AgEcon SEARCH
RESEARCH IN AGRICULTURAL & APPLIED ECONOMICS

The World's Largest Open Access Agricultural & Applied Economics Digital Library

This document is discoverable and free to researchers across the globe due to the work of AgEcon Search.

Help ensure our sustainability.

Give to AgEcon Search

AgEcon Search
http://ageconsearch.umn.edu
aesearch@umn.edu

*Papers downloaded from **AgEcon Search** may be used for non-commercial purposes and personal study only. No other use, including posting to another Internet site, is permitted without permission from the copyright owner (not AgEcon Search), or as allowed under the provisions of Fair Use, U.S. Copyright Act, Title 17 U.S.C.*

Studies on the Agricultural and Food Sector
in Central and Eastern Europe

Xiaobing Wang

Labor market behavior of Chinese rural households during transition

IAMO
LEIBNIZ-INSTITUT FÜR AGRARENTWICKLUNG
IN MITTEL- UND OSTEUROPA

Labor market behavior of Chinese rural households during transition

Studies on the Agricultural and Food Sector
in Central and Eastern Europe

Edited by
Leibniz Institute of Agricultural Development
in Central and Eastern Europe
IAMO

Volume 42

Labor market behavior of Chinese rural households during transition

by
Xiaobing Wang

IAMO

2007

Bibliografische Information Der Deutschen Bibliothek
Die Deutsche Bibliothek verzeichnet diese Publikation in der Deutschen Nationalbibliografie; detaillierte bibliografische Daten sind im Internet über http://dnb.ddb.de abrufbar.

Bibliographic information published by Die Deutsche Bibliothek
Die Deutsche Bibliothek lists the publication in the Deutsche Nationalbibliografie; detailed bibliographic data are available in the internet at: http://dnb.ddb.de.

This thesis was accepted as a doctoral dissertation in fulfillment of the requirements for the degree "doctor agriculturarum" by the Faculty of Natural Sciences III at Martin Luther University Halle-Wittenberg on 16.01.2007.

Date of oral examination:	07.05.2007
Supervisor and Reviewer:	Prof. Dr. T. Glauben
Co-Reviewer:	Prof. Dr. M. Grings
Co-Reviewer:	Prof. Dr. B. Brümmer

Diese Veröffentlichung kann kostenfrei im Internet unter <*www.iamo.de/dok/sr_vol42.pdf*> heruntergeladen werden.

This publication can be downloaded free from the website <*www.iamo.de/dok/sr_vol42.pdf*>.

© 2007
Leibniz-Institut für Agrarentwicklung in Mittel- und Osteuropa (IAMO)
Theodor-Lieser-Straße 2
06120 Halle (Saale)
Tel.: 49 (345) 2928-0
Fax: 49 (345) 2928-199
e-mail: iamo@iamo.de
http://www.iamo.de
ISSN 1436-221X
ISBN 978-3-938584-25-5

In der Schriftenreihe *Studies on the Agricultural and Food Sector in Central and Eastern Europe* werden durch das IAMO Monographien und Tagungsberichte herausgegeben, die sich mit agrarökonomischen Fragestellungen zu Mittel- und Osteuropa beschäftigen. Wissenschaftlern, die in diesem Bereich forschen, steht die Schriftenreihe als Diskussionsforum offen.

In its series *Studies on the Agricultural and Food Sector in Central and Eastern Europe* IAMO publishes monographs and proceedings focusing on agricultural economic issues specific to Central and Eastern Europe. This series offers a forum to researchers studying this area.

ISSN 1436-221X
ISBN 978-3-938584-25-5

Acknowledgment

I am greatly indebted to Professor Thomas Glauben for his dedicated supervision, patience, and support throughout the duration of my research study at University of Kiel, Institute of Agricultural Development in Central & Eastern Europe (IAMO) and University of Halle. My thanks also go to Professor Scott Rozelle at Stanford University, Professor Belton M. Fleisher at Ohio State University, Dr. Stephan Brosig at IAMO and Dr. Thomas Herzfeld at University of Kiel for their helpful comments and enthusiastic reviews that helped me complete this study. It is with sincere respect and appreciation that I acknowledge their contribution to my intellectual development.

I am also grateful to my colleagues and many graduate students at University of Kiel and IAMO for their sincere assistance.

Last but not least, I am grateful to my family for their encouragement and sacrifices that have made my education possible and to my close friends for their support and understanding.

The financial support of German research foundation (Deutsche Forschungsgemeinschaft, DFG) is gratefully acknowledged.

Halle (Saale), December 2006 Xiaobing Wang

Abstract

The goal of this study is to assess households' labor allocation in the wake of China's efforts to develop the rural labor market in a manner that is conductive to its transition to a market economy. Applying the agricultural household model as the theoretical framework, we help to understand the behavior of rural households in the labor market in three different but interrelated contexts: Participation behavior in hiring labor and supplying off-farm labor, the quantity of hired-labor demand and off-farm labor supply, and the dynamics of rural households' participation in labor markets. The empirical studies are based on micro-level panel data from Zhejiang province from 1995 to 2002.

We first derive a joint model of households' decisions on hiring labor and supplying labor off the farm, with special attention of households that participate in both markets simultaneously. The main result suggests that the decisions to hire labor and supply off-farm labor are jointly made and positively correlated. This supports the hypothesis that rural China has a poorly functioning labor market.

Next, we estimate a series of hired labor demand and off-farm labor supply functions using the wages of hired labor and off-farm workers as the instrumented variables. A household's labor demand decreases with the increasing wage of hired labor, whereas the effect of off-farm worker's wage on a household's labor supply differs significantly depending on the household's type of labor market participation. The wage paid for hired labor has statistically significant and negative effects on off-farm labor supply. This implies that the hired labor and off-farm labor are substitutes, *albeit* imperfect substitutes in rural China. Our analyses show that the expansion of livestock production has increasing effects on labor demand but reducing effects on a household's off-farm labor supply for households that participate in both markets. Land market integration significantly enhances participation in the labor market but has no significant impact on time allocation. Furthermore, the results suggest non-separability between off-farm labor supply and household structure as well as social network, again confirming that the rural labor market in Zhejiang province is still functioning imperfectly.

Finally, the panel data also allow us to evaluate the dynamics of households' participation in labor market by applying discrete hazard models. In particular, we

investigate the movements between participation and autarky in labor market, between part-time and full-time farming, and between hiring or not hiring labor. We intend to identify the factors that determine the duration for a household's participation in the labor markets. Our results show that the histories of households that participate in labor markets and the likelihood of the households to move among the labor markets are significantly related to several household and farm characteristics, as well as features of local community.

Zusammenfassung

Das Ziel dieser Studie ist die Analyse der Allokation von Arbeitsressourcen in ländlichen Haushalten im Zuge von Chinas Bemühungen zur Entwicklung eines ländlichen Arbeitsmarktes. Unter Anwendung eines Landwirtschaftlichen Haushaltsmodells versuchen wir einen Beitrag zum Verständnis des Arbeitsmarktverhaltens ländlicher Haushalte in drei verschiedenen, aber miteinander verbundenen Kontexten zu leisten: Verhalten bei der Einstellung von Leiharbeitern und dem Anbieten von außerlandwirtschaftlichen Arbeitskräften, Ausmaß der Nachfrage nach Leiharbeitskräften und dem Angebot von außerlandwirtschaftlichen Arbeitskräften sowie Dynamik der Beteiligung ruraler Haushalte in Arbeitsmärkten. Die empirischen Studien basieren auf Haushaltspaneldaten aus der Provinz Zhejiang und umfassen die Jahre 1995 bis 2002.

Zunächst entwickeln wir ein Modell, dass Haushaltsentscheidungen über Angebot und Nachfrage von Arbeitskraften verbindet. Besonderes Augenmerk wird gelegt auf die Haushalte, die in beiden Märkten gleichzeitig partizipieren. Das zentrale Ergebnis dieses Modells legt nahe, dass die Entscheidungen über Angebot und Nachfrage von Arbeitskräften verbunden und positiv korreliert sind. Dieses Ergebnis stützt die Aussage, dass China einen schlecht funktionierenden ländlichen Arbeitsmarkt besitzt.

In einem zweiten Schritt schätzen wir eine Reihe von Angebots- und Nachfragefunktionen unter Verwendung der beiden Instrumentvariablen "Anzahl der eingestellten Leiharbeitskräfte" und "Anzahl der außerlandwirtschaftlichen Arbeitskräfte". Die Nachfrage eines Haushaltes nach Arbeitskräften nimmt mit zunehmendem Lohnniveau für landwirtschaftliche Arbeitskräfte ab, während der Effekt einer Änderung des außerlandwirtschaftlichen Lohnniveaus stark abhängig ist von der Beteiligungsweise eines Haushalts am Arbeitsmarkt. Der Lohn für Leiharbeitskräfte hat einen signifikanten Einfluss auf das Angebot eines Haushaltes von außerlandwirtschaftlichen Arbeitskräften. Das legt nahe, dass Leiharbeitskräfte und außerlandwirtschaftliche Beschäftigung im ländlichen China Substitute sind, wenn auch unvollkommene. Unsere Analysen zeigen, dass bei Ausweitung der tierischen Produktion im Zeitablauf die Nachfrage nach Leiharbeitskräften steigt und das Angebot an außerlandwirtschaftlichen Arbeitskräften sinkt. Die Integration von

Bodenmärkten fördert die Arbeitsmarktbeteiligung, hat aber keinen signifikanten Einfluss auf die Allokation von Arbeitszeit. Vielmehr deuten die Ergebnisse auf die *non-separability* zwischen außerlandwirtschaftlicher Beschäftigung, der Haushaltsstruktur und dem sozialen Netzwerk hin, was wiederum eine Bestätigung für die Unvollkommenheit des Arbeitsmarktes in der Provinz Zhejiang ist.

Unter Anwendung von *discrete hazard models* erlauben uns die Daten schließlich eine Einschätzung der Dynamik von Arbeitsmarktbeteiligungen der untersuchten Haushalte. Im Besonderen untersuchen wir die Bewegungen zwischen Beteiligung am und Unabhängigkeit vom Arbeitsmarkt, zwischen Nebenerwerbs- und Vollerwerbslandwirtschaft, und zwischen Einstellung und Nicht-Einstellung von Leiharbeitskräften. Wir versuchen die Faktoren zu identifizieren, die für die Arbeitsmarktbeteiligung eines Haushalts bestimmend sind. Unsere Ergebnisse zeigen, dass die vergangene Enwicklung und die Wahrscheinlichkeit eines Haushalts sich zwischen verschiedenen Arbeitsmärkten zu bewegen signifikant mit mehreren Haushalts- und Betriebscharakteristika sowie mit Eigenschaften der ländlichen Gemeinde, in der sich der Haushalt befindet, verbunden sind.

Contents

Acknowledgment ..... **i**
Abstract ..... **III**
Zusammenfassung ..... **V**
List of tables ..... **IX**
List of figures ..... **X**
Abbreviations ..... **XI**
1 Introduction **1**
2 Agricultural policy reform during transition **7**
2.1 The decollectivization stage of reform (1978-1984) *8*
2.2 The market-oriented stage of reform (1985 onward) *9*
3 Theoretical framework and empirical approaches **17**
3.1 Theoretical framework *20*
3.1.1 Agricultural household model *20*
3.1.2 Optimal solution conditional on labor participation *24*
3.2 Empirical approaches *29*
3.2.1 The static approach *29*
3.2.2 The dynamic approach *34*
4 The rural labor markets in Zhejiang and data description **41**
4.1 General economy in Zhejiang province *41*
4.2 Data source *43*
4.3 Characteristics of sampled villages *45*
4.4 The evolution of labor markets in Zhejiang *47*
4.4.1 Trends of households' participation in labor markets *48*
4.4.2 The evolution of households' labor demand *50*
4.4.3 The evolution of households' labor supply *54*
4.5 Variables *57*
4.5.1 Dependent variables in the static approach *57*
4.5.2 Dependent variables in the dynamic approach *58*

4.5.3 Independent variables in empirical estimations *59*

5 Estimation approaches and empirical results 67

5.1 Households' participation in labor markets *69*

5.2 Instrumented wages of hired laborers and off-farm workers *80*

5.3 Hired labor demand functions *85*

5.4 Off-farm labor supply functions *92*

5.5 Dynamics of households' participation in labor markets *96*

6 Conclusion 112

References 116

Appendix A 125

Appendix B 127

List of tables

Table 2.1: Development of rural labor markets in China, 1978-2003 16
Table 3.1: Analyzed movement of households' participation in labor markets 35
Table 4.1: Years of households in sample 45
Table 4.2: Selected village characteristics 46
Table 4.3: Descriptive statistics of the dependent variables in the static approach 58
Table 4.4: Descriptive statistics of the dependent variables in the dynamic approach 58
Table 4.5: Descriptive statistics of the independent variables 60
Table 5.1: Results of households' labor participation from bivariate probit model 73
Table 5.2: Production function estimation and wage function for households with off-farm workers 82
Table 5.3: Estimated return to labor 84
Table 5.4: Estimated results of labor demand and supply functions 88
Table 5.5: Estimated results of the duration model between participation and not participation 100
Table 5.6: Estimated results of the duration model between supplying labor and not-supplying labor 102
Table 5.7: Estimated results of the duration model between hiring labor and not-hiring labor 105

Tables in Appendix B

Table B1: Static distribution of households' labor participation 127
Table B2: Education attainment and Skill of the labor force 127
Table B3: Maximum likelihood estimated results of the constant-only duration model 128

List of figures

Figure 2.1: Off-farm employment rate 13
Figure 4.1: Location of Zhejiang province in China 42
Figure 4.2: Location of ten survey spots in Zhejiang province 44
Figure 4.3: Gini index by villages 47
Figure 4.4: Households' static participation in labor markets by four regimes 49
Figure 4.5: Evolution of hired workers and off-farm employees 50
Figure 4.6: Percentage of households reporting demand of seasonal, long-term and total hired workers by the location of households in the regime h and the regime of sh in each panel 51
Figure 4.7: Average labor demand of seasonal, long-term, and total hired workers in units of working days calculated by the location of households in regime h and sh 53
Figure 4.8: Average labor demand of households calculated by seasonal, long-term and total hired workers in units of working days 54
Figure 4.9: Percentage of households reporting the supply of self-employers, wage earners and total off-farm employees by the location of the households in regime s and sh 55
Figure 4.10: Average labor supply of self-employer, wage earners and total off-farm employees in units of days calculated by the location of households in regime s and sh 556
Figure 4.11: Average labor supply of households calculated by self-employers, wage earners and total off-farm employees in units of working days 57
Figure 5.1: Predicted hazards for the transition of households in labor markets 107

Figures in Appendix B

Figure B1: Survival functions for the transition of households in labor markets 128

Abbreviations

CCPCC	Central Committee of the Chinese Communist Party
CD	Cobb-Douglas
CNSB	China National Statistical Bureau
CSYB	China Statistical Yearbook
EU	European Union
FOC	First order condition
GDP	Gross domestic product
HRS	Household Responsibility System
IFPRI	International Food Policy Research Institute
ML	Maximum likelihood
MP	Marginal product
NELM	New economics of labor migration
OLS	Ordinary least squares
PRC	People's Republic of China
RCRE	Research Center for the Rural Economy, Ministry of Agriculture, China
TVEs	Township and Village Enterprises
WTO	World Trade Organization
ZJSB	Zhejiang Statistical Bureau

1 Introduction

Rural labor markets rank high on the political and economic agendas of many EU and central and eastern European countries. Likewise, leaders in China are concerned about the performance of labor markets in rural China (MENG, 2000). The Chinese government published a white paper by the Ministry of Labor and Social Security on the nation's employment situation in 2004. The seven-part paper suggests that the government has paid great attention to the employment of the rural workforce. It particularly pointed out that "…the government has […] expanded the capacity of rural employment, adopted many measures to help the surplus rural workforce to transfer to the non-agricultural fields, and gradually removed the institutional obstacles to urbanization to guide the rational and orderly flow of the rural workforce." (CHINA.ORG.CN, 2004; page 12). Moreover, improving labor market conditions and labor mobility seems to remain one of the major goals on China's political agenda for the 21st Century (page 17).

China has earned special international public interest due to the size of its rural labor force and potentially migrating population. Almost two-thirds of all Chinese employed people live in rural areas. More than 300 million inhabitants currently active in agriculture are expected to move to other sectors in the future. While some rural residents will be able to remain at home and change jobs as the city grows up around them, it is predicted that more than 250 million job seekers will have to move to the cities by 2020 (AGRA-EUROPE GERMANY, 42/05; page 14).

How rural labor markets adjust to economic reforms is undoubtedly an important indicator of the progress of transition, although there are also other benefits of emerging labor markets. Without well-functioning labor markets, it is difficult to achieve the primary goal of economic modernization (DE BRAUW et al., 2002). Well-functioning labor markets also encourage the spread of new technology and the improvement of production efficiency (BENJAMIN, 1992). More flexible policies on labor mobility directly contribute to household income, and hence they effectively alleviate poverty (TAYLOR et al., 2003). Therefore, the issues of whether the rural labor markets in China function well or not and how rural households allocate labor resources among different on- and off-farm activities are fundamental to the rural and agricultural development process.

One of the interesting dimensions of studying China's labor market development is that almost all labor market activity has emerged since the onset of the reforms in the late 1970s. Before 1978, rural employment in China was predominantly agricultural and was organized by the collectives. There was almost no wage-earning employment off the farm and self-employment was nearly non-existent. Certainly, households that ran sideline businesses did not hire labor. In fact, the government primarily focused on securing sufficient agricultural output for food security reasons and limiting demand for subsidized food in urban areas. The result was a strict segmentation between rural and urban labor markets (DONG and PUTTERMAN, 2000; WALDMAN, 2004; ZHANG et al., 2006).

With the introduction of the Household Responsibility System (HRS) and the dismantling of collectives in rural China, the decision on time allocation of family members was transferred from the collective to households, thus offering new channels of employment.[1] Labor mobility was permitted and farm households began to integrate into rural labor markets (BENJAMIN and BRANDT, 1997; ROZELLE et al., 1999; DE BRAUW et al., 2002). Beginning in the first half of the 1980s, the Foundation of Township and Village Enterprises (TVEs) provided additional off-farm employment opportunities in these areas.[2] Further limitations on household business investments and operations were eliminated and households began to supply increasing quantities of labor through self-employment. Although a number of policies initially were designed to keep labor in rural areas, gradually measures during the 1980s and 1990s by local and regional governments allowed for migration (ROZELLE, 1994; BENJAMIN and BRANDT, 2002).

Considerable progress in the emergence of labor markets followed the removal of restrictive policies, which have kept rural labor on the farm. Employment in agricultural production declined from 93% to 64% of total rural employment between 1978 and 2003 (SSB, 2004). BENJAMIN and BRANDT (2002) provide evidence that the exchange of on-farm labor among households is marginal during busy season.

[1] Household Responsibility System (HRS) was implemented nationally in China at the end of 1978 to replace the previous communal system. Under HRS, the land in the village is distributed equally in quantity and quality to the households according to family size with land management rights vested in households but land ownership rights remaining in the village. Under HRS, households sign the contracts with the local village; these contracts link various taxes and quotas to the plots of contracted land but allow the households to retain the residual income after fulfilling the quotas and taxes. [For more details on HRS, please refer to LIN (1992) and LIU and WANG (2005)].

[2] Many TVEs followed the "commune-and brigade-run" enterprises established at the time of Great Leap Forward. TVEs are community enterprises that are either legally non-collectively-owned and controlled by the local residents or collectively-owned and mainly managed by the township and village government. [For more details on TVEs, please refer to TIAN (2000)].

From author's survey data (ROZELLE, 1994; ZHANG et al., 2006), *albeit* in relatively small numbers, households also began to hire labor for agriculture and self-employed business. In other words, the empirical literature demonstrates that rural households in China gradually began to supply labor off the farm as well as demand labor for on-farm agricultural and non-agricultural production.

Despite the progress, the literature makes clear that even in the 1990s and beyond, rural households still faced restrictions in their labor allocation. For example, although much progress has been made to improve the property rights of cultivated land, land rental markets still are thin in some regions (KUNG, 2002).[3] Due to this reason, households that would prefer to look for work off the farm may find themselves tied to their land. These households may refrain from abandoning agricultural production completely because they fear of loosing the assigned land or receiving inferior land in future reallocations by village authorities. In addition, low education rates persist in many villages, a factor that has been identified as a primary determinant of accessing the labor market (YANG, 1997a, 2004).

In many cases these restrictions have caused a gap between the market wage and the opportunity cost of farm labor, as would be expected from economic theory (COOK, 1999; ZHAI et al., 2003). This demonstrates that labor mobility constraints exist in rural China. The hypothesis that labor market imperfections still exist is also supported by other works. For example, BENJAMIN and BRANDT (1997) and LIU et al. (1998) identify an inverse relationship between farm size and labor use, indicating labor market constraints. MENG (2000) and YANG and ZHOU (1999) suggest that institutional restrictions, such as land tenure arrangements and the mandatory quota system, decrease off-farm labor market participation. BOWLUS and SICULAR (2003) indicate the non-separability between labor supply and demand decisions of farm households, and thus labor market imperfections.

On the other hand, some studies have illustrated the emergence of functioning rural labor markets and the breakdown of institutional barriers. MAURER-FAZIO (1999) believes that labor markets are beginning to function well, citing empirical evidence that off-farm labor returns are equal over several alternative employment opportunities. ZHANG et al. (2001) and DE BRAUW et al. (2006) show the increasing importance of education in the determination of accessing employment and wage levels. LOHMAR (2000) finds only small effects of land policies on rural households' off-farm labor adjustments. In addition, ROZELLE et al. (1999) report a strong increase in migration and off-farm participation, supporting the hypothesis that

[3] Aspects of land policy are discussed in KUNG (2002) and LIU et al. (1998).

labor markets are improving. These debates on labor market conditions in rural China make implicit a degree of progress in the emergence of rural labor markets.

Although earlier studies of labor allocation have been mostly descriptive, more recent analyses use established tools from the labor economics studies. Vested in the probit or logit models, numerous empirical analyses explore the effects of individual or household characteristics and farm structure on the seasonal fluctuation of the labor force (LOVELL and ESPERANZA, 2004); the entry, exit, and re-entry of non-farm employment (GOULD and SAUPE, 1989; ZHANG et al., 2001); the degree of migration from the agricultural sector (BARKLEY, 1990); and the labor participation decision between hiring labor and supplying labor off the farm (WANG et al., 2007). Others use multinomial logit models to quantify the household's decision-making among alternative labor market regimes. CHEN et al. (2002) and GLAUBEN et al. (2005) analyze the following options of Chinese households: Working off the farm locally or migrating versus working exclusively on the farm; working off the farm, hiring labor, simultaneously hiring and supplying labor versus choosing autarky in the labor market. BUCHENRIEDER et al. (2002) as well as CHAPLIN et al. (2004) apply a multinomial logit model to analyze non-farm employment in three Balkan countries and central European countries, respectively. To estimate the structural time-allocation in the rural households, the Heckman two-stage approach has been extensively applied in the empirical literature. Based on the cross-section individual data, several studies focused on the farm operator's time allocation of leisure, farm activities, and off-farm activities (HUFFMAN, 1980; SUMNER, 1982); or the interactive labor allocations of the operator and the spouse (HUFFMAN and LANGE, 1989; TOKEL and HUFFMAN, 1991; LASS and GEMPESAW II, 1992; SKOUFIAS, 1994).

