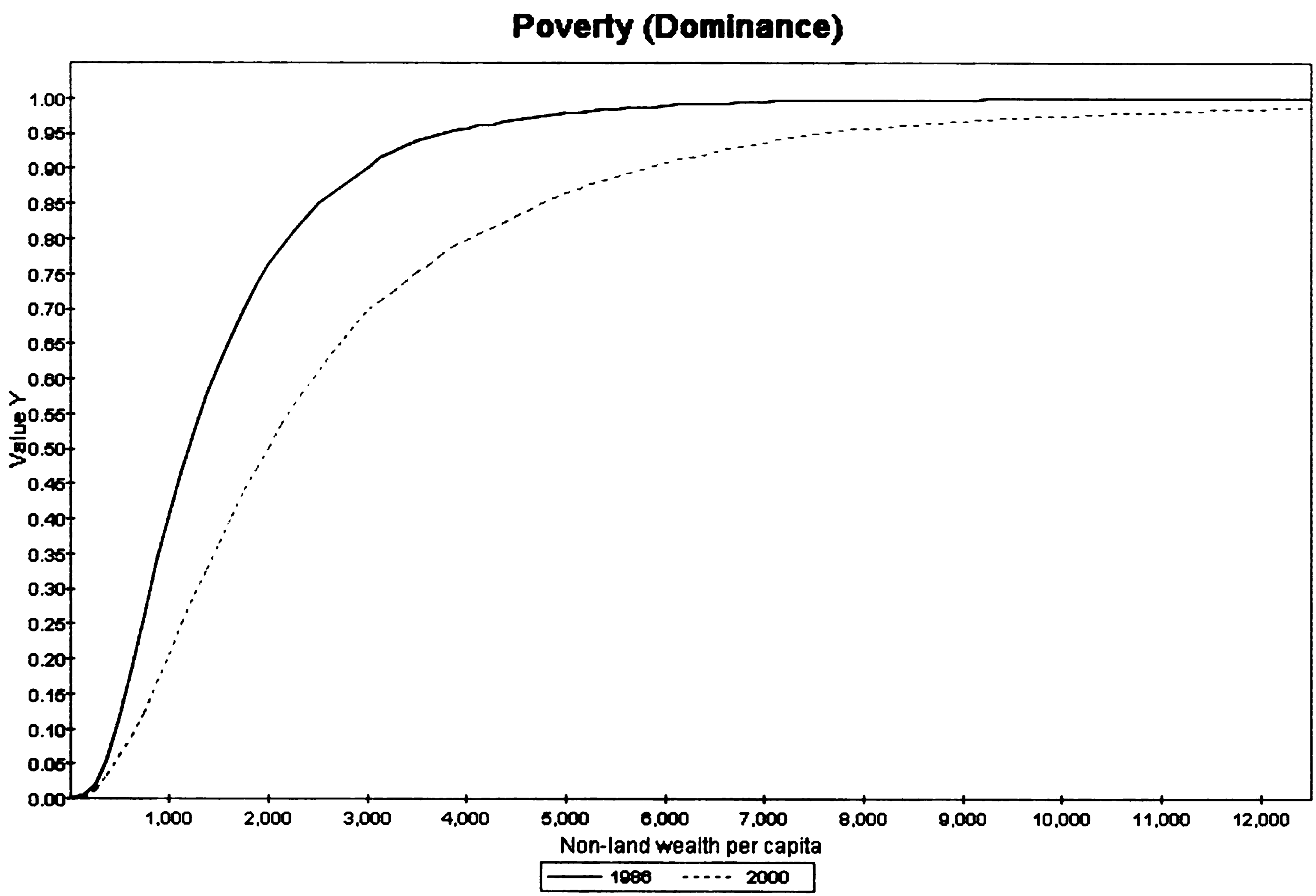
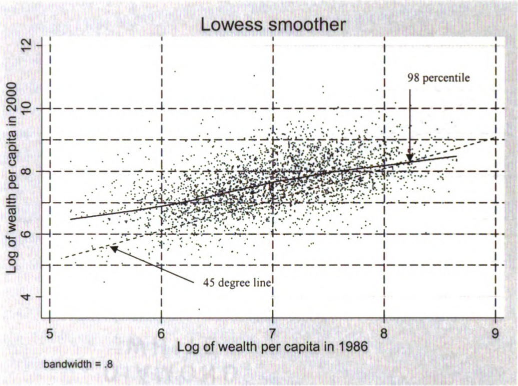
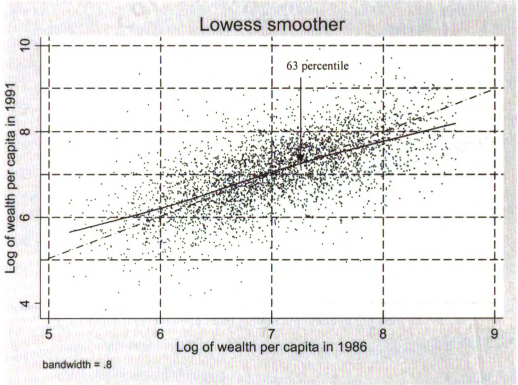