Several papers quantitatively evaluate Chinese households' time allocation (MENG, 2000; BOWLUS and SICULAR, 2003; YANG, 2004). Whereas MENG (2000) analyzes the total working days of household members, irrespective of the type of occupation, BOWLUS and SICULAR (2003) explore total agricultural labor use to test separability assumptions. YANG (2004) examines the determinants of households' labor demand for the non-agricultural part of the household business.

It is noted, however, that there are two overlooking in the existing literature. First, almost all of the literature to date has focused on the *supply* of labor from households into rural labor markets. Observations from the field and descriptive findings from the literature (BRAND et al., 2002; ZHANG et al., 2006) show that households in rural areas are beginning to hire labor for on-farm and self-employed non-agricultural business activities. According to FINDEIS and LASS (1994), when households both hire in labor and supply their own labor off the farm, the decision-making behavior

may differ. Hence, in this study, a theoretical framework is developed to analyze and compare the behavior of individual households that are engaged in hiring labor or off-farm employment markets, taking into account the possibility of simultaneous participation in both markets.

Second, the existing literature on the rural labor market almost exclusively assumes that labor market decisions, for each given household, are fixed decisions.[4] In other words, most papers implicitly assume that once households have chosen a participation state, they will remain in it. However, observation during our field work in Zhejiang and evidence in the literature suggest that over time there are frequent transitions between hiring labor and working off the farm (MOHAPATRA et al., 2006). Thus, papers that assume that households are fixed in a single employment category may neglect important aspects of the households' reallocation of labor resources, given the interaction between the individual households and labor markets.

Curiously, despite the emergence of rural hired labor markets and despite the fact that job switching appears to occur rather frequently, there seem to be few studies of these dimensions of labor market in rural China. Therefore, in this study, we specifically seek to meet four objectives. The first is to document the emergence of labor market, including the on- and off-farm labor markets by tracking the development of households' roles in rural labor markets.

The second is to understand the determinants of households' labor participation decisions and identify the factors that enable or constrain the ability for households to hire workers or join the off-farm labor market. By using the appropriate econometric technique, we can test whether the participation decision regarding the two labor markets is made jointly or separately. This allows us to assess whether the labor market functions efficiently or still functions frictionally.

The third is to assess the response of households' demand for hired labor and supply of off-farm members quantitatively to the endogenous measure of time value of rural labor and other exogenous household and village characteristics, whereas the shift of the households' production structure occurs inseparably. Furthermore, we explore whether labor allocation decisions change when households participate in rural labor markets that allow them to both hire labor and supply labor off the farm. In other words, we study whether households are more responsive to changes in wages and other factors when they have more decision-making options.

---

[4] There are two exceptions, which are vested in the previous state of households' participation in labor markets. WEISS (1997) and CORSE and FINDEIS (2000) use different specifications of a probit model to explain the persistence of off-farm participation, taking previously occupied labor market regimes into account.

The final objective is to identify the determinants of the spell of households' participation in labor market and the duration dependence of movements between labor market states. This part of the study aims to extend the literature by analyzing the duration dependence of the probabilities of transition among labor markets, which provide a valuable complement to the results on state dependence by WEISS (1997) and KIMHI (2006).

The thesis proceeds as follows: Chapter 2 summarizes the frequent policy shifts that characterize rural China during the transition process. Chapter 3 constructs agricultural household model and hazard model for analyzing the two sets of questions mentioned above, respectively. These two models are the basis for the following empirical estimations. Chapter 4 provides data resources, which we refer to as fix-pointed survey data from Zhejiang province covering the period from 1995 to 2002. We also describe the emergence of the labor market over time, with the special attention to Zhejiang province. To do so, we present information on the participation of households in labor markets, descriptive statistics on the development of labor hired by farm households and off-farm workers, and evidence of the transition in labor markets. Following that, we also statistically describe the variables used in the various empirical analyses. Chapter 5 presents the empirical results by estimating a model that analyzes the determinants of participation in hired labor and off-farm employment markets as well as a series of hired labor demand and off-farm labor supply functions. A discrete hazard model is also used to assess the transition of households in labor markets. The last Chapter concludes.

2 Agricultural policy reform during transition

Agricultural policies and their effects on the mobility of rural labor force are quite different in developing countries making transition from a command economy to a market-oriented economy than they are in other market economies. Some of the problems with the allocation of labor resources are specific to the transition, while others are common to the general process of development, but appear in special forms because of the legacy of transition. In particular, there are questions concerning the extent to which China's rural reforms have promoted the development of competitive, efficient, and widely accessible labor markets. The influences of the agricultural policies on the labor markets could arise from either the direct impacts of the policies on labor mobility and the development of TVEs and self-employed enterprises, which dominate the households' allocation and reallocation of labor in various production activities, or the indirect impacts of the policies on the grain production and other factor markets, especially the land market.

Thus, this part of the study presents a discussion of policies on issues related to the emergence of on- and off-farm labor markets, as well as the rise of TVEs and self-employed enterprises. We also review grain-related agricultural policies. It is important to understand grain policies because food security-oriented policies dominated the rural economy during the post-reform years. Until recently, grain was one of the greatest concerns of leaders and the government historically intervened heavily in grain production. It is proven that this intervention may be expected to dramatically affect the labor allocation decisions of rural households (SICULAR, 1995). Recent work highlights the impact of land market regulation on households' labor allocation (HERTEL and ZHAI, 2006). This study picks up these hypotheses and converges a summary of the policies on the land use right in the policies review.

The review of the agricultural policies suggests a chronological approach and the effects of the corresponding policies do indeed describe a process of sequential change. The reform began during a special plenum of the Eleventh Central Committee of the Chinese Communist Party (CCPCC), which is generally regarded as the landmark in China's economic development. Because this historic meeting took place in 1978, the policy review in this study begins with that year. As is

common in the literature (LIN, 1992; LIU et al., 1998), the reform period is divided into the period of the decollectivization (1978-1984) and the market-oriented reform stage (1984 onward). Because the second period is characterized by a series of policy implementation and retrenchments, it is further sub-divided into four phrases: 1985-1989, 1990-1993, 1994-1998, and 1999 onward.

2.1 The decollectivization stage of reform (1978-1984)

Starting in 1978 and culminating in the early 1980s, the initial phase of rural reform introduced the HRS, raised state-set agricultural prices and gradually began a series of changes to reform China's grain quota system (MCMILLAN et al., 1989; LIN, 1992). This series of reforms, in general, was designed to make the household the fundamental decision-making unit and the residual claimant of economic activity. In addition to greatly increasing incentives to working on the farm, it also enabled family members to begin to allocate their labor into off-farm activities. During this period, off-farm employees in TVEs increased nearly two times nationally from a base level of 2.8 million people in 1978 to 5.2 million in 1984. The share of rural labor that had a job off the farm rose from 9% in 1978 to 14% by the mid of 1980s (SSB, 2001).[5]

After 1981, leaders also began to encourage individual households to become involved in small-scale businesses and trade on the agricultural products in the second and third categories, such as vegetables, hand-made items, and so on.[6] After fulfilling state procurement quota, the rural households could exchange the grain surplus (beyond what was needed for feeding the household or the livestock) at a price which, in most years, was higher than the quota price and was established by the market. As a result, local county fairs and periodic markets sprang up, and thus breaking down the barriers for market-oriented behavior of rural households (SICULAR, 1995). The rise of markets and the relaxation of private housing markets triggered a rise in the demand for jobs in the commerce,

[5] China Statistical Yearbook (CSYB) only reported the employees in Township and Village Enterprises (TVEs) from 1978-1989 but does not record the self-employers of rural households.

[6] At the end of 1980, agricultural products and by-products were classified into three categories while the government implemented the different quota policies on the three categories of products. For the first group include grain, cotton, oil crops and woods and so on, the government set up the quantity and price on the quota; for the second one with 124 kinds of products including 54 kinds of Chinese traditional medicines and 21 kinds of aquatic products, the government established the quota quantity and set up two kinds of prices as the buying and selling prices. After fulfilling the quota, the households are allowed to sell the rest products in this category at the market price in the trade fairs. The rest are accounted as the third category, which is subject to the negotiated price and quota. To the end of 1984, only 38 kinds of products are under the trade restriction of the state, in which 24 kinds of Chinese traditional medicines were included.

transportation and construction industry. The very earliest occurrence of hiring labor began to emerge during this time. In 1984, national legislation legalized the formation of private businesses and implicitly condoned the right of individuals to hire labor. Events outsides of agriculture also affected the nature of farming itself. During certain times of the year, busy entrepreneurial individuals began to informally hire worker to work on and outside of their farms. Leaders leased land to farmers for a period of 15 years with the goals of motivating households to invest on land and allowing them to transfer land to their neighbors. In summary, these policy shifts greatly increased the scope of decision-making of households about their allocation and use of labor.

2.2 The market-oriented stage of reform (1985 onward)

Agriculture's positive response to the first round of reform led authorities to believe that agricultural production was sensitive and responsive to improved market conditions, incentive shifts, and the elimination of policy restrictions. Thus, the stage was set for a second round of reforms. After the mid-1980s, leaders launched a new round of reforms to make the economy more market-oriented and gradually eliminate the state control over prices so that resources could be used more efficiently. However, although the tendency after 1984 was pro-reform, the second stage has been a start-and-stop affair.

1985-1989 Period: Leaders initiated the second round of reforms in 1985 with two market-liberalizing policies. First, they abolished the compulsory quota system in some areas; second, they replaced the traditional mandatory quota system with a voluntary contract purchase system. The changes involved most major crops, including grain. The "two-track" price system also was abolished and replaced by a single proportional price system during this time. The new price was set at a level that was a weighted average of the previous quota price (30%) and above-quota price (70%). In the new system, a farmer's grain could be sold either to the grain bureau or to a middleman or directly to customers in local fairs. The government initially promised to purchase all grain at the quota price if the market price fell below a state-set floor price. In areas that did not abolish the quota, the official policy allowed farmers to complete their procurement quota either in kind or by paying cash. The government provided chemical fertilizer and diesel oil at below market prices during this period to maintain the enthusiasm of farmers to cultivate grain and other key cash crops, as in the pre-reform period.

Unfortunately, for a number of reasons, the policies of this period did not trigger the same increase in performance as in the first stage of reform. Instead, an unexpected stagnation of grain yields and a drop in agricultural production occurred.

Although part of the production decline may have been due to drought and other weather-related factors, it has been shown that a large part of it was due to the effect of several factors. For example, LIN (1992) found that the exhaustion of institutional reform effects and the deterioration of the relative terms of trade, which is the marginal price, fell from the negotiated price to the proportional price. Others attributed the stagnation to environmental stress (HUANG and ROZELLE, 1995).

Interestingly, another set of inquiries implicitly argue that the problems in agriculture were in part due to success in the non-agricultural portions of the reforms. For example, WEERSINK and ROZELLE (1997) show that the post-1985 stagnation in yields was partly due to the higher opportunity cost of the labor force that was moving away from farming as the restrictions on labor movement were being relaxed. The demand for off-farm labor also rose rapidly as the output of Township and Village enterprises rose in the late 1980s (SSB, 2001). In the mid- and late 1980s, TVEs became one of the most booming sectors of the Chinese economy. During this time (1985-1989), the yearly average growth rate of employment in TVEs was 6.02% (SSB, 2001). By 1990, the share of TVEs in nominal total GDP rose significantly from around 14% in 1978 to more than 45% (SSB, 1996).

All of these factors led officials to interrupt the progress of the reforms. Falling grain production triggered a reintroduction of the state procurement plan, an action that reversed earlier progress in grain market liberalization. In the new state-dominated system, farmers were forced to sell grain through state marketing channels even when they were not getting paid due to the serious issue of da bei tiao.[7] Grain producers were forced to sell the grain surplus through the state channels again to fulfil the state plan to purchase 50 million tons of grain from the year of 1987.

While grain policy was shifting to make it more difficult for farmers to move off the land (because they needed to complete their grain quota), a number of policies began to make it easier for farmers to move to cities (and other rural areas) to find jobs. The government began to issue identification cards to rural residents for the first time in the mid-1980s. This development helped farmers gain employment off the farm, especially in cities (DE BRAUW and GILES, 2006). In addition, the rise of TVEs continues, making it increasingly easier for farmers in some rural areas to find jobs, although in 1989 credit restrictions sought to slow the rapid growth of the sector (ROZELLE et al., 1999). Hence, in the late 1980s, there were both push and pull factors acted to influence rural residents to and hinder them from seeking off-farm employment.

[7] Because of the shortage of funding in local grain stations, when the farmers fulfilled the quota or sold agricultural products to the state, they were not paid directly in cash, instead they received a letter, in which the grain station promised to make the payment later.

1990-1993 Period: In 1990, following criticism of impact of the rural market program, the government introduced a set of adjustment policies to further phase out the old centrally planned agriculture system in favor of more market-oriented solutions.[8] After 1990, in terms of grain policy, a rebound followed the retrenchment. Encouraged by successive high yields (the years 1989 and 1990 generated historic highs), leaders launched another set of policy initiatives targeting the grain sector. The boldest measures were aimed at phasing out the urban grain ration system. If the government could eliminate planned sales to city residents, they eventually could eliminate the grain procurement system altogether. In fact, in many areas, especially the wealthier coastal provinces, compulsory grain quotas were sharply reduced and even eliminated.[9]

In addition to grain market liberalization, policy makers also made efforts to strengthen the property rights of farmers' claims to cultivated land. Most notably, it was announced that the length of land leases would be extended to at least 30 years as the end of the first 15-year contract period drew near (LIU and WANG, 2005). National policy makers recognized the rights of farmers to rent their land and in many provinces local leaders were directed to stop interfering in rental agreements between renters and rentees. Finally, the in-kind fertilizer and credit subsidies to farmers for grain marketing were discontinued. In other words, leaders sought to allow farmers to make more unconstrained decisions.

In 1991, after a slow down in 1989 and 1990, Deng Xiaoping, China's top leader, travelled to southern China and announced that he condoned the efforts of local leaders and private entrepreneurs to expand investments and increase output (ROZELLE and SWINNEN, 2005). Government has actively supported the development

[8] The introduction of the rural market program led to stagnant agricultural production and decreasing grain production from1985 to1988. This might partially be explained by the fact that labor mobility was allowed so that a labor outflow from agricultural activities took place.

[9] In addition, the government implemented a number of complementary policies to gradually phase out the Socialist grain policies. For example, the government fixed grain floor prices for the procurement quotas in the rest of China. The national grain warehousing system also set up a system to act as a buffer stock system. Three main measures were taken.The first was to establish various layers of a special grain and oil reserve system by building up the stocks of agricultural products centrally and locally with 5 million tons of grain and 0.2 million tons of oil annually in the subsequent five years from 1990. This was to satisfy the willingness of farmers to sell excess products at protective prices and stabilize the supply and demand of the market. The second was to establish a grain risk fund from budgetary revenue at the central and provincial levels to buffer grain and oil stocks. With the goal of mediating the market price, the state set up grain wholesale market in Zhenzhou, where the grain trade within provinces was transacted at negotiated prices between the sides of supply and demand. Third, in early 1993, the direction on quota adjustment was focused to safeguard the quantity while liberalizing the price, which implied that fulfilling the quota was still compulsory at national level and that the quota price should follow the market price.

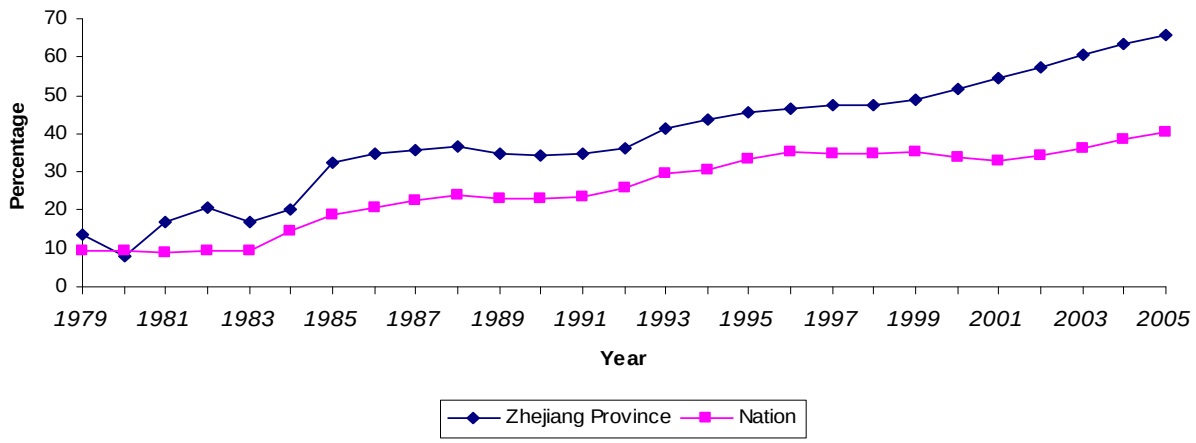
of non-agricultural production, in particular TVEs, to provide employment opportunities for the perceived rural labor surplus (COOK, 1999; BOWLUS and SICULAR, 2003). Credit restrictions were dropped. The rights of private businesses became more formalized. The environment for industrial and service sector expansion has never been more favorable.

In response, off-farm employment opportunities exploded. Between 1990 and 1995, the off-farm employment rate rose by 10% (DE BRAUW et al., 2002). Employment by TVEs accounted for a large part of the growth (MENG, 2000). In 1990, rural employees in TVEs accounted for 85.24% of total off-farm employees nationally; the rest were self-employed in occupations such as transportation and services. This proportion was comparatively stable until the end of 1993. Furthermore, employees in TVEs increased by more than 30 million (SSB, 2001). However, the early 1990s saw the beginning of the expansion of other employment sources. ZHANG et al. (2006) document an acceleration of self-employment activities in rural areas. In 1990-1995, the yearly average growth rate of self-employers was 16% (SSB, 2001). There also was a first push by migrants into the cities. Reforms in cities made it easier for state-owned and private firms to hire migrants (ZHAO, 2002), and better connections and infrastructure facilitated the movement of rural residents to more distant locations (ROZELLE et al., 1999). In some regions the rise of off-farm employment was very fast. For example, in Zhejiang province, the off-farm employment rate increased around 7% from 1990 to 1993, while nearly 40% of the labor force took non-agricultural employment in 1993, which was 10% higher than that at national level (Figure 2.1).

1994-1998 Period: The frequent policy adjustment during this period made it hard to identify the direction of reform, while the national self-sufficiency policy degenerated into a policy of local self-sufficiency to guarantee regional food security (BRÜMMER et al., 2006). From 1994, a number of measures were undertaken to aid producers. To buffer the drastic increases in market prices at the end of 1993, the government raised the fixed quota price by about 40% in 1994, then another 40% in 1996 from the base level of 1994. Soon after the adjustment of quota price, the concurrent market price correspondingly increased to a higher level. The rise of the fixed quota price prompted the implementation of the Provincial Governor's Grain Bag Responsibility System, a policy to ensure a balance of the supply and demand of grain in each province. Local governments in some provinces took actions to control increasing parts of grain economies by encouraging the expansion of grain sown areas and expanding their grain stocks. Furthermore, in many areas rules were promulgated to prevent private grain traders from buying grain directly from farmers before the farmers (as a group) had fulfilled their quotas. As suppliers in

each province rose induced by either high prices or the policy encouragement, there was thought to be a reduction in the volume of internal trade within China. If so, it is possible that farmers, as in earlier years, were tied more closely to the land and may have been less able to make unrestricted off-farm employment decisions.

Figure 2.1: Off-farm employment rate



Source: CHINA STATISTICAL YEARBOOK (various issues).

During this time when grain policies were in some sense becoming more restrictive, there was little effort to directly intervene in the decisions of farmers to find jobs off the farm. As a result, even when the rest of Asia was experiencing the Asia crisis during the mid-2000s, and China experienced the structural reform and a general slowing of economic growth, China's off-farm employment was continuously rising. According to data from the National Statistical Bureau, the numbers of TVEs reached 1.3 million by the mid-1990s; each enterprise on average employed 38 people (SSB, 2001). ZHANG et al. (2006) show that by the end of the 1990s there were more than 80 million self-employed. Therefore, more than 100 million people were employed off the farm in rural areas – either in TVEs or as self-employed people. Tens of millions more were working in cities as migrants (DE BRAUW et al., 2002). In some regions, for example Zhejiang province, by the end of the 1990s, 10 million rural laborers were employed in off-farm activities; the non-agricultural employment rate jumped more than 6% during the time span of 1993-1997.

Moreover, because there have never been any formal rules against hiring workers on the farm, there was a gradual emergence of hired farm labor. According to the First National Census on Agriculture, less than 1% of more than 214 million rural households hired on-farm labor.[10] The incidence of hired labor in farm households

[10] In January 1997, China's first National Census on Agriculture was conducted in more than 740,000 villages and covered more than 214,000,000 rural households in rural China to record

differs markedly between regions. Of those households with hired workers, around 49% were located in the comparatively developed and rich eastern provinces, 34% were in the central area, and the rest were in the western region. Among the hired workers, a bit less than two-thirds worked as long-term workers and the rest were seasonal workers. The proportion of hired female workers accounted for 36%.

Although Chinese authorities were pushing retrenchment-like policies in 1994 and 1995, there were many other indicators that liberalization was continuing, especially after 1996. Progress in market-oriented reforms in rural commerce can be seen in the data on the expansion of marketing activities. The census of agricultural statistics shows that there were an average 1.87 local fairs or markets at the town level. Of these, about two-thirds were comprehensive fairs and one-third were specialized markets. DE BRAUW et al. (2000) demonstrate that rural markets increased rapidly between the early 1980s and the late 1990s.

1999 and onward: By the end of the 1990s, China's leaders decided to make another push at grain marketing reform with the goal of increasing the efficiency of farming and allowing farmers to pursue activities in which they had a comparative advantage. The announcement of the state's new efforts came at the time of the record harvest in the late 1990s. At the same time, policies were adopted to encourage farmers to gradually shift the structure of their cropping and other agricultural activities in a campaign called the structural adjustment movement (Jiegou tiaozheng campaign).

Because the leaders intended to move toward an almost completely market-liberalized system, the new guiding principles of the campaign were called the "four separations and one improvement". The four separations included a.) the separation of the administrative duties of government bureaus in the implementation of policy duties from the commercial activities of the grain trading enterprises (which were often attached to local grain bureau offices; b.) the separation of the responsibility of the central government from those of local governments on issues of grain production, marketing, and storage; c.) the separation of the grain storage and reserve system from that of the operations of the grain marketing operations; and d.) the separation of the debts that had to be taken over by local governments from those bad debts that had to be taken over by the central government. The improvement was the new policy that allowed the level of the quota price to be set according to the prevailing market price, and that would no longer be used as a taxation instrument.

the economic activities of rural households throughout 1996, http://www.stats.gov.cn/tjsj/pcsj/index.htm.

Although it was not clear at the time, these policies were motivated more by the government's desire to raise rural incomes and improve efficiency, and less by reasons of national food security. In fact, within two or three years of the "four separations" policy, national leaders completely eliminated the grain quota, a policy that had been part of the government's policy tool kit for centuries. In addition, during the late 1990s and early 2000s, the government actively promoted the shift of farmers into non-grain crops, such as cash crops, fruit, vegetables, and other livestock and aquaculture enterprises. Without a grain quota there was little resistance by local leaders who heretofore had worried that extreme commercialization would have endangered their ability to collect and submit the quota.

The shift toward liberalization, however, did not end by 2000; in fact, it was just starting. One of the most far-reaching events after 2000 was China's accession to the WTO. After fifteen years of negotiations, the nation ratified an agreement committing itself to one of the most liberalized international trade regimes in the world. However, it is a mistake to think of the period of accession as the major watershed of trade liberalization. In fact, the nation had adopted numerous trade-policy-oriented measures in preparation. Tariffs had been lowered from more than 60% in 1990 to around 20% in 2000. The state trading regime was greatly liberalized. Many non-tariff barriers were dropped. China ceased subsidizing most of its agricultural exports. In fact, the changes during the immediate post-accession period (between 2001 and 2002) were probably less dramatic than those implemented during the time period prior to the accession date.

A number of policies also encourage the expansion of off-farm employment. For example, the privatization policies in the late 1990s, encouraged local rural governments to sell firms to individuals who would have greater incentives to invest and run the firms more efficiently (LI and ROZELLE, 2004). After 2000, restrictions in the cities were gradually relaxed, allowing migrants to find jobs and live in a more stable and friendly environment (ZHAO, 2002). Local governments began to adopt licensing and taxation policies that encouraged small businesses to expand their investments and increase employment (ZHANG et al., 2006)

Undoubtedly, these domestic and international trade and business policies allowed for more rapid structural adjustment in their crop mix and labor allocation to farm and non-farm activities. Table 2.1 indicates that the labor input into agriculture continually decreased while the number of individuals who found work off the farm increased rapidly between 1998 and 2003, rising by around 5 million (SSB, 2004). In Zhejiang province, the number of off-farm employees overweighed the number of rural laborers in agricultural production for the first time in 2000 (Figure 2.1). At the same time, new activities and opportunities were available to individuals who

wanted to find employment in agriculture. In the late 1990s and early 2000s some farmers began to return to the farm (DE BRAUW et al., 2002). The production of vegetables and fruit increased at rates that far exceeded anyone's expectations (ROZELLE et al., 2006).

Table 2.1: Development of rural labor markets in China, 1978-2003

	1978	1983	1988	1993	1998	2003
Share of rural labor in agriculture (%)[a]	92.9	91.2	78.5	75.2	70.3	63.8
Share of rural labor in manufacturing (%)		2.5	8.5	8.3	8.5	10.1
Share of rural labor in services (%)			9.2	12.3	16.0	19.5
Employment in TVEs (millions of people)	28.3	32.3	95.5	123.5	125.4	135.7
Share of rural labor in TVEs (%)	9.2	9.3	23.8	25.3	25.4	27.8
Share of rural labor as self-employers (%)				4.1	7.9	4.6
Share of rural labor in private enterprises (%)				0.4	1.5	3.6

Source: SSB.

Note: [a.] The figure is calculated by the person employed in agriculture to total rural labor force.

In sum, although China's agricultural and rural labor liberalization policies did not follow a straight line, and indeed spent 20 plus years starting and stopping, today China is one of the most successful transition economies in the world. There are currently few restrictions in rural China on the crops that farmers may plant and the inputs they may use. There are no taxes. Direct grain subsidies, although just beginning, are mostly thought to be decoupled (SONNTAG et al., 2005). In rural areas, farmers are completely free to allocate their labor as they desire. There are almost no labor laws restricting hiring or firing labor on or off the farm. The legacy of Socialism certainly is a thing of the past. And although land policy is still evolving, most papers have found that the tenure system does not distort incentives to invest (BRANDT et al., 2002). Today, labor continues to shift from rural to urban and from agriculture to industry at unprecedented rates (ZHAO, 2003). It is no surprise that these labor markets which have endured such fundamental changes in the last 20 years deserve to be the subject of studies.

3 Theoretical framework and empirical approaches

As mentioned in Chapter 1, the agricultural household model emerged from an attempt to develop a unifying microeconomic framework of farm households' decisions regarding production, consumption, and labor allocation in a theoretically consistent fashion. This chapter describes a more general analytical framework of this model, which serves as the theoretical foundation for the empirical analysis in the following chapter. This model is then used to analyze the labor allocation behavior of agricultural households in rural China.

The agricultural household model is characterized by the agricultural households that are nonetheless the dominant farm subjects, make the dual production and consumption decisions, allocate family time between leisure and work, and determine the households' participation in labor markets as suppliers of family labor or employers of hired labor as they respond to new agricultural policies.[11] As an operationally meaningful theory of agricultural development, the agricultural household model considers that agricultural households engage in agricultural production from a multi-sectoral perspective, in which the products are both for sale in the market and for the households' own consumption. An agricultural household is defined as a semi-commercialized rural unit rather than a profit-maximizing unit because it provides some inputs (labor and land) from its own resource endowment and also purchases some input factors. The household's goal is to maximize its utility from food consumption and leisure, whereby the consumption of products (either produced on the farm or purchased in the market), the profit from selling the agricultural products, and the quantity and price of the various agricultural inputs and outputs are involved in the utility assessment. Furthermore, the labor allocation of rural households in four competing alternatives – leisure, farm work, off-farm work, and demand for hired labor – interacts with the farm structure, the demand of input factors and supply of output, welfare, and the consumption pattern of households.

[11] This definition of "farm household" extends the previous formulation of its definition (NAKAJIMA, 1986) by completely incorporating a farm households' behavior in the labor market, including both the supply of family member as laborers on and off the farm and the demand of hired labor in the farm business.

This approach dates back to Becker's theory of household production (1965), in which he defines a household's utility attained from commodities and services as household activities, such as cooking, cleaning, and heating under the constraint of available time and the presence of durable appliance. Several researchers propose the possibly independent decision of a household's production with its consumption and labor supply decision (KRISHNA, 1964; JORGENSON and LAU, 1969). This has been extensively applied in many empirical studies to estimate the input demand and output supply by specifying the separable models (BARNUM and SQUIRE, 1979).

The cardinal marginal utility and disutility framework for developing an agricultural household model, particularly in the context of Russian farm households, has been elaborated on by CHAYANOV (1986). Consequently, the theoretical improvement of the agricultural household model develops to the ordinal unity concept from the cardinal utility concept. The theoretical and empirical basis for household's behaviour research is subject to an intensive review following the refinements of agricultural household models in a duality framework by SINGH et al. (1986). Their book derived various versions of model modification, which are extensively applied in several empirical studies on developing countries. Their book also provides the evidence that the agricultural household model with proper modification could be useful for many other themes including exploring the factors on resource allocation, the effects of pricing policy on nutritional status, the relationship of farm profit and health, agricultural production risk, and so on.

The agricultural household model, which considers the household's utility maximization under the constraint of production, consumption, and time constraints, also has proven to be a useful framework for analyzing a rural household's behavior in labor markets. Since the early 1980s, this framework, with appropriate modify-cation, has been recognized as providing a number of powerful insights into the time allocation of rural households. In these studies, several aspects have been focused on the off-farm supply of the household's operator (HUFFMAN, 1980; SUMNER, 1982); the interactive decision regarding off-farm employment between the operator and the spouse (HUFFMAN and LANGE, 1989; TOKEL and HUFFMAN, 1991; LASS and GEMPESAW II, 1992; SKOUFIAS, 1994; SADOULET et al., 1998); and the joint decision regarding hiring labor with the activities of the operator couple (BENJAMIN et. al., 1996; FINDEIS and LASS, 1994). Some researchers have studied the rural household's allocation of time spent on leisure, farm work, and off-farm work in the context of risk (FINKELSHTAIN and CHALFANT, 1991; FAFCHAMPS, 1992), credit constraints (DE JANVRY et al., 1991), and transaction costs associated with the access to product markets (KEY et al., 2000).

Though the above studies rely on agricultural households as the theoretical framework, the empirical estimations still focus on individual behavior in the labor market. This study extends the existing literature by making the household the accounting unit in the context of a transitional economy. Focusing on the household's role in labor market instead of individual observations is potentially important for a number of reasons. In the Chinese agricultural sector, the production and consumption unit is vested in the household level. Chinese agricultural institutions underwent a dramatic reform of the formulation and eventual predominance of HRS in the early 1980s, which led to the replacement of collective farming by the individual household-based farming. Under HRS, production decisions about the plots of contracted land and other fixed resources, such as machinery, draft animals, and the output quotas, are subject to the responsibility of individual households. The farm households also choose the patterns, methods, and inputs as well as the mix of on- and off-farm activities. These production decisions imply a widely varied demand for family labor or hired labor across households as well as a seasonal distribution of labor. From the consumption point of view, households save the monetary surplus from the sale of their products and off-farm income, as well as the products they have produced. Such a system balances dual production and consumption by individual agricultural households with the introduction of market-oriented reform. As a result, in all the aspects, Chinese rural households are representative to the analysis drawn the support from agricultural household models. Studies also verify that the time allocation and contribution of family members in either the farm or non-farm sub-sector partly account for the productivity and intra-family distribution of income (ROZELLE et al., 1999; BENJAMIN et al., 2002).

In addition, according to the theory of "new economics of labor migration (NELM)", the participation in the labor market is a joint decision of a household rather than an individual behavior (STARK and BLOOM, 1985; TAYLOR et al., 2003). Finally, the impact of heterogeneity of the family and farm may certainly trigger and constrain the roles of individual family members in the labor market, which is taken into account at the household level.

This study examines labor allocation of Chinese rural households in labor markets by means of a modified agricultural household model. Section 3.1 presents a theoretical model of the rural households in a simplistic version and the directions of the possible modification closely related to this study. This model analyzes households' participation in hired labor and off-farm labor markets, the contributed working days of hired labor, the quantity of the family members' off-farm labor supply, and the dynamics of households' participation in labor markets. Next, it turns to empirical programming models in Section 3.2. Regarding the

empirical analyses, the econometric approach concentrates on the following aspects: Exploring which kind of households tend to hire labor or provide labor off the farm; analyzing the demand functions of hired labor and the supply functions of off-farm labor while the respective imputed wages of hired labor and off-farm workers are included as instrumented variables; understanding the determinants of households' duration in the possible labor market regimes; and evaluating the dynamics of households' participation in labor markets, with a special focus on the probability of transition between various labor markets conditional on the length of time spent in the original participation state.

3.1 Theoretical framework

The approach is extended from FINDEIS and LASS (1994) to consider labor market imperfections (GLAUBEN, 2000). The following assumptions are included in theoretical model: First, the model framework considers the household rather than the individual family members as a decision-making unit (STARK and BLOOM, 1985; TAYLOR et al, 2003). It is well known that under perfect labor market conditions, the allocation of family labor between on-farm and off-farm farm work and demand for a hired workforce in agricultural production could be determined separately. However, it is possible for joint decisions to be made in imperfect labor markets (SADOULET et al., 1998); that is, the labor participation and optimal time allocation in the labor market are simultaneously determined. Second, according to neoclassical economics, households are assumed to be rational in adjusting labor demand and supply responding to the variation of internal wages and the functioning of labor market. Third, to concentrate on the role of labor market decisions, a static model is established ignoring some aspects of farmers' decisions, for example, risk (FINKELSHTAIN and CHALFANT, 1991; FAFCHAMPS, 1992), credit constraints (DE JANVRY et al., 1991), transaction costs associated with the access to product markets (KEY et al., 2000), and other input markets.

3.1.1 Agricultural household model

The objective of the rural household is in essence to maximize utility derived from consumption and leisure by allocating its labor resource into several on-farm and off-farm activities, subject to a technology constraint on agricultural production (2), a time constraint (3), and a budget constraint (4). Therefore, a farm household solves the following maximization problem (WANG et al., 2007):

$$\max U(C_m, C_l; z_u) \tag{1}$$

subject to

$$G(Y, X_v, L, K; z_g) = 0 \tag{2}$$

$$T_l - L + L_h - L_s - C_l \geq 0 \tag{3}$$

$$P_m C_m \leq P_y Y - P_v X_v - h(L_h; z_h) + s(L_s; z_s) + E \tag{4}$$

Here, U is a farm household's utility function, which is assumed to be well-behaved. C is a vector of consumption goods consisting of commodities (C_m) and leisure (C_l), and z_u represents exogenous utility shifters, e.g. heterogeneous household characteristics. G represents a well-behaved production technology (2). The rural household is assumed to produce agricultural products (Y) using variable inputs (X_v), the total of on-farm labor time (L), which could be subdivided into family labor (L_f) and hired labor (L_h), and quasi-fixed factors (K) capital and land while z_g are exogenous production shifters. The household faces a time constraint (3), where T_l is the total time available and L is the total of on-farm labor time. Furthermore, L_s represents a household's supply labor service in off-farm activities (GLAUBEN et al., 2005; WANG et al., 2007).

The budget constraint of a rural household (4) states that the household's expenditure on the consumed commodities must not exceed the monetary income from various activities, subsidies from governments, and net transfers from or to relatives. Here, P_i (i=m, y, v) represents the exogenous consumer and producer prices. Conditional on the labor market participation regimes noted above, rural households might generate revenue from farming $P_y Y - P_v X_v - h(L_h; z_h)$, labor income from off-farm employment $s(L_s; z_s)$, and exogenous transfers (E) while $h(L_h; z_h)$ denotes the cost of hiring on-farm labor.[12] To consider labor market imperfections, the cost of hiring labor $h(L_h; z_h)$ and the revenues from off-farm employment $s(L_s; z_s)$ are conceptualized as functions of hired labor time (L_h) and supplied off-farm labor time (L_s), and several exogenous shifters, z_h and z_s, respectively (GLAUBEN, 2000; GLAUBEN et al., 2005). These exogenous shifters may include the heterogeneous characteristics of human capital or transaction costs associated with accessing the labor market.

This household model can cover two different types of labor markets. The first assumes a perfectly competitive labor market; thus the above two functions are both linear with the contributed time of hired labor and off-farm workers as $h(.) = w_l L_h$ or $s(.) = w_l L_s$. Hence, marginal costs of hiring labor and marginal off-farm earning are equal to an exogenous wage rate w_l. This assumption of a perfectly functioning labor market implies separability of households' production and

[12] If E>0, then the household receives transfers (or unearned income), whereas if E<0, it provides them.

consumption decisions. Farm households first make the optimal farm production decisions, and then decide on the optimal level of consumption and leisure.

However, the more general case of labor markets is assumed to be imperfect. Given the imperfectly competitive labor markets, both supplied and hired labor functions become nonlinear with the following properties: $\partial h(.)/\partial L_h > 0$; $\partial^2 h(.)/\partial L_h^{\,2} \neq 0$ and $\partial s(.)/\partial L_s > 0$; $\partial^2 s(.)/\partial L_s^{\,2} \neq 0$ (LEE, 1998; GLAUBEN; 2000; BENJAMIN and KIMHI, 2003; WANG et al., 2007). That is, the cost of hired labor is a nonlinear function of hired labor time and off-farm income is a nonlinear function of supplied off-farm working time. In this case, the price of labor and leisure (w_l) is endogenously determined, and thus the farm household model is non-separable. The production and consumption decisions are simultaneously determined by the stationary solution of the equation system (1) to (4).

This framework is applicable to several kinds of labor market imperfections.[13] In particular, it accounts for those that lead to an upward-sloping or backward-sloping price effectively received for each further unit of off-farm employment and paid for each further unit of hired labor time. Hence, the per-unit cost of accessing labor markets can be increasing or decreasing. Increasing per-unit costs of hired labor may result from increasing search activities. These increases may stem from the growing difficulty of finding the 'right' staff for the different and often farm-specific areas of production. Similarly, land-specific experience may lead to a decreasing substitutability between family and hired labor. Thus, hired labor could become less productive and the costs of a standardized hired labor unit could increase. However, the familiarity between the hired laborers and hosting households resulted from spending more time together leads to decreasing costs of supervising and monitoring hired laborers. Thus, the marginal cost of hired labor could possibly decrease given the more efficient work of hired labor.[14]

[13] In general the literature points to several reasons why labor markets may be imperfect, leading to non-separation of consumption, production, and labor-supply decisions. For example, binding hour constraints in off-farm employment may prevent a complete adjustment in agricultural labor markets (BENJAMIN, 1992). Family and hired labor may be imperfect substitutes in agricultural production (DEOLALIKAR and VIJVERBERG, 1987; JACOBY, 1993). Also, farmers may have preferences for working on or off the farm (LOPEZ, 1994). In addition, costs associated with labor market transactions can explain why households have different relationships to the labor markets (SADOULET et. al., 1998).

[14] Note that the approach could additionally incorporate fixed costs of transactions that are invariant to the traded quantity, but also could affect the farm household's decision to participate in markets [SADOULET et. al., (1998) for the labor markets; GOETZ (1992) as well as KEY et. al., (2000) for food markets; SKOUFIAS (1994) and CARTER and YAO (2002) for the land market]. Fixed transaction costs may include bargaining and negotiation efforts and

Increasing per-unit costs associated with working off the farm may be caused by increasing heterogeneity between on- and off-farm family labor. With increasing migration, household members are first transferred to the 'best jobs' followed by the 'next best jobs' and so on (LOW, 1986). However, off-farm networks within a household or village are proven to reduce the information cost for potential off-farm workers by providing information about off-farm posts (ROZELLE et al., 1999; ZHAO, 2003). With an effective and expanding network, marginal costs of family members' off-farm employment decrease. Thus, the effects of internal wages on off-farm labor supply could present the opposite directions.

According to the theoretical framework, four labor market regimes of households' labor demand and supply may arise. These could be expressed by the terms of the working days of hired laborers and off-farm workers as follows:

(1) Exclusive demand of hired on-farm labor ($L_h > 0$, $L_s = 0$) further denoted with regime *h*;

(2) Exclusive supply of off-farm labor ($L_h = 0$, $L_s > 0$) further denoted with *s*;

(3) Demand of hired labor and supply of off-farm labor ($L_h > 0$, $L_s > 0$) further denoted with *sh*;

(4) Neither demand of hired labor nor supply of off-farm labor ($L_h = 0$, $L_s = 0$) further denoted with *a*

Here, the state of households exclusively hiring on-farm labor (*h*) is identified as the households hire on-farm labor in agricultural production activities while family members may or may not join into agricultural production but none of family members are employed off the farm;[15] households in the state (*s*) are defined as those with some or all of the family members working as self-employers in their households' non-agricultural business or as wage earners in off-farm employment while it is certain that the households do not hire any labor for the on-farm production activities but to a large extent, some of the family members also work on-farm fully or partly; the definition of households participating in both markets (*sh*) means that a household supplies labor in the off-farm labor market and demands labor service for household business work simultaneously and the rest of family members, if any, may or may not play roles in agricultural production;[16]

transportation costs; these often take place once per transaction and are invariant to the level of transaction.

[15] In the following analyses, state and regime are synonymous.

[16] For the demand of hired labor in households that participate in both markets, we cannot explicitly separate hired labor into on-farm hired labor or those who work in the household's non-agricultural business, including industry, construction, transportation, and service. Therefore, the

autarky (*a*) in labor market is self-explained. The households' labor allocation decision could be analyzed empirically in the hired labor demand and off-farm labor supply functions conditional on their participation decision in labor market.

3.1.2 Optimal solution conditional on labor participation

Due to labor market imperfections, the optimal solution cannot be found by simply solving the first order conditions. The solution is thus processed into three steps: Finding the optimal quantity of labor allocation in various activities in terms of utility conditional on each labor market regime; choosing the labor participation states by comparing the utilities; and determining the response of labor demand and supply within the optimal participation regimes that leads to the highest level of utility. Rational households repeat the decision processes given the interaction of the labor market and the characteristics of households and farms. This potentially leads to the dynamics of households' behavior in labor markets.

The stationary solutions of the maximization problem (1)-(4) determine the optimal quantities of consumption and production goods and the allocation of time conditional on the participation regimes in labor markets. Assuming that there exist the interior solutions $(\phi, \mu, \lambda > 0)$, the Kuhn-Tucker condition characterising an optimum is derived (HUFFMAN, 1991; TOKLE and HUFFMAN, 1991):

$$U_{C_m}(.) - \lambda P_{C_m} = 0 \tag{5a}$$

$$U_{C_l}(.) - \mu = 0 \tag{5b}$$

$$\phi G_Y(.) + \lambda P_y = 0 \tag{6a}$$

$$\phi G_{X_v}(.) - \lambda P_v = 0 \tag{6b}$$

$$\phi G_L(.) - \mu = 0 \tag{6c}$$

$$-\mu + \lambda h_{L_h}(.) = 0 \tag{7a}$$

$$\mu - \lambda s_{L_s}(.) = 0 \tag{7b}$$

$$G(Y, X_v, L_f, L_h, K; z_g) = 0 \tag{8}$$

$$T_l - L + L_h - L_s - C_l = 0 \tag{9}$$

$$P_y Y - P_v X_v - h(L_h; z_h) + s(L_s; z_s) + E - P_m C_m = 0 \tag{10}$$

incidence of labor demand in our study differs from estimates by ROZELle (1994) as well as BENJAMIN and BRANDT (2002).

here, $\phi, \mu, \lambda > 0$ are Lagrangian multipliers associated with technology, time and budget constraints, respectively; while U_{C_m}, U_{C_l}, G_Y, G_{X_v}, G_L, h_{L_h} and s_{L_s} represent the first derivatives of the corresponding utility, production, and labor functions.

Transformation of FOC (7a)

$$h_{L_h}(.) = \frac{\mu}{\lambda} = w_l \tag{11a}$$

Transformation of FOC (7b)

$$s_{L_s}(.) = \frac{\mu}{\lambda} = w_l \tag{11b}$$

here, $w_l = \mu/\lambda$ denotes the internal wage rate that results around the optimum as an implicit function of all of the exogenous variables mentioned above: $w_l = \lambda(P_c, P_v, K, E, T_l, z_h, z_s)$. Combined equation (11a), (11b) with FOC (5b) and (6c), $\frac{U_{C_l}}{\lambda}(.) = \frac{\phi G_L(.)}{\lambda} = s_{L_s}(.) = h_{L_h}(.) = w_l$ determines a complete set of labor demand and supply functions (HUFFMAN, 1980; HUFFMAN and LANGE, 1989; LASS and GEMPESAW II, 1992).