Figure 4. Smoothed Relationship between Wealth Per Capita in 1986 and 2000



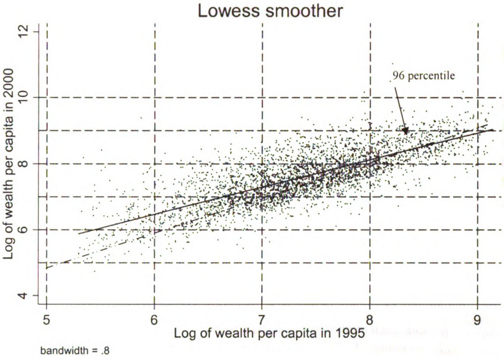
Note: 1. Data are truncated at lowest and highest 1 percentile of log of wealth in 1986. 2. Number of observations as a balanced panel between 1986 and 2000 is 3122.

Figure 5. Smoothed Relationship between Wealth Per Capita in 1986 and 1991



Notes: 1.Data are truncated at lowest and highest 1 percentile of log of wealth in 1986. 2. Number of observations as a balanced panel between 1986 and 1995 is 3829.

Figure 6. Smoothed Relationship between Wealth Per Capita in 1995 and 2000



Note: 1. Data are truncated at lowest and highest percentile of log of wealth in 1995. 2. Number of observations as a balanced panel between 1995 and 2000 is 3670.

References

Banks, J., R. Blundell, and J. Smith (2003), "Financial wealth inequality in the United States and Great Britain," *The Journal of Human Resources*, Vol.38, No.2, pp.241 – 279.

Benjamin, D., L. Brandt, and J. Giles (2002), Income persistence and the evolution of inequality in rural China, mimeo.

Brenner, M. (2001), "Reexamining the Distribution of Wealth in Rural China," in Riskin, C.,Z.Renwei, & Li Shi, ed., *China's Retreat from Equality: Income Distribution and Economic Transformation*, New York: M.E.Sharpe.

Davies, J. B. and A. Shorrocks (2000), "The Distribution of Wealth," Chapter 11 in Atkinson, A. and F. Bourguignon ed., *Handbook of Income Distribution*, Vol.1, pp.606 – 675.

Chow, G. (2002), *China's economic transformation*, Blackwell publishers Inc.

Draguhn, W. and R. Ash (1999), *China's economic security*, St. Martin's press.

Fang, C. et al. (2002), "Emergence of urban poverty and inequality in China: evidence from household survey," *China Economic Review*, Vol.13, pp.430 – 443.

Fields, Gary S. (2001), *Distribution and development: a new look at the developing world*, MIT press.

Griffin, K. and A. Saith (1982), "The pattern of income inequality in rural China," *Oxford Economic Papers*, Vol.34, pp.172 –206.

Hare, D. (1994), "Rural nonagricultural activities and their impact on the distribution of income," *China Economic Review*, Vol.5, pp.59 – 82.

Hill, B. (2000), *Farm incomes, wealth and agricultural policy.*

Hussain et al. (1994), "Income inequalities in China: evidence from household survey data," *World Development*, Vol.22, pp.1947 – 1957.

Khan, A. R. and C. Riskin (1998), "Income and inequality in China: composition, distribution and growth of household income, 1988 to 1995," *The China Quarterly*, Vol.154, pp.221 – 253.

Mckinley, T. (1996), *The distribution of wealth in rural China*, M.E.Sharpe, Inc.

Park, A. and S. Wang (2001), "China's poverty statistics," *China Economic Review*, Vol.12, pp. 384 – 398.

Rozelle, S. (1994), "Rural industrialization and increasing inequality: emerging patterns in China's reforming economy," *Journal of Comparative Economics*, Vol.19, pp.362 – 391.

World Bank (1997), *China: strategies for reducing poverty in the 1990s*, Washington DC: World Bank.

Yang, D.T. (2002), "What has caused regional inequality in China?," China Economic Review, Vol.13, pp.331 – 334.

Yao, S. and L. Zhu (1998), "Understanding income inequality in China: a multi angle perspective," *Economics of Planning*, Vol.31, pp.133 - 150.

Zimmerman, F.J. and M.R. Carter (2003), "Asset smoothing, consumption smoothing and the reproduction of inequality under risk and subsistence constraints," *Journal of Development Economics*, Vol.71, pp.233 – 260.