For the interior solutions, FOC (5b), (6c), (7a), and (7b) imply that all marginal contributions of labor and leisure should be equal to the internal wage rate. However, from the empirical point of view, there might be differences between the internal wage rate for hired labor ($w_l^h = h_{L_h}(.)$) and that for supplying labor time off-farm ($w_l^s = s_{L_s}(.)$). This has been proven by the studies on developed labor markets such as Japan and the developing economies such as Indonesia and China (BENJAMIN, 1992; COOK, 1999; SONODA and MARUYAMA, 1999). Their studies also provide evidences that the internal wage of off-farm employees is evidently much higher than that of on-farm labor or hired labor. In the potentially imperfect labor market, the following causes are possible:

(a) Owing to the heterogeneous accumulation of human capital and the tasks performed, hired labor and off-farm workers may not necessarily have identical effects on the productivity. In agriculture, hired laborers often perform specialized tasks, such as tractor or bullock operation, which is generally beyond the abilities of family members. Furthermore, off-farm workers are often young, educated, and healthy with construction skills or service experience.

(b) As mentioned before, due to the incentive problem, costs are incurred from monitoring and supervising the hired laborers. Furthermore, there are transaction costs associated with finding qualified workers and commuting costs associated with off-farm work, as well as informational or psychic

costs when migrating to a different culture or environment (SCHIMT, 1991; ZHAO, 2003). This transaction cost assumption is inevitable in imperfect labor markets, in which households suffer from limited opportunities of off-farm employment.

(c) Employment preference is involved in the concept of labor participation. For example, elderly Japanese farmers gain satisfaction or utility by working on the farm even though their marginal productivity is lower than off-farm wages (SONODA and MARUYAMA, 1999). In rural China, risk-averse farmers simply prefer to access labor market to cope with the shocks affecting the on-farm income, if the off-farm wage is exogenously fixed (GILES, 2006). However, some farmers tend to work on their own land rather than take off-farm employment to keep the use right of the land and avoid the risk of being reallocated an inferior land or losing the assigned land.[17] For the majority of farmers in China, land provides a relatively secure source of income and food sufficiency.

(d) In the context of China, the return to employment activities dilemma is intrinsically involved in the institutional or political connection among households. In this case, it is reasonable to assume the internal wages of difference activities vary systematically and reflect the distinctly institutional situation (SICULAR, 1995; COOK, 1999).[18]

(e) The characteristics of imperfect labor markets are locally-based: That is, non-farm sectors are becoming booming sectors in some regions that previously were agricultural in nature, while other regions remain agricultural. The localized off-farm labor markets in China are near the coast or directly adjacent to large cities, or are located in areas with they have some opportunities for lucrative activities. By accessing to local labor market, households have more

[17] The HRS has resulted in the important change in the land tenure system. The most important aspect of land tenure administration by the central government is the extension of the land use right to 15 years in 1984 and another 30 years from 1993 onward with unchanged status quo. However, policy statements established at the central government level cannot be taken granted to be translated into unified policies at the local level. Frequent reallocation of land occurs in many forms. For example, village leaders shorten the land tenure for part of the households in the village. In the village that contracted land strictly on the basis of family size, the whole cultivated land is reassigned frequently to keep the egalitarian distribution of land given possible demographic changes. Furthermore, the reallocation of land differs heterogeneously among villages, counties, and provinces.

[18] The institutional and political context of China includes several aspects such as the residential registration system, which was loosened in the early 1990s. Furthermore, the Chinese government is starting to abolish the residential registration system in 11 out of 31 provinces (New York Times, November 3, 2005).

chance to engage in profitable activities rather than continuing to perform tedious on-farm tasks (BENJAMIN, 1992). This may also involve multiple job-holding as a household unit, by working on and off-farm simultaneously or hiring cheaper farmers according to the efficiency interpretation (BENJAMIN, 1992). Furthermore, several transaction costs are involved in accessing the local off-farm labor markets, and thus the internal wages of the local residents would be different than those of the immigrants or commuters.

Now we establish the conditions that determine the labor market participation of a farm household and the movement between alternative labor market participation states, respectively. It should be noted that the assumed labor market conditions can create non-convexities of the budget set. Thus, the simple scenario of reservation wage in the neighbourhood of zero "marketed" labor hours does not hold. Once the net wages of off-farm workers and hired labors and time intervals in which the reservation wage scenario hold, the complete budget set must be considered in assessing labor market participation. In other words, the purely local consideration of reservation wage models is no longer sufficient to determine whether a household chooses to participate in labor markets when non-convexities are present (HAUSMAN, 1980).

Therefore, labor market participation is determined by comparing the utilities obtained for the different labor supply and demand regimes (KEY et al., 2000; HILL, 1989). Because all four regimes can be formally written as a similar optimization problem, the maximum utility obtained in each regime *m* can also be formally written with the same indirect utility function as $V_m = V(w_l, \pi; z_h, z_s)$ with *m=h, s, sh* and *a* while π is the households' income. Indicators (D_h^*) are assumed to represent indirect utility differences between households that hire labor and those that do not.

$$D_h^* = \underset{m=h,sh}{V} - \underset{m=s,a}{V} \tag{12}$$

Positive working days of hired labors ((L_{hi}) will be observed if the potential indirect utility earned by a household from hiring laborers is greater than the indirect utility of a household that does not demand extra laborers. The participation decision rule to hire labor for the *i*th household is as follows:

$$L_{hi} \begin{cases} > 0 & if \quad D_{hi}^* > 0 \\ = 0 & if \quad D_{hi}^* \leq 0 \end{cases} \quad i=1,\ldots,N \tag{13}$$

Regarding the household's decision to participate in off-farm labor markets, the household compares the indirect utility earned from its supply of laborers off the farm to the utility earned if there is non-participation in off-farm occupations. If

the utility earned from off-farm employment exceeds that without off-farm workers, the household will supply off-farm labor (L_{si} > 0). In this case the unobserved utility difference between households with and without off-farm workers is represented by D_s^*.

$$D_s^* = \underset{m=s,sh}{V} - \underset{m=h,a}{V} \tag{14}$$

The participation decision rule to supply off-farm labor for the *i*th household is:

$$L_{si} \begin{cases} > 0 & if \quad D_{si}^* > 0 \\ = 0 & if \quad D_{si}^* \leq 0 \end{cases} \quad i=1,\ldots,N \tag{15}$$

The indirect utility differences (D_h^* and D_s^*) are not observable, but it is possible to define two observable dichotomous variables D_h and D_s, which equal to 1 if the corresponding indirect utility differences (D_h^* and D_s^*) are positive, respectively, and 0 otherwise. Combined with the equation (13), if D_h =1, $L_h > 0$ and if $D_h = 0$, $L_h = 0$. Similarly, if D_s =1, $L_s > 0$ and if D_s =0, $L_s = 0$. When D_h and D_s each equal 1 if the households participate in hired labor or off-farm employment markets, these decisions could be analyzed econometrically using binary choice models.[19]

The above analysis of households' behavior in labor markets assumes a static-state situation. However, households are observed reallocating labor resource, which potentially shifts the status of households in labor market from one state to another.[20] In theory, the households' transition decisions are conditional on the expected indirect utility ($V_{j,t+1}$) derived from a potential new labor market state at time $t+1$, the indirect utility ($V_{m,t}$) of the current state net of the utility at time *t*, and the transaction cost ($TC_{m,t}^{j,t+1}$) associated with the transfer between the states.

[19] Several empirical studies prove that the labor allocation of rural households depends on the pattern and depth of the households' integration into the labor market (HUFFMAN and LANGE, 1989; FINDEIS and LASS, 1994). This study also concerns it by deriving the two dummy variables to represent the four independent and mutually exclusive regimes of labor markets (GLAUBEN et al., 2005; WANG et al., 2007). It is well known that farm households are differently integrated into labor markets according to different external conditions such as employment alternatives or political measures, and with the links to household characteristics and farm structure, as well as the costs of accessing labor markets such as information, transportation, and supervisor costs.

[20] If a household reallocates the working time of off-farm workers or hired laborers to zero or a household begin to supply off-farm laborer or hire labor, the transition of the household's participation in the labor market occurs.

These costs are mainly fixed and may include both pecuniary and psychic costs.[21] Thus, the households' transition decisions regarding labor markets can be expressed as:

$$M_{m,t}^{j,t+1} = V_{j,t+1} - V_{m,t} - TC_{m,t}^{j,t+1} \quad (m,j=h,s,sh \text{ or } a) \tag{16}$$

The change of the labor market participation state occurs from the state *m* to *j* ($m \neq j$) given $M_{m,t}^{j,t+1} > 0$; if $M_{m,t}^{j,t+1} < 0$, the household will continuously remain in the current state $m = j$. When $M_{m,t}^{j,t+1} = 0$, the above two choices are possible, that is, the household could remain the current state or shift to another labor market state.

3.2 Empirical approaches

The basic elements of the agricultural household model have been presented in the theoretical section with the appropriate modification for the relevant analysis for this study. The core of the study is to analyze the labor allocation of rural households in labor markets with special attention to participation and time allocation. The empirical models of households' labor time allocation consists of three aspects: The two participation rules of hiring labor or supplying labor off the farm derived in section 3.1.2; the demand functions for hired labor (L_{hi}) (FINDEIS and LASS, 1994) and the supply function for family off-farm labor (L_{si}) (HECKMAN, 1974, 1979; HUFFMAN and LANGE, 1989; TOKLE and HUFFMAN, 1991; LASS and GEMPESAW II, 1992; FINDEIS and LASS, 1994); and the dynamics of the households' participation in labor market (WEISS, 1997). The econometric methods used to assess the first three aspects of labor allocation assume a kind of static-state situation, and thus we present them in the following section on the static approach. The last aspect concerning the dynamics of households' labor participation is analyzed in the section on the dynamic approach.

3.2.1 The static approach

The importance of individual and households' decisions in labor markets has attracted considerable attention. Among the existing studies, several aspects have focused on the off-farm supply of the household's operator (HUFFMAN, 1980; SUMNER, 1982); the interactive decision of off-farm employment between the operator and the spouse (HUFFMAN and LANGE, 1989; TOKEL and HUFFMAN, 1991; LASS and GEMPESAW II, 1992; SKOUFIAS, 1994); the joint decision on hiring labor with the activities of the operator couple (FINDEIS and LASS, 1994; BENJAMIN, et. al., 1996); and the seasonal adjustment of individual labor participation (JARVIS and VERA-TOSCANO, 2004).

[21] Variable and fix costs of accessing labor markets are already considered in the maximization problem (1)-(4), and thus they are also involved in the indirect utility for all four labor market states. However, fixed costs do not influence the internal price of labor and leisure.

However, the earlier studies neglected the possible joint decision on the demand for hired workers and supply of family members including the operator, the spouse, and other active laborers in the family, such as elder children. To fill the gap in the literature, four possible regimes arise, as mentioned in section 3.1.2, if the corner solution existed in the demand of hired labor and the supply of family members in off-farm employment.[22]

Assuming a binding non-negativity constraint of household's time allocation implies non-separability among farm production, household consumption, and the off-farm labor supply (SINGH et al., 1986). Given that households' decisions on hiring labor or supplying labor off the farm are assumed to be jointly made within a household-optimizing framework, the probability of households' hiring labor is affected by the probability of the households' supplying labor off-farm, and *vice versa*. These decisions also are affected by random or unmeasured shocks to labor demand and supply functions, and these shocks likely occur for both hired labor and off-farm workers. Thus, a bivariate probit model is appropriate for the static analysis of the households' labor participation estimation (TOKLE and HUFFMAN, 1991; LASS and GEMPESAW II, 1992). If the correlation coefficient of the error terms in the bivariate probit equation is statistically different from zero, this indicates that the household decisions to hire labor and supply labor off-farm are not statistically independent. This could indicate that the rural labor market is still imperfect.

Previous studies indicate there is the possibility of a sample selectivity bias in the error terms of the labor supply and demand equations because labor demand and supply functions are conditional on participation in the respective labor market, (HECKMAN, 1974, 1979). Thus, the inverse Mill's ratio is calculated from the bivariate probit model as the sample selection terms and consistent tests of sample selectivity bias will be conducted (HECKMan, 1974, 1979; SUMNER, 1982).

It is of direct interest to understand whether the households' labor allocation changes when households participate in rural labor markets that allow them to both hire labor as well as supply labor off the farm. In other words, are households more responsive to changes in internal wages and other factors when they have more labor decision-making options? Thus, the second step is to estimate the hired labor demands for households that purely hire labor and those that participate in

[22] The decisions of households may lead to the corner solutions given any of the labor supply or demand being equal to zero. This division of the labor market also encompasses the concept that the individual household may maximize its utility at an interior solution point. That is, the households' participation in labor markets is non-zero time to the possible family labor supply between on-farm and off-farm activities, and positive demand for hired labor.

both markets, respectively; and the two off-farm labor supply functions including one for households exclusively supplying labor off the farm and the other for those in both markets.

As mentioned previously, the appropriate reduced-form of hired labor demand and off-farm labor supply functions are simultaneously determined by solving Kuhn-Tucker conditions. Therefore, the demand of hired on-farm labor is not conditional on the supply of off-farm labor when none of the family members take off-farm employment as in regime *h*:

$$L_h = L_h(w_l^h, z_h) \tag{17}$$

Equation (17) indicates that the quantity of time contributed by the hired laborer for on-farm work is a function of the internal wage of hired labor and the exogenous shifters, including the household, farm and village characteristics, and the time trend, that affect the efficiency of on-farm work. Assuming the cost of hiring labor takes the nonlinear form with contributed labor time, the change in the working time of hired labor caused by the change of internal wage rate could be expressed with l_{hh} as follows where an asterisk (*) indicates an optimal level:

$$l_{hh} = \partial L_h^* \big/ \partial w_l^h = 1 \Big/ \left(\partial^2 h(.) \big/ \partial L_h^{*\,2} \right) \neq 0 \tag{17*}$$

This indicates the change of contributed working time of hired labor given the change of internal wage rate that could be positive or negative according to the assumed property of the cost function of hiring labor mentioned in Section 3.1.1.

When some family members participate in off-farm employment, their wage or income influences the demand of hired labor, as in the case in regime *sh*. As mentioned in section 3.1.2, although in theory there optimally should be no difference between the internal wage for hired labor (w_l^h) and the wage rate for labor supplied off-farm (w_l^s), empirically the difference between these two wage rates is obvious (COOK, 1999; ZHAI et al., 2003). Thus, because the demand for hired labor is not independent from the wage of off-farm labor when the household simultaneously hires labor and supplies family labor off the farm, we also include the wage rate for off-farm labor in the demand function for hired labor in regime *sh*:

$$L_h = L_h(w_l^h, w_l^s; z_h, z_s) \tag{18}$$

For the households that participate in both markets, the quantity of time contributed by hired labor depends on both the internal wages of hiring labor and off-farm labor simultaneously, while similarly to equation (17), the exogenous shifters also affect the working time of hired labor. Here, it is expected that the

change in the contributed working time of hired labor given the change in the internal wage rate of hired labor could also be positive or negative as explained in the equation. According to the study by DEOLALIKAR and VIJVERBERG (1987), we assume that the hired labor and off-farm workers are substitutes, *albeit* imperfect substitutes. Thus, the change in the contributed working time of hired labor given the change in the internal wage rate of off-farm workers (l_{hs}) is expected to be positive $l_{hs} = \partial L_h^* / \partial w_l^s > 0$.

The off-farm labor supply function is defined similarly. In the absence of hired labor, the households' off-farm labor supply does not depend on the cost of hiring labor for households in regime *s*:

$$L_s = L_s(w_l^s, z_s) \tag{19}$$

Equation (19) explicitly indicates that the off-farm labor supply at the household level could be calculated by the total time endowment (a fixed amount) minus the sum of optimal time allocations to on-farm work and leisure. With access to the off-farm labor market, the time supply of off-farm family members depends on the internal off-farm wage and the exogenous shifters, which influence the access to the off-farm labor market, including the household, farm and village characteristics, and the time trend. The earning of off-farm labor is assumed to be the nonlinear function of off-farm working time; thus the variation in off-farm working time caused by the variation of the internal wage rate of off-farm family members (l_{ss}) could be expressed as follows while an optimal level is denoted by an asterisk (*):

$$l_{ss} = \partial L_s^* / \partial w_l^s = 1 / \left(\partial^2 s(.) / \partial L_s{}^2 \right) \neq 0 \tag{19*}$$

Equation (19*) suggests that if the external wage level of off-farm employment remains constant, given the possible increased internal wage rate of off-farm labor, the off-farm working time will decrease or increase correspondingly within the household.

In regime *sh*, off-farm labor supply decisions are influenced by the cost of hired labor and off-farm wages as the impacts of the two kinds of wage rates on labor demand function in the same regime (18), though the magnitude and direction may be differential:

$$L_s = L_s(w_l^h, w_l^s; z_h, z_s) \tag{20}$$

For households in both markets, the quantity of off-farm employment measured by working days is the function of both the internal wages of hiring labor and off-farm labor. Furthermore, the exogenous shifters also influence the supply of off-farm labor within the household. Here, this relationship between the internal off-farm wage

rate and working days is expected to be the same in equation (19*). However, the impact of the internal wage rate of hired labor on the off-farm labor supplies $l_{sh} = \partial L_s^* / \partial w_l^h < 0$ is expected be negative under the assumption that the hired labor and off-farm family labor are substitutes, though they may not be perfect substitutes (DEOLALIKAR and VIJVERBERG, 1987).

In the last regime of autarky (*a*), households do not earn income from off-farm employment and they do not hire additional labor. As a result, labor demand and supply functions do not exist for this kind of households.

Much of the literature proves that internal wages, rather than observed market wages, determine the household's labor allocation quantitatively (SUMNER, 1982; HUFFMAN and LANGE, 1989; BENJAMIN, 1992; JACOBY, 1993; SKOUFIAS, 1994). Similar to the procedure in SUMNER (1982) as well as HUFFMAN and LANGE (1989), wage functions are modeled for hired labor and off-farm workers. The resulting values enter the demand and supply function as predicted endogenous variables.[23] Some researchers suspect that the predicted wage rates eliminate the variation of wage rate (LASS and GEMPESAW II, 1992). However, in this study, the imputed wage rates effectively capture the important variation in hired labor wages from the following two aspects: First, the empirical estimation relies on household-level data. This fully accounts for the fact that each household faces a different set of independent variables and therefore the elasticity of labor variables varies among households; second, the different behaviour of households' labor allocation in production activities also results in the imputed wage rates of hired laborers varying with the type of production of each household (COOK, 1999).

Assuming hired labor and family on-farm labor are substitutes – *albeit* imperfect substitutes – the anticipated wage of hired labor could be expressed by the marginal return to hired laborers' farm work according to the first order conditions from the household's agricultural production:

$$w_l^h = \frac{\partial G}{\partial L_h} \text{ and } \frac{\partial^2 G}{\partial L_h^2} < 0 \tag{21a}$$

here, the wage rates of hired workers are derived from marginal products of hired labor in the household's farm production. This means the wage function of hired labor is the change in net farm returns of household production resulting from a marginal increase in hired labor input.

[23] More precisely, because off-farm work in the sample includes wage employment as well as self-employment, it is better to use the term 'average household earnings from any off-farm occupation'. To simplify matters, the term 'off-farm wage' encompasses all sorts of off-farm income from working activities.

Regarding the aggregated return to households' off-farm activities, the anticipated wage of off-farm workers is assumed to be influenced by the accumulation of the household's human capital and local labor market characteristics (z_s) (TOKLE and HUFFMAN, 1991):

$$w_l^s = w_l^s(z_s) \tag{21b}$$

Labor demand and supply are measured in working days and wages in Yuan per day. The bivariate probit equation and the labor demand of households that exclusively hire on-farm labor are estimated as a pooled cross section. All other specifications are estimated as panel models.[24] This procedure controls for unobserved household characteristics such as management ability or inherent preferences for farming. The exogenous variables in the participation and labor supply models include characteristics of the household, farming activity, and village.

3.2.2 The dynamic approach

The above methodological information on assessing households' behavior in labor markets strongly assumes a kind of static-state situation. However, there is a growing consensus in the literature that the labor market behavior is linked to its participation history in the labor market (CORSI AND FINDEIS, 2000; KALBFLEISCH and PRENTICE, 2002; ZHAO, 2002). By applying duration or hazard models, several works assess the length of unemployment spells depending on individual characteristics and labor market policies (SUEYOSHI, 1995; ADDISON and PORTUGAL, 2003; RØED and NORDBERG, 2003). CHAN and STEVENS (2001) and GUTIÉRREZ-DOMÈNECH (2005) investigate the likelihood of a return to employment, while BRADLEY et al. (2003) focus on the transition between different employment categories over time. BLAU and RIPHAHN (1999) study the transition between employment alternatives in a joint decision process between spouses and MEITZEN (1986) as well as LIGHT and URETA (1992) focus on the gender specifics with regard to change of occupation. LIGHT and OMORI (2004) investigate the impact of unemployment insurance on the duration of unemployment, and finally, BURDETT and CUNNINGHAM (1998) model the search process of employers.

Seeking hazard models, the discussion of rural labor markets in transition economies could also be found in the following studies. ORAZEM and VODOPIVEC (1997) apply a proportional hazard model to analyze the exit from unemployment to a new job using Slovenian data and they compare their results for the pre- and post-transition period. They find that better educated people have a higher probability of finding a new job after the economic transition. JUVANCIC and ERJAVEC (2005) analyze

[24] It is probable that the coefficients in the bivariate probit model might be overestimated because they are not controlled for unobserved household characteristics.

asymmetries and other dynamic aspects of farmers' labor allocations during the transition period between 1991 and 2000. SORM and TERELL (2000) analyze the transition between three different labor market participation states in the Czech Republic using a discrete-time hazard model. They find that younger, less educated, single men, working in the construction or trade sectors, face a higher probability of becoming unemployed. With regard to China, APPLETON et al. (2002) focus on laborers laid off during retrenchment waves of state-owned enterprises. One of their results is the identification of socioeconomic characteristics that affect the duration of unemployment after retrenchment. To our best knowledge, there is no work that explicitly analyzes the dynamics of households' labor participation considering their past participation history in the labor market. This study goes beyond the existing literature by estimating the hazard models for the transitions of rural households among labor market regimes.

The following portion of the study investigates the choice among different labor market participation states of Chinese farm households. The limitation of the probit model used above is only to assess the dichotomous decision of the households' participation in a segmented labor market. It does not permit the examination of how the preceding time spent in a certain state increases or decreases the likelihood of households' shifting to any of the other three states. To break through the constraint of probit models, a more flexible technique of hazard model is applied to explore the dynamics of households' participation in the labor market. There are several possible movements of households in a labor market. Here, we focus on six directions of movement, which have important policy implications for efficiency in labor allocation in Table 3.1. Furthermore, these six types of transitions occur frequently in the sampled data.

Table 3.1: Analyzed movement of households' participation in labor markets

Type of Transition	**Original state**	→	**Destined state**
Start participation	***a***	→	***h*** *or* ***s*** *or* ***sh***
Stop participation	***h*** *or* ***s*** *or* ***sh***	→	***a***
Start supplying off-farm labor[25]	***a*** *or* ***h***	→	***s*** *or* ***sh***
Stop supplying off-farm labor[26]	***s*** *or* ***sh***	→	***a*** *or* ***h***
Start hiring external labor	***a*** *or* ***s***	→	***h*** *or* ***sh***
Stop hiring external labor	***h*** *or* ***sh***	→	***a*** *or* ***s***

[25] This movement means the household changes from full-time farming to part-time farming.
[26] This movement means the household changes from part-time farming to full-time farming.

It is appropriate to apply a hazard model when analyzing the length of households' participation spell in the labor markets. Three aspects of issues are focused. First, this duration technique focus on modeling the determinants of the hazard rate, specifically stating that the probability of transition of a household's participation at time t is conditional upon the household's being in a previous labor state up to time $t-1$. We assess the impact of the length of time households spend in a state on the probability of leaving it. That is, the probability of transition between such states, which is closely related with the length of time spent in the original participation state. Next, we analyze whether the state previously occupied by a household influences the probability of leaving it. Finally, we identify the factors that determine the length of time a household spent in the previous state and provides insight on the additional impacts of covariates, including household, farm, and village characteristics, on the probability of households' changing their participation states. This study goes beyond the existing literature by analyzing the impacts of previous labor market occupations of Chinese rural households on their current states.

Discrete hazard model Before formally constructing a hazard model to assess the dynamics of households' labor participation in labor markets, we address the issue of the right-censored problem, which occurs randomly in the sampled data.[27] According to KALBFLEISCH and PRENTICE (2002) and BURDETT et al. (1984), the observation is right-censored if its survival time is greater than the time until the occurrence of failure event. In the transition models, the analysis of the functions associated with each of the possible events can be conducted similarly to the previous analysis, considering that all of the observations referring to the events distinct from those being analyzed are treated as right-censored. For example, when analyzing the households that start supplying labor over time, the original state of the observations indicate that they are not hiring labor *(h)* or *(a)* are treated as right-censored. The same treatment should be applied to all of the possible transitions. It has been noted that the original state *i* of the certain household is not fixed in the full duration, given that the household may shift the state from one to another many times during the analysis period.

[27] Right censoring is when the subject participates in the study for a time and, thereafter, is no longer observed (CLEVES et al., 2004). In our study, right censoring occurs in the following ways: 1. when a household is surveyed for a time, but it disappears from the survey for unknown reasons before the occurrence of the transition event; 2. when a household is surveyed for the whole period (1995-2002), but does not experience a transition in the labor participation by the end of the period. This means the household is located in the same regime of labor market during 1995-2002; 3. a household experienced a transition in the labor participation period and remained in the new state until it disappeared from the survey or the end of the period.

While the assumption that economic activity occurs continuously is only an abstraction of many applications of duration data, this dataset deserve a discrete time approach for the following four reasons. First, RCRE data only recorded in a conventional calendar year introduce a discrete nature or are grouped. Second, at best, it is only noted that a household's transition in labor markets occurs at the end of the year; that is, we only know that a household's transition occurs during a twelve-month period. Third, a household's decision leads to its participation in the labor market as a discrete event (LIGHT and OMORI, 2004). Finally, treating grouped data as if they are continuous, as is the case here, leads to a substantial bias in estimation (FAHRMEIR and TUTZ, 1994). Thus, these considerations make a discrete duration model appropriate for this sampled data.

In the discrete time survival analysis, the underlying durations are intrinsically observed in disjointed time intervals $[a_0, a_1)$, $[a_1, a_2)$, $[a_2, a_3)$, …, $[a_{k-1}, a_k)$ $[a_k, \infty)$, where $a_0=0$ and a_k denotes the last observation. For the subsequent analysis, each interval is defined as the length of years for each household. To simplify, all intervals are assumed to be of unit length with a year, while this length of interval implies that a vector of covariates associated with each household is constrained to remain constant within each one-year interval but can change values from one interval to the next (LIGHT and OMORI, 2004). Identifying the discrete time index t with interval $[a_{t-1}, a_t)$, $t \in \{1, \ldots, k+1\}$, a discrete failure time T is considered, where $T=t$ denotes failure within interval t. Thus, the discrete hazard function for an individual household i at time t is defined as equation (22) for failure in year t, conditional on survival lasting until this year:

$$\lambda_{it}(t \mid X_{it}) = \lim_{\Delta t \to 0} \frac{\Pr(t \le T + \Delta t \mid T \ge t, X_{it})}{\Delta t} \tag{22}$$

Only so-called external time-varying covariates are included in this analysis X_{it}. Here, X_{it} is a vector of exogenous covariates summarizing observed differences between individual households i at t, including household and village characteristics, whereas the shift of household's production structure occurs inseparably. These variables can be observed independent of the behavior decisions of households in labor markets.

The likelihood to survive in t-th interval for household i is given by

$$\Pr(T > t \mid X_{it}) = S(t \mid X_{it}) = \prod_{j=1}^{t} [1 - \lambda_{ij}(j \mid X_{ij})] \tag{23}$$

The probability of exit in the t-th interval for household i is

$$\Pr\{T = t \mid X_{it}\} = S(t-1 \mid X_{it}) - S(t \mid X_{it}) = \lambda_{it} \prod_{j=1}^{t-1} (1 - \lambda_{ij}(j \mid X_{ij}) \tag{24}$$

The hazard rate function for individual household *i* at time $t > 0$ is assumed to take a proportional hazard form so that the covariates, X_{it}, raise the baseline hazard $\lambda_0(t)$ by a given proportion (APPLETON et al., 2002):

$$\lambda_{it}(t \mid X_{it}) \big/ \lambda_0(t) = \Lambda_{i0}(t) \tag{25}$$

here, the random variable $\Lambda_{i0}(t)$ [28] is the integrated baseline hazard up to each observation's realized duration.

Given that the misspecification of the baseline hazard leads to the bias estimation of the parameters of the covariates (LIGHT and OMORI, 2004), we apply a fully non-parametric baseline hazard, which allows for a completely flexible estimation of impact of the baseline hazards. Following KIEFER (1988) and KUHN and SKUTERUD (2004), we treat the log form of the integrated baseline hazard as a linear combination of observed covariates X_{it} and estimated parameter β. That is, we use the function as:

$$\log \Lambda_{i0}(t) = -\beta' X_{it} + \mu_{it} \tag{26}$$

where μ_{it} follows a type-1 extreme-value distribution.[29] Thus, function (25) can be rewritten as:

$$\lambda_{it}(t \mid X_{it}) = \lambda_0(t) \exp(\beta' X_{it}) \tag{27}$$

Past research has found that heterogeneity is critical to survival analysis (MEYER, 1990; KALBFLEISCH and PRENTICS, 2002). The heterogeneity in this study includes two aspects: One is the observed covariates, which are measured over time; the other is the unobserved characteristics within households, farms and local communities. The former explains the estimated distribution of time spent in any states by a household and the latter is proven to change the baseline hazard rate of transition as a latent multiplicative effect, called frailty parameter (MEITZEN, 1986; BLAU and RIPHAHN, 1999). For instance, households may differ in respect to their attitudes toward off-farm employment. Incorporating a term controlling for unobserved heterogeneity ε_i, the hazard rate function becomes (MEYER, 1990):

$$\lambda_{it}(t \mid X_{it}) = \lambda_0(t) \exp[\beta' X_{it} + \log(\varepsilon_i)] = \varepsilon_i \lambda_0(t) \exp(\beta' X_{it}) \tag{28}$$

where ε_i is a Gamma distributed random variant with unit mean and variance σ^2.

---

[28] $\Lambda_{i0}(t) = \int_0^t \lambda_0(\tau) d\tau$ This specification allows for the log form of integrated baseline hazard that is monotonically increasing in interval *t*.

[29] The cumulative distribution function for the extreme-value distribution is given by $F(\mu_i) = \exp(-\exp(-\mu_i))$ (KUHN and SKUTERUD, 2004).

The duration model is specified to estimate the determinants of the households' transition, given that covariates cannot be explicitly taken as fixed at the time interval (GREENE, 2000). Defining c_i=1 if individual household i' spell ends in a transition and 0 otherwise. Allowing for time-varying covariates in the duration model, the corresponding log likelihood function of equation (29) can be written as: (KIEFER, 1988):

$$\log L = \sum_{i=1}^{n} \{c_i \log[\lambda_{it} \prod_{j=1}^{t-1} (1-\lambda_{ij})]\} + (1-c_i) \log\{\prod_{j=1}^{t} (1-\lambda_{ij})]\}$$

$$= \sum_{i=1}^{n} c_i \log[\lambda_{it}/(1-\lambda_{it})] + \sum_{i=1}^{n} \sum_{j=1}^{t} \log(1-\lambda_{ij}) \qquad (29)$$

Because (26)-(30) involve nonlinear functions of β, the values of β that maximize the log-likelihood function are usually found using iterative methods. Standard asymptotic estimation techniques provide viable means of estimating the relative risk parameters β, even when the covariate process includes internal components only so-called external time dependent covariates. These covariates are observed independent of behavior choices of households in labor market (KALBFLEISCH and PRENTICE, 2002, page. 196).

In this study, the risk of slipping out of and into a labor market state is impacted by exogenous covariates, such household and village characteristics whereas the shift of a household's production structure occurs inseparably. The hazard ratios, which are $\exp(\beta' X_{it})$, can be explained as the change in the hazard rate associated with a unit change in the value of the corresponding covariate. That is, if the hazard rate $\exp(\beta' X_{it})$>1, then the probability of transition from the original state to the destined state in Table 3.1 would increase, while $\exp(\beta' X_{it})$<1 describes a reduced risk to the corresponding transition (CLEVES et al., 2003, page. 159). For the quantitative covariants, subtracting the hazard ratio by 1 and then multiplying it by 100 yields the estimated percent change in the hazard for one unit increase in the value of the covariant. For dummy variables with the integral of 1 or 0, the risk ratio can be interpreted as the ratio of the estimated hazard for those transitions within the states with a value of 1 to the estimated hazard for those with a value of 0. Following the same technique, the risk ratio of categorical variables can be explained as the ratio of the estimated hazard for transitions within the states with a value of a certain level to the estimated hazard for those with a value of one less level (CLEVES et al., 2003, page 159).

Furthermore, one of the main purposes of the study of households' participation dynamics is to identify how the number of years that a household spends in the

original states influences the probability of this household making the transition into the destined states. The hazard function provides a convenient definition of duration dependence, which could be interpreted as the instantaneous probability that a state, in which a household is located ends at period *t*, conditional on the spell lasting until time *t*. Positive duration dependence and an increasing hazard rate exist at point *t* if $\partial\lambda_{it}(.)/\partial t > 0$. That is, the probability of leaving the original state increases with the number of intervals (years) that a household spends in this state. Conversely, negative duration dependence and a decreasing hazard rate exist at point *t* if $\partial\lambda_{it}(.)/\partial t < 0$. This indicates the probability of leaving the original states falls with the number of intervals (years) a household spends in the state.

4 The rural labor markets in Zhejiang and data description

The theoretical discussions of households' labor allocation behavior are accompanied by the empirical analysis. Before formally interpreting the empirical results, we present the description of data source and examine the evidence on the emergence of labor market, which serve as prerequisites for understanding the empirical results in Chapter 5. To narrow the scope of the analysis and due to data limitations, we center the empirical analysis on households in only one province, Zhejiang, a relatively rapidly developing province on the southeastern coast of China (see Figure 4.1). While looking at only one province limits our ability to discuss the nation-wide implications of the emergence of labor markets, it is nevertheless believed that the choice of province offer both informative and interesting results and may portend what will happen in the rest of China in the coming years. Based on the officially published statistics, the economic situation of Zhejiang province, where the sampled data originated, is described in Section 4.1. Section 4.2 presents details on the collection of data. Section 4.3 describes the village characteristics in the context of resource endowment and agricultural structure change. Section 4.4 presents the evolution of the rural labor market in Zhejiang. Section 4.5 presents the descriptive statistics of the variables used in the empirical estimations.

4.1 General economy in Zhejiang province

Zhejiang province is located in the southern wing of the Yangtze River Delta in China. The directed distances from east to west and from north to south of the province are about 450 kilometres, covering a total continental area of 101,800 square kilometers, which is 1.1% of the country. The population density of Zhejiang province is 444 people per square meter (ZJSB, 2000). By comparison, the population density of the Netherland is 395 people per square meter. The province possesses varied topography: Hills and mountains account for 70.4% of the total area; plains and basins make up 23.2%; the remaining 6.4% is composed of rivers and lakes. In Zhejiang province, the arable land accounts for 2.125 million hectares, or 1.6% of the country (SSB, 2001). From 1978 to 2002, its GDP achieved a yearly growth rate of 13% on average, and thus it developed from 12th to 4th position among all 31 Chinese provinces in terms of economy. The GDP per

capita rose to 16,570 Yuan (2,004 US$) in 2002 with an annual increase of 12.1%, while the per capita net income of rural residents reached 4,940 Yuan (597 US$) with an annual growth rate of 8.7%.

Zhejiang is developing rapidly and today is one of the richest provinces in China. Its labor market has undergone a tremendous transition and seems to be the most suitable for the following empirical analysis. The sectoral composition of the province's economy has changed dramatically as compared to other provinces over the course of economic reforms. Agriculture accounts for only 33% of provincial employment compared to a national average of 64%. Tertiary industry accounts for 33% (SSB, 2004).

Focusing on the rural areas of Zhejiang province, employment in agriculture dropped by 1.6% annually between 1978 and 2003, whereas rural non-agricultural employment grew at the impressive rate of 8.9% annually. However, there is also great heterogeneity within the province, e.g., per capita income between the richest 10% of the counties and poorest 10% of the counties differs more than 90% and off-farm employment rates range from more than 64% to 32% (SSB, 2004). In short, the rural labor markets in Zhejiang province have changed dramatically over the past 25 years and their emergence has contributed to the success of the local rural economy.

Figure 4.1: Location of Zhejiang province in China

4.2 Data source

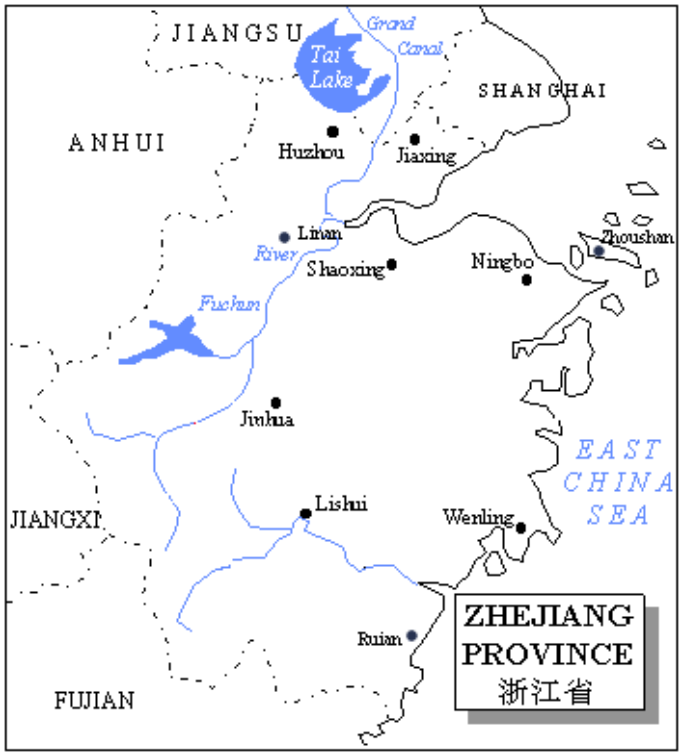
The database is drawn from fixed-point survey data series across ten regions in Zhejiang province, conducted annually by rural survey teams. The large-scale panel survey was conducted from 1995-2002. [30] In some aspects, fixed-point survey data are among the most comprehensive datasets in the world, especially when individual household data, linked with the corresponding village-level data are available.[31] The survey is based on a multistage, random-cluster process to attain the rich information of rural reform on agricultural production and rural development. Counties, which are below province-level administrative units, were stratified by income level and selected according to a weighted sampling scheme. The villages within the counties were then randomly chosen according to geographic diversification (plain, hilly, or mountainous area), location (suburb of city or not), and economic features defined as mainly agriculture, forestry, husbandry, fishery or others.

The village survey provides information on resource endowment, employment, and production activities, as well as welfare and social economic indicators. The village data for each year are aggregated from the account book edited by the local village accountants for every economic transaction and production activities. Other social-economic indicators of the village, such as the geography, location, and land resource, etc., are recorded by the village leaders with the help of the local enumerators, who are the staff members from the local bureau of agriculture. The ten villages in the survey are under ten of administrative regions in Zhejiang province. The locations of the ten villages are marked with black dots in Figure 4.2.

[30] The rural survey teams of the Research Center for Rural Economy (RCRE), Ministry of Agriculture, China conducted the primarily trial survey at the beginning of 1983 in nine provinces. After 1984, the survey was extended to 28 provinces (excluding Tibet and Taiwan; later the survey included Hainan and Chongqing after they separated from Guangdong and Sichuan provinces, respectively, as well as Tibet. Thus, the survey finally covers 31 provinces and is conducted annually), covering 71 counties, 93 townships, 272 villages and 37,422 rural households. This fixed-point rural survey established by the central government explores important effects of rural reform and development on households and villages as well as enterprises. Given the different status of agriculture in each municipal city, province, and autonomous region, the numbers of villages extracted from each region varied between three (Beijing) and 25 (Shaaxi province). The number of households chosen from each village, which vary in size, was also heterogeneously distributed. The survey questionnaire was revised in 1991, 1993, and 2003 to provide more information (http://www.rcre.org.cn/RCRE/GDGC/default.htm). For financial reasons, the survey was not conducted in 1992 and 1994. By agreement, we have obtained access to the household and village data of Zhejiang province from 1995-2002.

[31] Political administrative levels in China include, in descending order, province, city (county), township and village. Each of the upper-level administration units includes several of the lower-level regions, for example, each township includes several villages.

Figure 4.2: Location of ten survey spots in Zhejiang province



Subsequently, the household data of the respective villages are randomly selected from the comprehensive household list kept by the village leader. To maintain longitudinal household information, the same households were interviewed each time the survey was conducted. If the household is dropped from the survey and is not recorded on the household list in the village, a new sample household is recruited from the same village with another ID and remains in the survey for the following years if it is qualified.[32] Local enumerators train assistants from the village and rural households to maintain daily diaries to completely record all economic activities. Every 10 households are assigned an enumerator assistant who helps the households complete their diaries. The assistants also check the diaries once per month. Every quarter of a year, the local enumerators collect and check the completed forms. At the end of the year, the forms are returned and entered into a nationally designed coding program. Households receive the payments between of 50 to 200 Yuan (around 6 to 24 US$) from the local government for their efforts.

[32] The household was dropped from the survey due to the emigration of the whole family from the village to the urban area or other town or village, or the family members died after several years in the survey.

The individual household data contain detailed information on household and farm characteristics, on- and off-farm activities.[33] The survey particularly provides information on households' time allocation of labor to several occupations such as farming, self-employment off the farm or wage work, as well as each household's demand for additional hired labor in household production activities, measured in a daily unit. The sample covers around 500 households per annum from 1995 onward with about 50 households in each village. Close supervision of the data collection process and careful consistency checks ensure that this dataset is of relatively high quality.

The information on the survey procedure indicates that RCRE seek to minimize attrition in the data collection. Table 4.1 provides some supports for this by tabulating the number of farms surveyed with the number of years in the survey. More than 200 households are observed in all of the eight years period, while less than 15% of the households were interviewed only once in the survey. Excluding the households with missing variables, 566 different households are used in the following analysis and more than 85% of the sample households were interviewed for at least two successive years.

Table 4.1: Years of households in sample

No. of years in sample	*No. of households*	*Percentage[a] (%)*	*Accumulated percentage[b] (%)*
8	208	36.75%	36.75%
7	135	23.85%	60.60%
6	55	9.72%	70.32%
5	12	2.12%	72.44%
4	25	4.42%	76.86%
3	26	4.59%	81.45%
2	22	3.89%	85.34%
1	83	14.66%	100.00%
Total	566	100.00%	

Note: [a] The figures in this column are calculated by the number of households in the same row to total households in the sample. [b] These are calculated based on the figures in column 3.

4.3 Characteristics of sampled villages

Turning to the village-level characteristics, we find that the nine villages in the sample vary sharply in the kinds of background characteristics that might influence the labor allocation of households in markets.[34] Table 3.2 highlights some of the

[33] One shortcoming of the survey is the lack of individual-level information of each family member. However, we know the gender composition of household members and their activities in the labor market, as well as the number of dependents.

[34] The village in Zhoushan is dropped from the estimation because there is no arable land and the village specializes in fishing.

important differences at the village level while focusing on endowments, location, income and the land rental market. Two villages stand out in their proximity to the city or county seat.[35] The households in those villages benefit from the favorable location, including the excellent road or water transportation for agricultural inputs and outputs. The villages in the mountainous or hilly areas are smaller as measured by the number of households, but are endowed with more land resources, and thus these villages are located in more sparsely populated areas. The two poorest villages in the sample, as measured by net income per capita, are located in the hilly area. Contrarily, the higher income villages tend to be located in the plain and more densely settled areas. The only village in the mountainous area was in the group of the three high-income villages in 1995 because this village took advantage of its location to specialize in the production of bamboo, tea, and medicine, and it developed the forestry products processing. Though the ranks of villages in the sample based on the net income per capita changed from 1995 to 2002, it should be noted that the group of the two poorest villages in 1995 and 2002 were located in hilly areas. This may suggest that geographical conditions highly affect the income resources of households.

Table 4.2: Selected village characteristics, 1995-2002

Village	*NH*[a]	*NHS*[b]	*Population density (person/hectare)*	*Geo-graphy*	*Near*[c]	*1995 NIPC*[d] *(yuan)*	*2002 NIPC*[d] *(yuan)*	*Rent*[e] *(%)*
Lishui	167	50	2.5367	Hilly area	0	1925	3143	0.1125
Jinhua	195	50	7.0285	Hilly area	0	2618	3282	0.0988
Jiaxing	418	50	9.1529	Plain	1	3001	4900	0.0279
Huzhou	344	50	10.1349	Plain	0	3183	3372	0.0624
Ningbo	513	50	12.8096	Plain	1	3450	8246	0
Shaoxing	346	50	33.9730	Plain	0	4652	7914	0.0877
Linan	157	50	0.7736	Mountain	0	5248	6647	0.1729
Ruian	452	50	58.0285	Plain	0	6700	7387	0.0696
Wenling	292	50	23.8516	Plain	0	8005	12445	0.1796

Note: [a] Number of households. [b] Number of households surveyed. [c] Near a city or county seat (dummy variable, yes=1, and otherwise 0). [d] Net income per capita in the village at 1995 constant price. [e] Share of households that rent in land to total households in the village. Here, the households that rent in land include both of the surveyed and non-surveyed households.

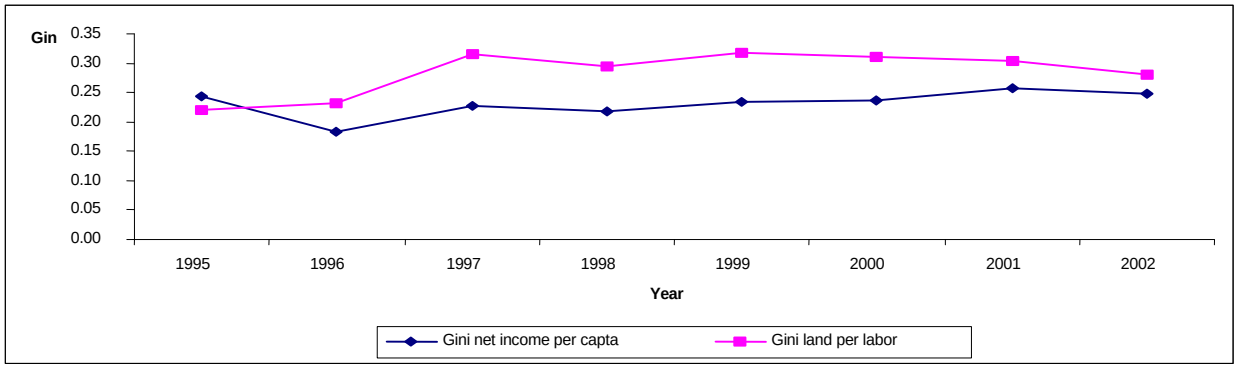
Considering the inequality of net income per capita and land per labor by villages from 1995 to 2002, the Gini index is presented in Figure 4.3, which is selected mainly because of its comparability and extensive use in the literature. The Gini coefficients of net income per capita ranged narrowly between 18.4% and 25.6%

[35] To explore the location characteristics, the distance to the nearest city is used extensively (HUFFMAN, 1991). However, this information is lacking in this dataset.

during 1995-2002. The Gini index for land per labor at the village level increased from 21.9% in 1995 to the summit of 31.4% in 1997, and then fluctuated around 30% in the rest of years. The figures to this point have let us to draw two conclusions. First, inequalities of net income per capita and land per labor vary according to the nature of the village. Second, there is considerable variation in the level of inequalities across village over time.

There are also important differences in the percentage of households that rent out land. However, evidence from Table 4.2 indicates that the land rent-out ratio is not systematically related to the village-level income or land resource. On average, in one-third of the sampled villages, the land rental ratios are greater than 10%. On the other hand, one village reported that none of the households was tied to the land rental market in the complete survey period. This roughly mirrors the conclusion by KUNG (2002) that the land rental market is still imperfect in rural China, even though the land rental market has helped to equalize the marginal products across the households with the different land-labor endowment in some areas. Thus, the description of village characteristics points to the conclusion that there is considerable attrition of the villages over the survey span and that the village panel dimension reasonably captures the social-economic features in Zhejiang province and the economic variations over time.

Figure 4.3: Gini index by villages, 1995-2002



4.4 The evolution of labor markets in Zhejiang

We now examine the evidence on the emergence of labor markets in Zhejiang. In addition to the advantage of panel data, which generates additional degrees of freedom, the panel dataset allows us to study the change in the participation and time allocation of a single household in labor markets over time and the variation in time allocation of many representative households at a given time. This section illustrates the evolution of labor markets in Zhejiang, as distinguished between off-farm labor and hired labor markets. This adds to the existing literature the widely unacknowledged difference between households' demand for hired labor and theirs

supply of off-farm labor, with the special attention to those households in both markets. Further dividing hired on-farm labor into long-term and seasonal hired labor as separate states would be of considerable interest, but the resulting model has nine states with too few observations in some states to make estimation feasible. For the same reason, separating the off-farm employment as self-employer and wage earner as distinct states is not applicable. However, we will update the evolution of households' participation, demand for hired labor, and supply of off-farm workers by the subdivisions as follows.

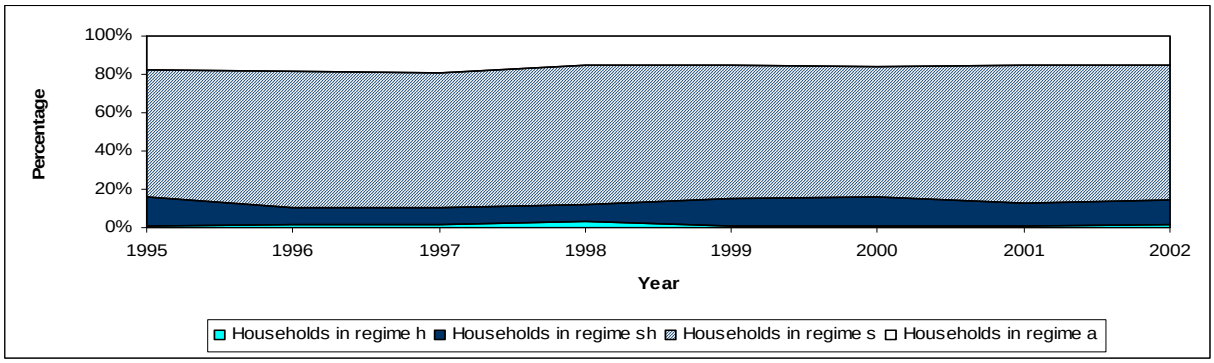
4.4.1 Trends of households' participation in labor markets

With the relaxed control of the household registration system (*Hukou*), or the residency permit system, and grain procurement quota system in rural China, combined with the rapid development of TVEs, the labor mobility was explicitly allowed for, which could be observed from an increasing integration of farm households into the labor market (COOK, 1999). Figure 4.4 illustrates households' participation in each state of the labor market.[36] Trends of households' involvement in various kinds of labor markets show that the participation activities in labor market sectors decreased around 1% yearly from 1995 to 1997, then increased slightly afterward. It is obvious that significant numbers of households provided labor off the farm. During the surveyed period, roughly 66% of households worked off the farm in 1995, and this share reached the summit of about 73% in 1998.

There is evidence that households that only hire labor were comparatively few. In some years, the proportion of households that only hire labor fell below 1%. The survey demonstrated that the participation of households that supply and demand labor simultaneously changed noticeably in the eight years, while on average 12% of the households were involved in both markets during this period. Given the considerable volume of households entering into the labor market, the proportion of households in autarky fluctuated between 14% and 20% over time. By pooling all of the observations, 16.4% of households, on average, have experienced at least one year in autarky in the labor market.

[36] The percentage of households' participation is calculated based on the absolute numbers of households in the four labor market states tabulated by year in Appendix Table B1. This table indicates that on average, 70.2% of households supply labor off the farm, 1.4% hire additional labor, and 12% participate in both markets.

Figure 4.4: Households' static participation in labor markets by four regimes, 1995-2002



Note: The area between the bottom horizontal line and the lowest trend line, filled with light blue is the percentage of households that purely hire labor (*h*); the gap between the lowest and the second lowest trend line is the percentage of households that demand and supply labor simultaneously (*sh*); the area between the top and second lowest trend line, marked with oblique lines, is the percentage of households that provide off-farm workers (*s*); and the gap between the top horizontal line and the top trend line is the percentage of households in autarky (*a*).

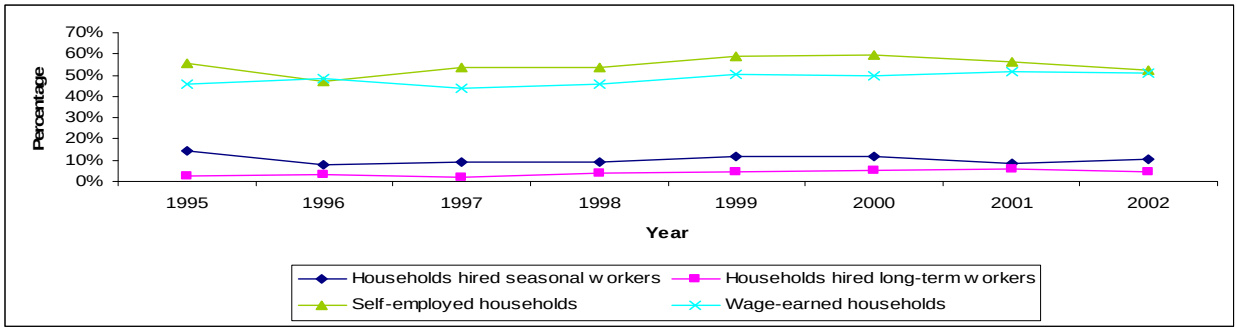
There is evidence that households that only hire labor were comparatively few. In some years, the proportion of households that only hire labor fell below 1%. The survey demonstrated that the participation of households that supply and demand labor simultaneously changed noticeably in the eight years, while on average 12% of the households were involved in both markets during this period. Given the considerable volume of households entering into the labor market, the proportion of households in autarky fluctuated between 14% and 20% over time. By pooling all of the observations, 16.4% of households, on average, have experienced at least one year in autarky in the labor market.

To explore the extent of households' integration into labor markets more deeply, we describe the trend of household participation by disaggregating the labor demand into the distinct states as long-term and seasonal demand, and labor supply into the self-employers and wage-earners, respectively, in Figure 4.5. This figure also permits us to compare our findings with the previous studies on the evolution of China's rural labor markets.

Beginning at a lower level of a bit more than 2.5% of households that hired long-term workers, the proportions of households that reported to a demand for long-term workers doubled over eight years. Demand for seasonal labor fluctuated between 8% and 14.5% of all households. In 1995, more than 55% of the households were observed to supply labor as self-employment; however, this figure dropped around 8% in the following year. From 1997 to 2000, the proportion of households with self-employment jumped to near 60% but that percentage fell in the following two years. Our data indicates the proportion of self-employed households was higher

than estimates in a previous study (DE BRAUW et al., 2002).[37] This difference could be explained by Zhejiang province having the most developed non-agricultural sectors, and thus there are more chances for family members to work in self-employment. In this sample, off-farm employment as a wage earner showed a noticeable fluctuation from 1995 to 1997, and then presented an increasing pattern from 1997 onward. At the end of 2002, more than 50% of rural households supplied off-farm employment as wage earners. This is consistent with the existing literature on the assessment of labor markets for both the developed and less developed provinces (DE BRAUW et al., 2002).

Figure 4.5: Evolution of hired workers and off-farm employees, 1995-2002



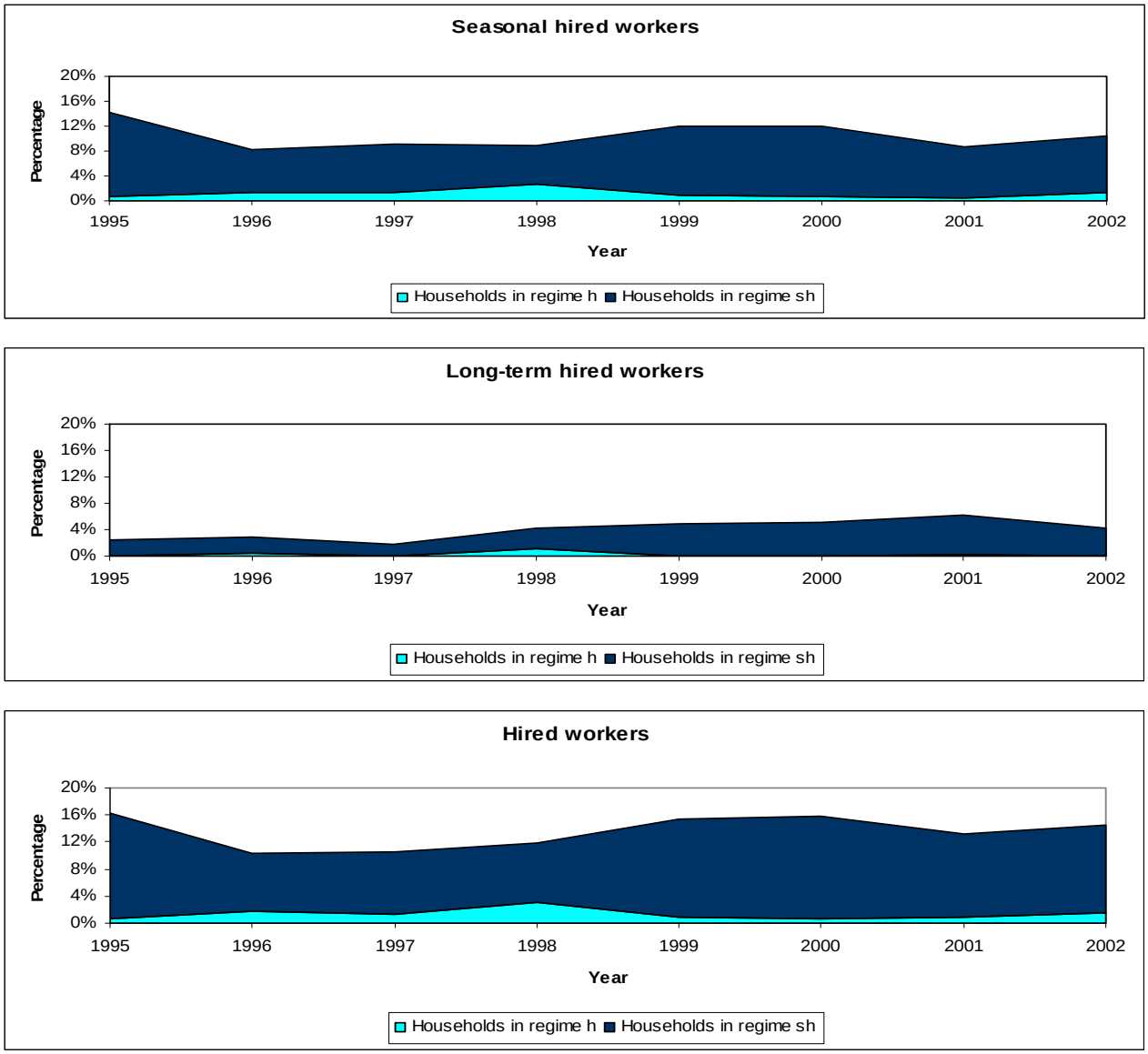
Note: Percentage of households reporting demand for hired workers and supply of off-farm employees in Zhejiang province.

4.4.2 The evolution of households' labor demand

Figure 4 .6 illustrates the trends of hired workers and its sub-categories of long-term and seasonal hired workers within the corresponding labor market regimes in the surveyed period. The figures point to the two conclusions. One is that the demand for both seasonal and long-term hired worker has been greater for households in both markets (*sh*) than for those that purely hire workers (*h*) over the past eight years. The other concerns the subcategories of hired workers; demand for seasonal workers is much greater than for long-term workers in either regime of purely hiring workers (*h*) or the regime covering both markets (*sh*).

[37] Their study covers not only the developed provinces such as Zhejiang and Liaoning, but also comparatively less developed provinces such as Hebei, Shaanxi, Hubei and Sichuan. Thus, compared with the aggregated results reported by DE BRAUW et al. (2002), the higher self-employment figure in one of the most developed provinces, Zhejiang from my sampled dataset is fairly accurate.

Figure 4.6: Percentage of households reporting demand of seasonal, long-term and total hired workers by the location of households in the regime *h* (light blue area) and the regime of *sh* (dark blue area) in each panel



In the sample, the proportion of the households that participate in the hired labor market seasonally and were located in the regime of households that purely hire labor (*h*) was an average of less than 1.3%. In the subsequent three years from 1999, this proportion dropped to less than 1%. The proportion of households that hire seasonal workers and were in the regime of households that supply and demand labor service simultaneously (*sh*) was around 9%. Furthermore, for some years, these figures were greater than 10%. In this dataset, it is noted that hiring seasonal workers was underreported because some of the households may informally exchange farming service during the busy season and these were not

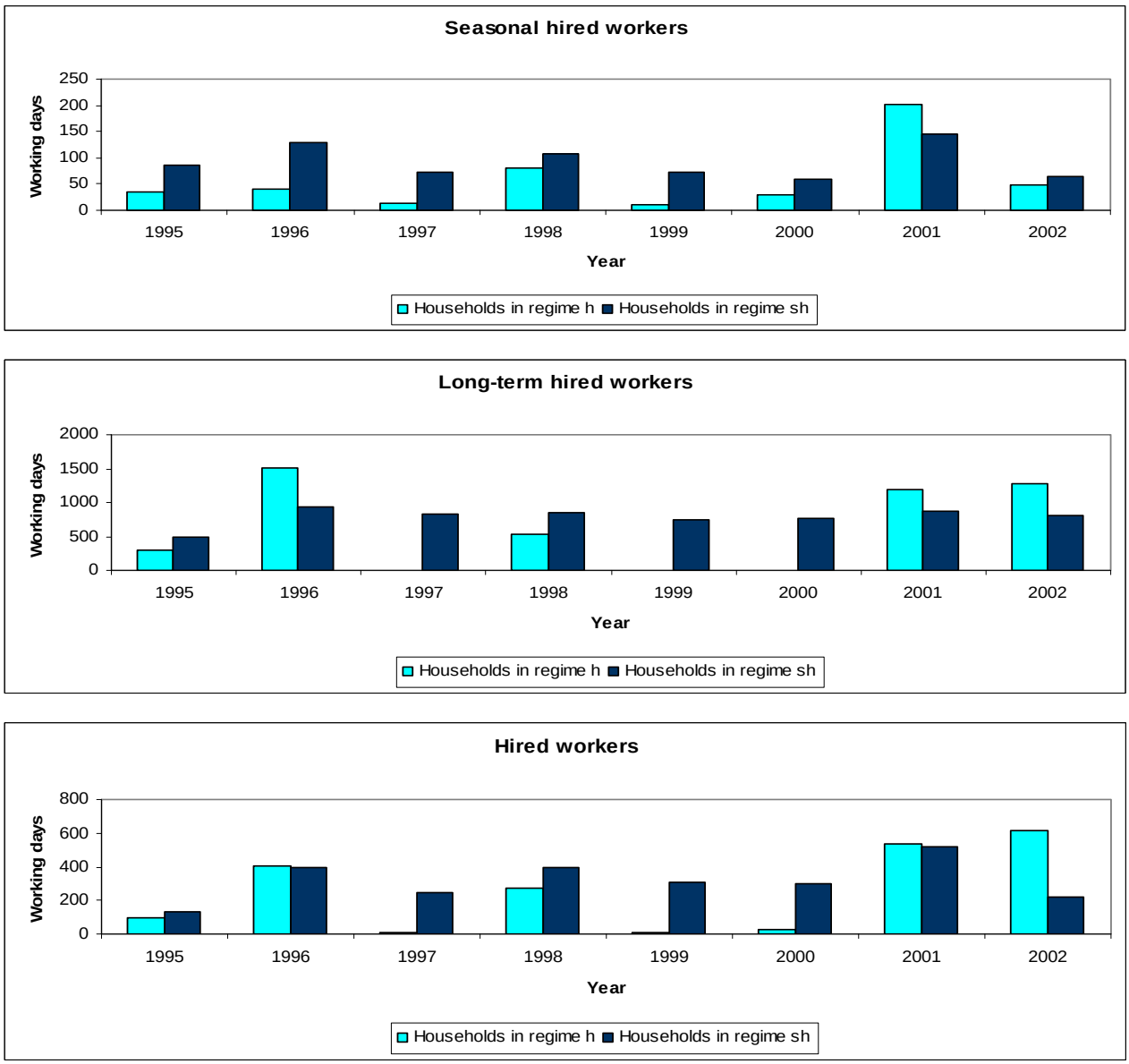
recorded in the survey.[38] Considering the long-term hired workers in the second panel of Figure 4.6, The proportion of households that hire worker in the long term and were in regime *h* was less than 0.25%, while those in regime *sh* were around 3.7% of the sampled households. This leads us to conclude that if households need more extra hands for household-run businesses, they are more likely to hire workers seasonally. Demand for hired workers was greater for households in both markets (*sh*) than for those that purely hire worker (*h*) in the analysis period. The proportion of households in both markets (*sh*) that demand hired labor presented a cyclical pattern: They deceased suddenly, then increased slowly, and then decreased again. Demand for hired workers for households in regime *h* remained at a lower level of less than 3.5%; however, this proportion dropped below 1% between 1999 and 2001.

To provide more information on the demand for hired labor, in Figure 4.7, we illustrate the pictures of average working days of seasonal, long-term and total hired workers in every calendar year in both the state *h* and *sh*. From the three panels, it is observed that the time contribution of the hired workers in a daily unit fluctuated significantly. The time contribution of workers hired seasonally by households that participate in both markets (*sh*) was much more than that by households that purely hire labor (*h*). The one exception was in 2001. For households in regime *h*, the time contributed by hired seasonal labor was an average of around 55 days; though in five of eight years, it was less than 50 days. For households in regime *sh*, the contributed time of hired seasonal workers fluctuated between 35 days and 145 days.

The working days of long-term hired workers presented the cyclical pattern for households in both markets (*sh*). For the households that purely hire labor (*h*) in five of eight years, there is no demand for long-term hired workers. However, the picture changed dramatically in 1996, when the average number of working days of long-term hired workers was more than 1,500. For households in both markets (*sh*), calculating the average working days of both of the long-term and seasonal hired workers, it is found that the contributed time of hired workers has a range between 160 and 520 days for the surveyed period. Because there is no demand for long-term hired labor for several years by households that purely hire labor (*h*), the average contributed time of hired workers in those households fluctuated greatly in the survey period.

[38] Here, the informal exchange of farming service means some of the households provide the farming service without any monetary payment or in-kind payment.

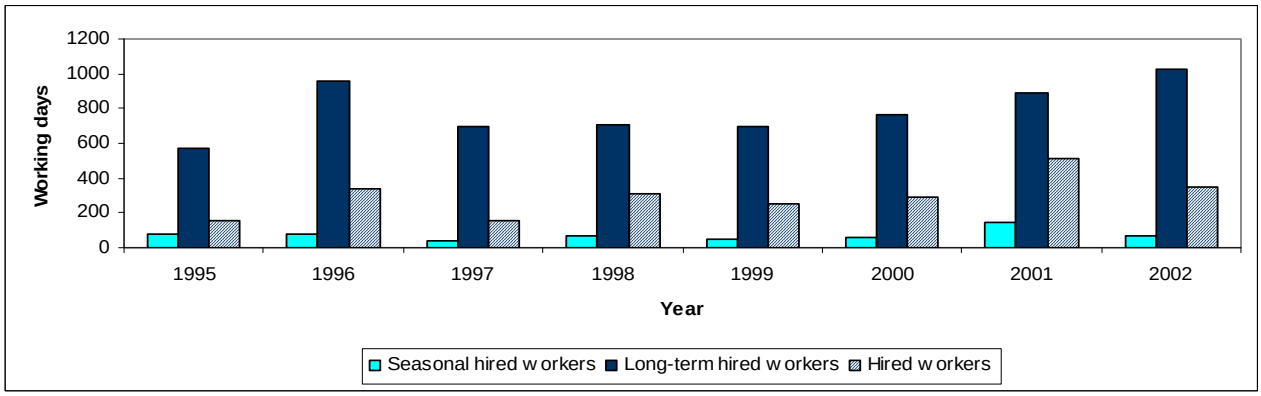
Figure 4.7: Average labor demand of seasonal, long-term, and total hired workers in units of working days calculated by the location of households in regime *h* (light blue columns) and *sh* (dark blue columns)



Ignoring the division of the regimes, Figure 4.8 shows the average demand at household level in units of working days. The light blue columns report working days of seasonal hired labor, the dark blue columns report working days of long-term hired labor, and the columns marked with oblique lines combined both of them to represent working days of total hired workers. For the seasonal workers, the median of average working days was 67.13 days during the analysis period, with the first quartile at 54.19 days and the third quartile at 78.02 days. These figures illustrates that the contributed time of long-term workers fluctuated greatly over time. While the minimum days were 575 days in 1995, this figure reached

more than 1,000 days in 2002. These point to the conclusion that when households hire long-term workers, they generally hire at least two people. For the whole category of hired workers, the average demand in days over time was around 300 days; the maximum was 515 days in 2001 and the minimum was 150 days in 1997. These indicate that hired workers account for a large amount of the work in agricultural production or farm business.

Figure 4.8: Average labor demand of households calculated by seasonal (light blue columns), long-term (dark blue columns) and total hired workers (the columns marked with oblique lines) in units of working days



4.4.3 The evolution of households' labor supply

Figure 4.9 reports the percentage of households that supply workers as self-employment, wage earners and total off-farm employees to all the sampled households by the corresponding regimes of *s* and *sh* from 1995 to 2002. From Figure 4.9, it is found that the proportion of the households' off-farm labor supply was much higher for households that solely supply labor off the farm (*s*) than for households in both markets (*sh*) in the whole period. For households in the regime of solely supplying labor off the farm (*s*), the difference of their participation in the sub-categories of off-farm labor markets as self-employers or wage earners was not evident, while the two participation rates fluctuated between 39% and 49% in the eight years.

For households that are in both markets (*sh*), those choosing off-farm employment are more likely to choose self-employment rather than wage earning. In this sample, more than 67% of the households chose the regime of off-farm employment (*s*) during the surveyed period while in five of eight years, this figure was higher than 70%. For households in both markets simultaneously (*sh*), the proportion of off-farm employment presented a cyclical pattern: They decreased below 10%, then gradually increased to the level of 15%, and then decreased again to 13% in 2002.

Figure 4.9: Percentage of households reporting the supply of self-employers, wage earners and total off-farm employees by the location of the households in regime *s* (light blue area) and *sh* (dark blue area)

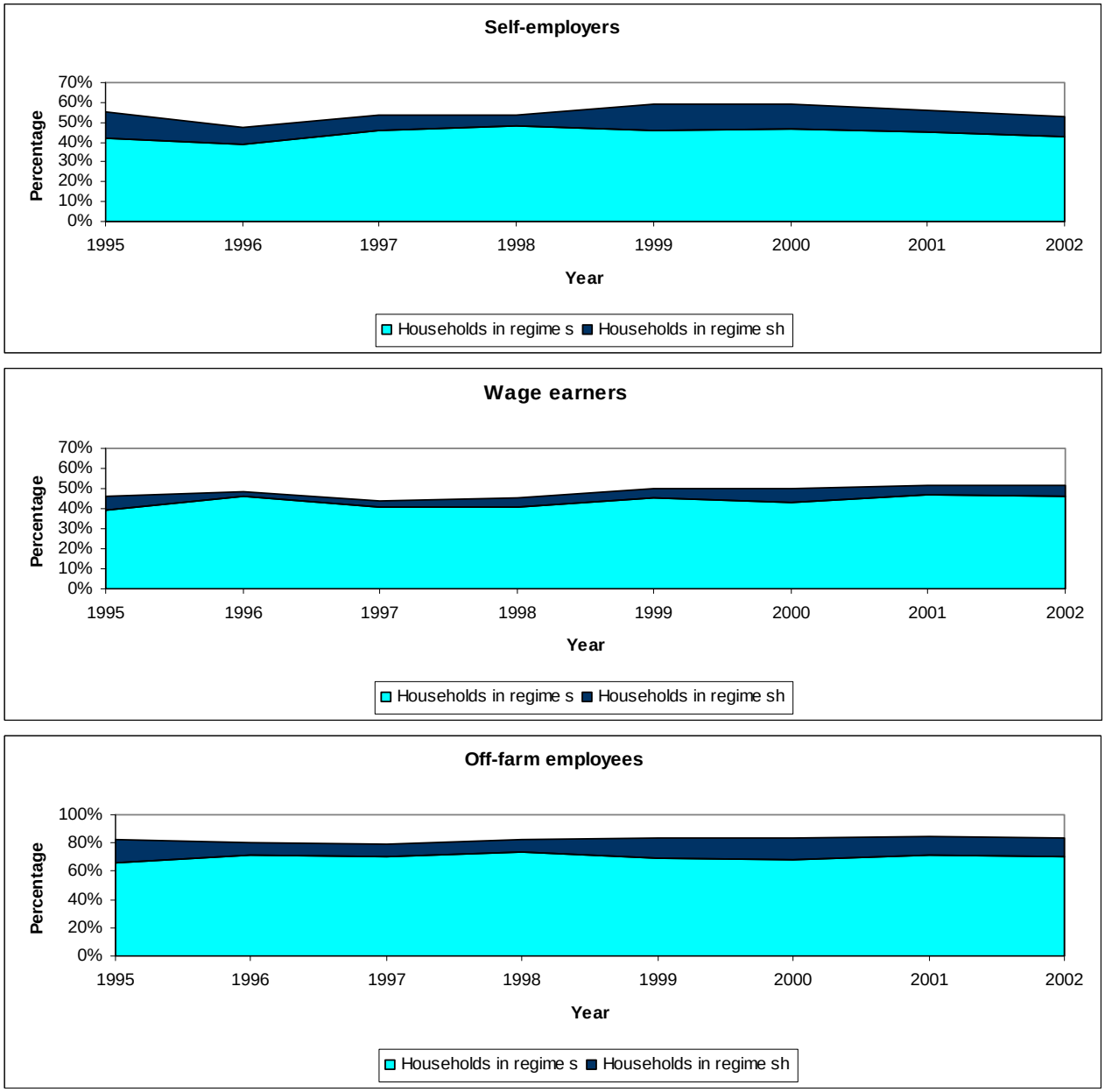


Figure 4.10 reports the average working days of self-emloyers, wage-earners and off-farm employees at the household level according to the labor market regimes in which the households are located. The average working days of self-employers are much higher for households that in both markets (*sh*) than for households that in regime *s* for the entire eight years. For wage-earners located in regime *s*, the average working days fluctuated between 350 days and 455 days at the household level. When wage earners came from households in both markets (*sh*), the average wage earning days in the households fluctuated between 250 and 423 days in 1995-2002. The average off-farm labor supply at the household level was more than 450 days

whether the households belong to the regime of supplying labor (*s*) or are in both markets (*sh*). This means that once the households supply labor off the farm, the average number of off-farm family members is more than one.

Figure 4.10: Average labor supply of self-employer, wage earners and total off-farm employees in units of days calculated by the location of households in regime *s* (light blue columns) and *sh* (dark blue columns)

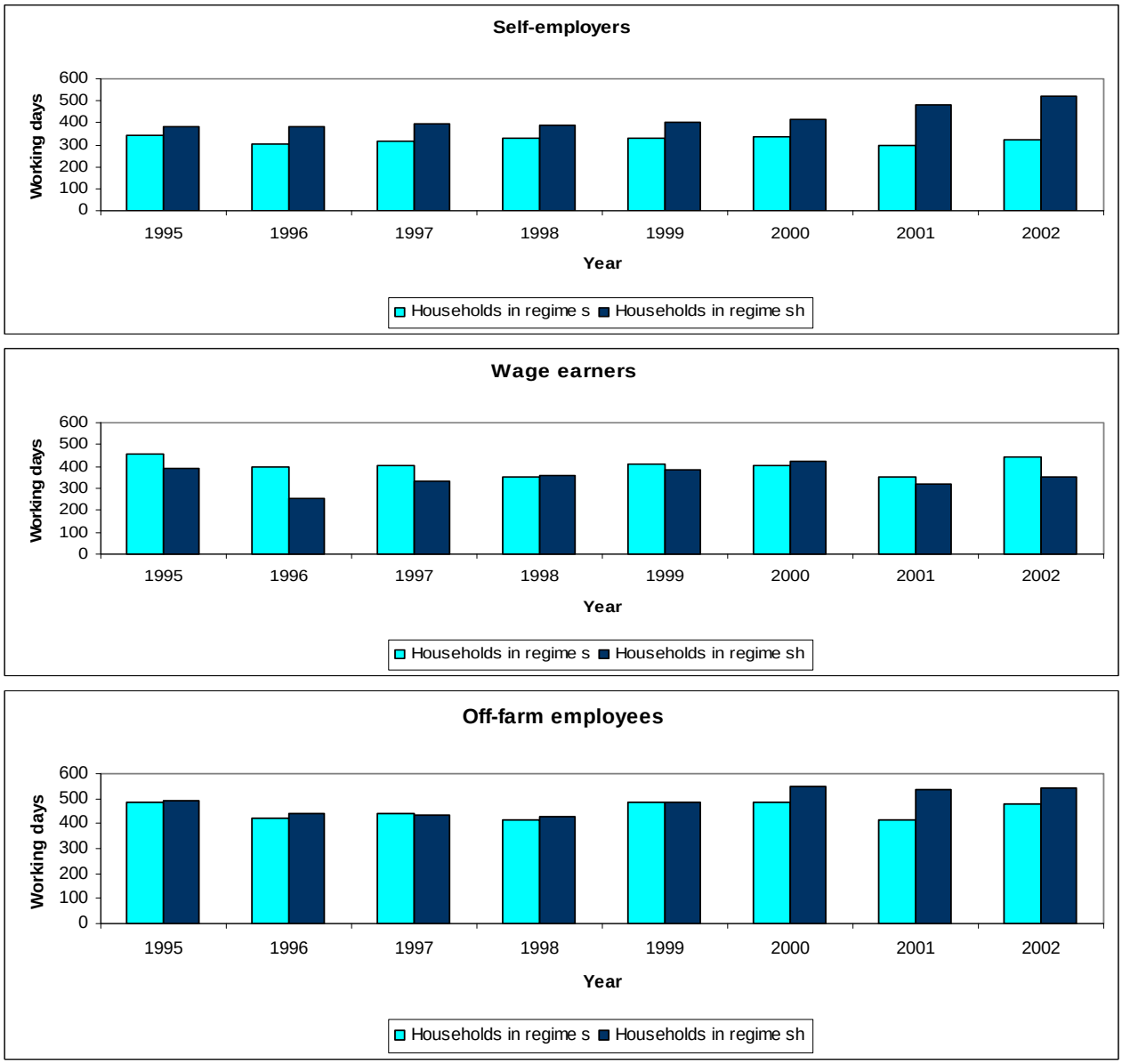
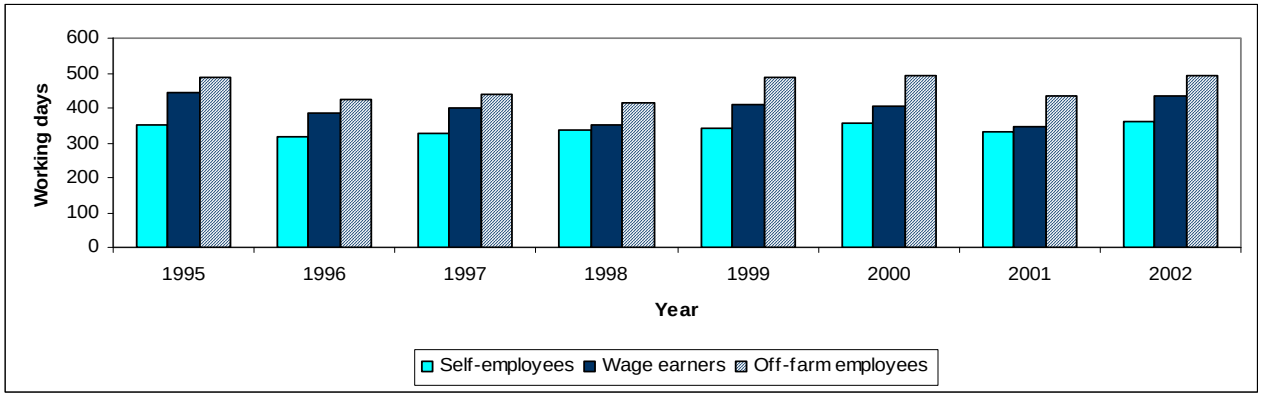


Figure 4.11 provides a description of average working days by the off-farm statues as self-employers, wage earners, or either of them at the household level, regardless of the households' participation regimes in labor markets. The working days of self-employers in a household were, on average, more than 310 days but less than 360 days over all eight years. The working days of wage earners in a household fluctuated between 350 and 450 days over the surveyed period. Figure 3.11 provides

evidence that the average workings days of off-farm employees at the household level is higher than either of that of self-employees or that of wage-earners. This also leads us to conclude that when households supply self-employers, they also supply some family members off the farm as wage earners, or *vice versa*.

Figure 4.11: Average labor supply of households calculated by self-employers (light blue columns), wage earners (dark blue columns) and total off-farm employees (the columns marked with oblique lines) in units of working days



4.5 Variables

As mentioned in Section 4.2, the empirical analysis is based on RCRE data from Zhejiang province. Now we present the dependent variables used in the agricultural household model in Table 4.4 and the hazard model in Table 4.5, respectively. Following that, the independent variables used in the empirical estimations are statistically described from the aspects of household-level information on education attainment of family members, social networking and households' composition, farm characteristics, and village-level data as well as time trends categorized by the participation behavior of households in hired labor and off-farm labor markets in Table 4.6. All of these variables are applied to fulfil the purposes of empirical estimations in Chapter 5.

4.5.1 Dependent variables in the static approach

To explore the determinants of the households' participation in the labor markets, we use two dummy variables in the first step estimation discussed in Section 3.1.2. One represents whether the household participate in hired labor market, and the other captures whether households supply labor off the farm. As can be seen from Table 4.4, about 13.37% of the sampled households hire labor while on average, 82.23% of the rural household supply labor off the farm as recently as 1995-2002. The second stage of estimation is to take the total working days of hired labor or off-farm family labor at the household level as the respective dependent variables to

assess the time allocation of rural households. Two on-farm labor demand equations are estimated: One is for households that only hire on-farm labor (*h*), and the other is for those that both hire and supply labor to the off-farm sector simultaneously (*sh*). Likewise, labor supply functions are estimated for households that only supply labor off the farm (*s*) and those that participate into both on- and off-farm labor markets (*sh*). On average, the households demand 199 working days of hired laborers for households that solely hire labor (*h*), whereas for households in both markets (*sh*), the contributed working days of hired laborers is 305 days per year. For the off-farm labor supply, households that exclusively supply labor off the farm (*s*) provide an average of 452 working days off the farm. If the households are in both markets (*sh*), they supply 496 days off the farm.

Table 4.3: Descriptive statistics of the dependent variables in the static approach, 1995-2002

Labor markets	**Hired labor**		**Off-farm employment**	
Participation rate (%)	13.38		82.23	
	(34.05)		(38.23)	
Labor market regimes	*h*	*sh*	*s*	*sh*
Labor demand (days per household)	199.13	305.43		
	(468.54)	(517.32)		
Labor supply (days per household)			452.46	495.63
			(294.25)	(280.93)

Source: Fixed-pointed survey data in Zhejiang province, 1995-2002.

Note: Figures in parentheses are standard deviations.

4.5.2 Dependent variables in the dynamic approach

To explore the determinants of households' participation dynamics in the labor markets, we should use one dummy variable, equals to 1, to represent a household's shift from the original state to the destined state; otherwise it is zero in the dynamic discussion in Section 3.2.2. From Table 4.4, we note that the relative frequency of a household's transition in the labor market states, especially for the movement to be integrated into labor market (***a*** → ***h*** *or* ***s*** *or* ***sh***) and to be part-time farming (***a*** *or* ***h*** → ***s*** *or* ***sh***).

Table 4.4: Descriptive statistics of the dependent variables in the dynamic approach

Type of transition	**Symbol**	**State changes (No.)**	**Transition rate (%)**
Start participation	***a*** → ***h*** *or* ***s*** *or* ***sh***	236	43.54 (49.63)
Stop participation	***s*** *or* ***h*** *or* ***sh*** → ***a***	227	8.22 (27.47)
Start supplying off-farm labor	***a*** *or* ***h*** → ***s*** *or* ***sh***	253	43.10 (49.56)
Stop supplying off-farm labor	***s*** *or* ***sh*** → ***a*** *or* ***h***	248	9.13 (28.81)
Start hiring external labor	***a*** *or* ***s*** → ***h*** *or* ***sh***	147	5.14 (22.08)
Stop hiring external labor	***h*** *or* ***sh*** → ***a*** *or* ***s***	142	32.13 (46.75)

Source: Fixed-pointed survey data in Zhejiang province, 1995-2002.

Note: Figures in parentheses are standard deviations.

4.5.3 Independent variables in empirical estimations

To estimate the model developed in Chapter 3, the independent variables are included from four aspects: Household and farm characteristics, local village features and time trends to control the macroeconomic effects.39 The set of independent variables is more comprehensive, compared to the existing studies (ZHAO, 1999; DE BRAUW et al., 2002). Table 4.6 presents a summary of data definitions and descriptive statistics of the independent variables according to their participation in hired and off-farm labor markets during the observation period.

Household Characteristics Following the literature, education is one of the most important determinants of off-farm employment (COOK, 1999; DE BRAUW et al., 2002; ZHANG et. al., 2002; CHAPLIN et. al., 2004). The years of schooling for the labor force are not reported in the survey but the completion levels of education attainment are. The completion levels of the labor force are categorized into four levels: Illiterate, elementary schooling, secondary schooling, and high schooling and above.[40] Individual information regarding education attainment of each household member is not available. However, the numbers of laborers with each of the four completion levels of educational attainment in every surveyed year are reported. Thus, fractions of a household's laborers attaining education (*Element*, *Second*, and *High*) are calculated with illiterate as the reference. The same technique is applied to capture the special skills of family members (*Skill*).

The information on the shares of laborers with different levels of education attainment and skill is presented in Appendix Table B2. The education attainment of laborers evidently improved over the eight-year period, though the highest share of the labor force is illiterate – the omitted category, and only a very tiny portion has attended school for 8 to 9 years or more. However, it should be noted that the percentage of illiteracy and elementary schooling fell about 4% and 3%, respectively, from 1995-2002. The decline in the illiteracy rate and the rise in the share of laborers with secondary and high schooling are mainly due to the changes in household size and structure, as well as two discernable trends in the development of labor markets. First, more educated young labor forces are entering into the labor market (DE BRAUW et al., 2002). Second, less educated aging labor forces are exiting the labor market

[39] Unfortunately, we are not able to track different occupations of individual household members. Therefore, we are not able to control for personal characteristics of off-farm workers as in other studies (HUFFMAN and LANGE, 1989; SUMNER, 1982).

[40] The four completion level of education could be converted into years of schooling with the designation of less than 2 to 3 years (illiterate), less than 5 to 6 years (elementary schooling), less than 8 to 9 years (secondary schooling), and more than 8 to 9 years (high schooling and above).

(YANG, 2004). Compared to the education attainment of the labor force, we find that the share of skilled laborers kept at the constant level of 8% over time.

It is hypothesized that the households with larger fractions of educated laborers would have a higher probability of being employed off the farm and as well as lower possible transaction costs to hire labor. The previous studies indicates that a significant positive relationship between an individual's education attainment and various types of off-farm employment, including migrants, self-employers, and local wage earners (HUFFMAN, 1991; ZHANG et al., 2004; ZHAO, 2003). However, the differences among the effects of the education categories on participation in labor markets are not explicitly predicted. Using different samples, ZHAO (1999) found that the coefficient of elementary schooling is statistically significant in promoting off-farm employment in Sichuan province, while another of her studies presents that secondary schooling makes a positive and larger impact on migration by using rural household survey in six provinces (ZHAO, 2003). To test these hypotheses, we incorporate the fractions of the completion levels of education attainment and skill to assess and compare the impacts of different levels of schooling and skill training on decisions regarding households' labor allocation.

A household is composed of labor forces and dependents. The labor force is defined as those over 16 years old who are currently taking or hunting for a position in agriculture or off the farm. Previous literature on labor supply indicate that due to the different roles in the family, male and female laborers exhibit different patterns of labor participation behavior over their life cycles (MEITZEN, 1986; DE BRAUW et al., 2002). Thus, the labor force is decomposed by gender (*M-labor and F-labor*) to identify the connection between household composition and the household's behavior in the labor market.

Table 4.5: Descriptive statistics of the independent variables, 1995-2002

Labor markets	***Symbol***	**Hired labor**		**Off-farm employment**	
Participation (1=Yes, 0=No)		$D_h = 1$	$D_h = 0$	$D_s = 1$	$D_s = 0$
Household characteristics					
Fraction of laborers graduated from elementary school	*Element*	0.39 (0.32)	0.43 (0.34)	0.42 (0.33)	0.43 (0.35)
Fraction of laborers graduated from secondary school	*Second*	0.40 (0.31)	0.34 (0.32)	0.36 (0.32)	0.31 (0.31)
Fraction of laborers graduated from high school	*High*	0.12 (0.22)	0.07 (0.19)	0.083 (0.20)	0.06 (0.17)
Fraction of laborers with special abilities	*Skill*	0.15 (0.24)	0.08 (0.18)	0.10 (0.20)	0.06 (0.16)

Table 4.5: Continued from previous page

Labor markets	***Symbol***	**Hired labor**		**Off-farm employment**	
Participation (1=Yes, 0=No)		$D_h = 1$	$D_h = 0$	$D_s = 1$	$D_s = 0$
No. of male laborers (person)	*M-labor*	1.45	1.35	1.39	1.24
		(0.65)	(0.63)	(0.64)	(0.60)
No. of female laborers (person)	*F-labor*	1.18	1.19	1.21	1.08
		(0.60)	(0.68)	(0.68)	(0.62)
No. of dependents (person)	*Dependent*	1.20	1.16	1.19	1.07
		(0.91)	(0.98)	(0.97)	(0.94)
Net transfer per capita	*Transfer*	-0.30	-0.23	-0.27	-0.08
(1000Yuan/person)		(1.96)	(2.55)	(2.41)	(2.75)
Cadre (dummy variable, 1=yes, otherwise 0)	*Cadre*	0.16	0.08	0.08	0.14
		(0.37)	(0.27)	(0.27)	(0.34)
Communist party membership (dummy variable, 1=yes, otherwise 0)	*Pmember*	0.26	0.13	0.14	0.21
		(0.44)	(0.34)	(0.34)	(0.41)
Farm characteristics					
Household's production assets	*Asset*	7.28	3.06	3.32	0.51
Per capita at 1995 constant price (1000 Yuan/person)		(14.85)	(13.56)	(11.13)	(2.23)
Land per capita (mu/person)[a,b]	*Landpc*	6.75	2.35	2.98	2.74
		(10.88)	(5.05)	(6.62)	(4.78)
Animal husbandry (Ln form of output in quantity)	*Livestock*	-1.27	-1.94	-1.85	-1.85
		(4.62)	(4.39)	(4.41)	(4.52)
Fraction of vegetable sown area	*Vegetable*	0.14	0.10	0.10	0.11
		(0.24)	(0.19)	(0.19)	(0.21)
Agricultural output value divided by input value	*O/I-ratio*	0.24	0.17	0.11	0.51
		(2.90)	(1.36)	(0.70)	(3.60)
Value of output at 1995 constant price (Yuan)	*Output*	7919.38	8700.75	6461.23	18478.28
		(17221.35)	(2585.67)	(14643.66)	(37223.68)
Land (mu)[b]	*Land*	22.94	7.88	10.14	8.77
		(31.21)	(14.37)	(19.04)	(14.45)
Family labor (days)	*Family-l*	121.28	161.90	140.24	231.54
		(231.60)	(195.22)	(168.90)	(297.38)
Hired labor (days)	*Hire-l*	294.61	0.00	44.63	15.27
		(513.08)	(0.00)	(225.08)	(138.91)
Capital at 1995 constant price (Yuan)	*Capital*	26610.49	11484.22	12503.54	18155.97
		(50199.49)	(48833.40)	(41566.50)	(75195.88)
Expense of fertilizer (Yuan)	*Fertilizer*	384.50	304.11	312.95	323.69
		(1245.98)	(353.44)	(598.49)	(349.55)
Sum of intermediate inputs at 1995 constant price (Yuan)	*Intermediate*	4278.01	5819.95	3601.46	14927.43
		(15608.94)	(20512.42)	(13606.78)	(35712.48)

Table 4.5: Continued from previous page

Labor markets	***Symbol***	**Hired labor**		**Off-farm employment**	
Participation (1=Yes, 0=No)		$D_h = 1$	$D_h = 0$	$D_s = 1$	$D_s = 0$
Village characteristics					
Fraction of households that rent in land to total households in the village	*L-rent*	0.12 (0.13)	0.09 (0.11)	0.10 (0.12)	0.07 (0.08)
Fraction of the unemployed	*Unemp*	0.14 (0.12)	0.13 (0.12)	0.13 (0.13)	0.12 (0.12)
Population density (inhabitants/mu)	*Popden*	0.92 (1.19)	1.22 (1.17)	1.20 (1.22)	1.05 (0.96)
Annul net income per capita in the village at 1995 constant price (1,000 Yuan/person)	*Anipc*	5.47 (2.36)	5.06 (2.29)	5.24 (2.36)	4.54 (1.92)
Time trend					
Time	*Time*	4.71 (2.26)	4.55 (2.22)	4.61 (2.23)	4.41 (2.22)
Observations		442	2862	2717	587

Source: Fixed-pointed survey data in Zhejiang province, 1995-2002.

Note: Figures in parentheses are standard deviations. [a] Given 1 *mu* = 0.0667 hectare. [b] The survey records five types of land: Cultivated land, orchard land, woodland, husbandry areas, and water areas for fish ponds. The land used in this study includes all five types.

In the family, the non-labor force (those who are not counted as labor force in the survey) includes children who are younger than 16 years, the elder who are more than 65 years of age and those who are over 16 years old but retired, cannot work due to health-related reasons, or are still full-time students. They are summarized in the variable of dependents (*Dependent*). It is evident that a household composition changes over time, and that influences the households' labor allocation in the labor market. These changes of the numbers of labor force and dependents are mainly due to the aging and death of family members, baby births and children maturing, migration and marriage, and so on. Assuming that a household's attitude toward the labor market could be altered by unearned income, the magnitude of net transfer per capita (*Transfer*), consisting of subsidies from governments and donations from and to the relatives, is included in the empirical models.

The proxies that represent social networking in a household include whether any family member is the member of the Communist party (*Pmember*) or a cadre (*Cadre*) in a township or village. Given the possible linkage between party membership and employment opportunities, a dummy variable is used to control for the impact of

party membership on a household's labor participation. The dummy variable equals to 1 if any of the family members is admitted to the Communist Party, whereas zero represents the family member in the party leaves the household or nobody in the family has party membership. Previous literature suggests that being a cadre households provides easier access to the agricultural input resources and output markets and provides authority in securing the land tenure at the village level (CARTER and YAO, 2002; JACOBY et al., 2002). A dummy variable is used to control for the impact of any special perks that a household can access when a family member is committed to be the cadre (*Cadre*), or any losses experienced when none of the family members is the cadre.[41]

Farm characteristics Farm characteristics include land, durable assets for agricultural production, variables representing the production structure, and the ratio of agricultural output value to input value. Households with relatively more land per capita (*Landpc*) may show a higher probability of hiring additional labor or may refrain from working off the farm.[42] The previous literature on rural labor markets in developed countries drew the inconsistent conclusions on the relationship between the farm size and the demand for hired laborers. BENJAMIN et al. (1996) show the opposite results. Their results, with respect to French farmers, suggest that the probability of hiring labor decreases with an expanding farm size. However, the size of land in China differs greatly from that in France. Households with only some land will cultivate it alone, and otherwise hire extra labor if the farm size increases, as is the case in the U.S. and shown by FINDEIS and LASS (1994). A great deal of evidence exists in the empirical studies to show that China is characterized by a surplus of underemployed rural labor (KNIGHT and SONG, 1995; COOK, 1999; BOWLUS and SICULAR, 2003). Thus, this study tends to explore the impact of farm size on labor demand in the transition economy.

In agriculture, production assets – 'labor-saving technology' – are designed to substitute power and machinery for labor (HAYAMI and RUTTAN, 1985). However, if the desired capital accumulation exceeds the profit-maximizing level of capital input in production, then the household can hire labor to drive the machinery; if the household capital supply is less than this amount of capital input, then the household can supply labor off the farm. Thus, it is assumed that a positive relationship between durable assets per capita (*Asset*) and the probability of hiring labor, but a negative relationship between durable assets per capita and the probability

[41] The cadre in the village and town, which is not a permanent position, could be elected by the local residents or appointed by the upper-level government.

[42] The survey records five types of land: cultivated land, orchard land, woodland, husbandry area and water areas for fish ponds. The land used in this study sums up all five types.

to supply labor off the farm. To control for the differences in farm performance and production structures, we include the share of vegetable area to total sown area (*Vegetable*) and the natural logarithm form of the total output of swines and ruminants in quantity (*Livestock*). [43] It is expected that the change of farm structure will induce different patterns of the household's labor allocation.

Village characteristics Several authors highlight the importance of land markets on households' time allocation (BENJAMIN, 1992; YANG, 1997b; KUNG, 2002; HERTEL and ZHAI, 2006). One precondition for the structural change in farming, which influences the allocation of labor resources, is that land can be transferred between households, though the buying or selling are not possible in China. This maintains that some households can intensity their farming and potentially hire labor while others may reduce or abandon farming activities and shift to off-farm employment. Furthermore, a household's labor allocation is proven to be constrained by its land endowment given the imperfect labor markets with the observed surplus of labor (COOK, 1999). However, the incidence of land rental transactions in a household is assumed to be endogenous with respect to a household's labor allocation because it is plausible that the household's participation decision in labor markets take place following the renting in or out of land.

To fulfill the purpose and control for this source of endogeneity, we apply the fraction of the number of households that rent out land to the total number of households (*L-rent*) in the village in the empirical estimations, representing the land rental transaction at the village level. This variable could be treated as weakly exogenous to households' labor allocation because the outcome of land rental markets depends completely on the decisions of community authorities. In the sampled data, we observe that in some villages across the geographical landscape, active rental of land occurred in the past while there is the absence of land rental markets in other villages (see Table 4.2). Moreover, land rental activities are likely to increase in the future (KUNG, 2002). Thus, our hypotheses concern how the allocation of labor resources is likely to be affected by the emergence of the land rental market and the extent to which the land rental activities quantitatively affect the decisions of households' labor allocation. This study picks up these hypotheses and tests them in the empirical estimations.

Furthermore, some regional characteristics are considered to capture external labor market conditions. Other studies use distance to the nearest city or frequency of public transportation to capture the transaction costs of accessing labor markets (HUFFMAN, 1991; CHAPLIN et al, 2004). Because comparable information is lacking in

[43] Here, livestock excludes chicken because in China most of households breed up chicken for own consumption of eggs.

the dataset, we apply a number of variables assumed to be closely interlinked with the economic conditions, especially the functioning of the local labor market: The unemployment rate (*Unemp*), population density (*Popden*) and annual net income per capita (*Anipc*).

The information on unemployment rate (*Unemp*) is only available for the local community. It probably triggers the off-farm employment as migration if households located in a village with a higher unemployment rate (*Unemp*). In agriculture, the skill differential between the family and hired labor make the two kinds of labor inputs imperfect substitutions (DEOLALIKAR and VIJVERBERG, 1987). Special tasks, such as tractor or bullock operation, that are performed by the hired labor cannot readily be performed by family members. Therefore, with a high unemployment rate, households hardly find the qualified on-farm hired labor. Furthermore, relatively high unemployment rates would lead to relatively low general wage levels, which may make off-farm employment less attractive and hiring on-farm labor less costly. Population density (*Popden*), which describes the number of inhabitants occupying an area in relation to the size of that area, is generally used to measure the urbanized process (MILLS, 1972). Furthermore, the spatial distribution of population density at the different level of the scale captures the regional differences in the urbanization process. It is expected that the geographic concentration of production activities followed by the force driving of the urbanization process raise the probability of finding an off-farm employment. From the standpoint of development economics, the urbanized agglomeration with concentrations of people and firms offers the cost-reducing advantage of economies of scale and proximity as well as numerous economic and social externalities, e.g. skilled workers, cheap transportation, and social and cultural amenities. The annual net income per capita in the respective villages (*Anipc*) is included to more directly reflect the differences in the external wage level. Proxied by the three village-level variables, the cost level of participating in the labor market can be tested in the empirical study.

Frequent adjustments of agricultural policies have occurred in China, sometimes in favor of market liberalization, but often the direction was implicit (See Chapter 2). On several occasions, policy changes were designed to put the old central planning back in force. Because land and capital markets were still constrained, it is logical that the higher grain quotas induced a reallocation of labor force from other activities, including off-farm activities (ZHAI et al., 2003).[44] The most popular example was the

[44] According to the theoretical model a higher grain price leads to a higher internal wage rate. Assuming a concave off-farm income function and convex cost function for hired labor, as considered in the theoretical framework, a higher internal wage rate induces a decreasing supply of family labor off the farm and an increasing demand for hired labor. Therefore, also

introduction of the governor's grain responsibility system in 1995, in which each top governor must ensure self-sufficiency in grain production for his own province. A similar system, called the mayor's responsibility system, was introduced for vegetables, fish, meat, eggs and milk at a local level. Restoration of public influence during the mid-1990s may increase agricultural activities, so families may fear to lose their land use right if they do not fulfil quota or do not work on their contracted land. Furthermore, increased agricultural productivity, which is observable during this period, may enable family members to move toward off-farm employment. Thus, a time trend is included to capture the impact of frequent policy changes on the households' labor allocation and the trend of households' labor allocation in the observation span.

In summary, our descriptive analysis illustrates the performance of the hired labor and off-farm employment market in this chapter. Furthermore, we also formally propose several hypotheses that the labor allocation of households is significantly influenced by the characteristics of the household, farm, and village. The econometric procedures to test these hypotheses and the conclusion drawn from the empirical estimations are revealed in the following chapters.

the grain price adjustments connected with the self-sufficiency policies in the mid 1990 might result in a lower probability of supplying labor off the farm and demand for hired labor.

5 Estimation approaches and empirical results

Numerous empirical studies concerning the time allocation of rural households have been conducted in the last few decades, starting with the seminal work of HUFFMAN (1980). His studies only have examined the time-allocation decision of one-person, i.e. the operator's decision regarding leisure and off- and on-farm activities. The NELM theory concludes that the participation decisions of family members are not independent but jointly determined within a household (STARK, 1991; TAYLOR et al., 2003). In general, a household is comprised of more than one laborer; thus, the study by HUFFMAN (1980) ignores the interaction of the time allocation of the main laborer with that of other laborers in a family. Specifically, the time allocation of a rural household member is not an individual decision; rather, it is made in the context of an interdependent relationship with those of other family members.

Since HUFFMAN and LANGE (1989), several extensions have made to deal with the joint decisions of the operator and spouse (TOKEL and HUFFMAN, 1991; LASS and GEMPESAW II, 1992; SKOUFIAS, 1994). These applications are incomplete in their explanations of labor composition within families because they only concern nuclear households, counting the operator and spouse as laborers and children as dependents. Less frequently, a married couple lives alone. However, there are still inter-generational households of older couples who live with sons and/or daughters, daughters-in-law and/or sons-in-law, and grandchildren, or households comprised of younger couples living with their children and parents. For the inter-generational households, the labor force in a family consists not only of the operator and spouse but also the senior offspring or the elders.

All the above-mentioned studies use the cross-sectional data, and thus we are not well informed about the off-farm decision in the survival process of farm, nor a life-cycle setting. There is, however, a growing consensus in the literature that cross-sectional approaches cannot adequately capture households' behavior in labor markets over time (NAKAMURA and NAKAMURA, 1985). Thus, several researchers have advocated the use of longitudinal data, which create a new dimension of variation within households with the usual across-household information (SUMNER, 1991; WEISS, 1997). GOULD and SAUPE (1989) and WEISS (1997) use two period panel data to estimate the farm survival decision as dependent upon the off-farm participation

over the life cycle. CORSI and FINDEIS (2000) applied a dynamic model of off-farm labor participation to distinguish between true state dependence and unobserved heterogeneity. Applying the recent panel data from Israeli, AHITUV and KIMHI (2002, 2006) identify the strong correlation between the off-farm participation decision and the farm attributes by treating the capital stock or land endogenous, respectively.

The use of longitudinal data to analyze the labor allocation in China can be found in the recent works by BOWLUS and SICULAR (2003), YANG (2004), and GILES (2006). BOWLUS and SICULAR (2003) use the panel data of one county to examine the independence of labor demand in production and the off-farm labor supply. YANG (2004) concludes that the optimum level of resource allocation does not achieve in households' non-agricultural activity by relying on the input demand and household net profit functions. GILES (2006) analyzes the impact of the accessibility of labor markets on the variability of Chinese rural households' income. He finds that households' vulnerability, with respect to shocks to agricultural production, is substantially reduced by improved access to local and migrant labor markets. However, none of the studies treats the contributed time of hired labor separately with family members in the labor demand estimation. Their panel data only cover the period before 1998, and thus their empirical results cannot completely capture the development of the rural labor market in the more recent transition progress of China.

For the empirical analysis, this study is devoted to the assessment of rural labor markets in several dimensions. First, the empirical study is based on a more recent panel dataset from 1995-2002, capturing the more flexible labor mobility of rural China. 2000 witnessed the far-reaching event of China's accession to WTO. The commitment of the Chinese government to the agricultural sector will affect the employment structure of the rural labor force in the subsequent years. Second, we extend the empirical applications by including the off-farm employment decisions of the nuclear and inter-generational households. Specifically, we incorporate the decision regarding work of all of the adult laborers in a family, rather than just the operator and spouse under the assumption that family members' decisions about off-farm work are not separate (STARK, 1991; TAYLOR et al., 2003). Third, the labor inputs are decomposed into family members and hired workers in the household-run businesses, given the heterogeneity of the two kinds of labor factors. Fourth, the theory of agricultural households recognizes that farm operation decisions and off-farm employment decisions are made separately through reasonably competitive factor markets. BOWLUS and SICULAR (2003) claim that the separability of labor supply in on- and off-farm activities could be possible by the exchange of labor and land. To achieve welfare-maximum, the households with more than

desired labor-to-land ratio in production could supply labor off the farm or rent in land; whereas households with a less than the desired labor-to-land ratio could hire extra labor or rent out land. We examine the interaction of households' off-farm employment and hired labor decisions controlling for the exogenous land rental market at the village level. This study also allows the unobserved heterogeneity between and within households in the estimation of the quantity of hired labor demand and off-farm supply by using the panel data. Finally, to our best knowledge, there is no work that explicitly analyzes the state dependence of a household's participation in the labor market. By applying a hazard model, we go beyond the existing literature and focus on dynamic aspect of the transitions between participation states, rather than taking a static view focusing on the states themselves. We analyze the duration of participation and the duration dependence of movements between the states. In analyzing the duration dependence of the probabilities of transitions, a valuable complement is added to the results on state dependence as in WEISS (1997) and GLAUBEN et al. (2004).

The purpose of this chapter provides the empirical evidence on the households' behavior in the labor market in the context of farm structural changes and the regional labor market, based on the econometric models discussed in Chapter 3 and the data description in Chapter 4. The empirical analysis proceeds with the following behavior functions: The households' participation behavior in hired-labor and off-farm employment markets, the contributed time functions of hired labor, the off-farm labor time functions, and the duration estimations of households in labor markets.

5.1 Households' participation in labor markets

Employing maximum likelihood (ML) technique, a bivariate probit model is used to identify the determinants of the households' participation in off-farm employment and hired-labor markets. The empirical results are presented in Table 5.1. Furthermore, the bivariate probit model also allows us to find out whether households' participation in hired-labor and off-farm labor markets is jointly determined. Two dependent variables are included to represent two choices of household's participation in labor market (a) households hire labor $D_h = 1$ or 0; and (b) family members work off the farm $D_s = 1$ or 0. The estimated cross-equation correlation between the decision to hire labor and work off the farm is positive 0.1439 and statistically different from 0 at the significant level of 1% or better. This implies that the random disturbances in the households' decisions on hiring labor and off-farm labor supply is affected in the same direction by random shocks (or unmeasured effects). More specifically, omitted factors that explain the probability

of hiring labor or supplying labor off the farm are positively correlated. Therefore, we cannot reject the null hypotheses that the households' participation in hired labor and off-farm labor markets is not statistically independent.[45] That is, the decision to hire labor increases the likelihood that households participate in off-farm employment, and *vice versa*. The finding of nonseparability between the households' off-farm employment and hiring labor decisions imply that in the later 1990s and early 2000s, rural labor markets in the comparatively developed province, Zhejiang, still remained underdeveloped despite more than a decade of transition reform to a market-oriented economy. Econometric estimations to explore the decisions of households' time allocation in labor markets need to test whether the sampled data has the selection bias (HUFFMAN and LANGE, 1989; LASS and GEMPESAW II, 1992). Thus, the inverse of Mills' ratio, accounting for the propensity for a household to participate in the labor market, is computed for each observation from the bivariate probit estimation. The sample selectivity term – he inverse of Mills' ratio will be applied into the following hired labor demand and off-farm labor supply functions to test if sample selectivity bias occurs in the sampled data.

The bivariate probit parameters estimation explore the determinants that influence the probability of a household entering into the two labor markets – hiring labor or supplying labor off the farm. The estimated labor participation equations perform well in terms of the ML ratio test and the Wald Chi-square test, which are statistically significant at 1% at the value of –2574.99 and 473.16 with 40 degrees of freedom, respectively. The results in Table 5.1 suggest that the households' participation decisions regarding labor markets are significantly related to a number of household, farm, and village characteristics. The estimated parameters of the independent variables are in line with previous research on labor market participation using Chinese data (HARE, 1994; ROZELLE et al., 1999; TUAN et al., 2000; ZHANG et al., 2001; DE BRAUW et al., 2002; CHEN et al., 2004). The estimated positive parameter of the explanatory variable means that by keeping other variables constant, the higher value of this continuous independent variable or changing the dummy variable from 0 to 1 increase the probability of households participating in the respective hiring labor or off-farm labor markets, and *vice versa*. To explain the results more explicitly and intuitively, measures of the direct marginal effects of the independent variables on the households' labor participation probability dF/dx also are listed in Table 5.1. This could be explained as the percentage change in the probability of households' participation in the respective labor market due to a unity change in a

[45] It is argued that if the correlation coefficient of the two dependent variables is not statistically significant at the traditionally accepted level, then the separate decision of the households' participation into the two labor markets could be accepted. If so, the use of two univariate probit estimates is appropriate (HUFFMAN and LANGE, 1989).

particular continuous variable or a dummy variable shifted from 0 to 1. Although estimated parameters are linear in the determinant variables, the partial derivatives computed from the estimated coefficients themselves are non-linear. Partial derivative is point estimation while the sign of the marginal effects of the variable is consistent with the sign of the estimated parameter and independent of the chosen point.[46] Here, partial derivatives for the continuous variable are estimated at their means by default, while for dummy variables, the change from 0 to 1 is derived for the change of probabilities. This study relies on the partial derivative of parameters to interpret the empirical results.

Household characteristics With the illiterate as the reference group, all the other categories of education (*Element, Second, High*) make the positive effects on family members' off-farm employment and hiring labor. The results confirm the findings of the existing studies: Higher-educated laborers show a significantly higher probability to participate in the off-farm labor market (HUFFMAN, 1991; KIMHI, 1994; ZHANG et al., 2004; ZHAO, 2003). As expected, education variables (*Element, Second, High*) have higher impacts on the probability of working off-farm than hiring labor by comparing the magnitudes of marginal effects of the variables. Though education may increase the productivity both on and off the farm, LASS et al. (1991) point out that it has a stronger effect on off-farm productivity than on-farm productivity. When explored more deeply, the extent to which the level of education attainment affects the households' participation decision differs signify-cantly. Compared to the marginal effects of education variables, high schooling makes the largest effect on off-farm employment decision. By holding all other factors constant, a 10% increase of the ratio of labor with high, secondary and elementary schooling separately corresponds to 15.63%, 12.24%, and 8.19% better chances of households' supplying labor off the farm, respectively. This sample group was also asked about the number of laborers with special skills, but it is impossible to identify that whether the special skills are related to off-farm work or if the laborer has a certificate for an on-farm job, such as breeding or veterinary medicine. The positive marginal effect of the special skill variable means a household with special skilled laborers is 12.64% more likely to enter the off-farm labor market. For the hiring labor equation, the largest and positive marginal effect

[46] The derivative for any model based on a cumulative distribution function $F(x)$ which links the regressors to the binary dependent variables D, has a simple general form. We start from $D = F(x/\beta)$, β are estimated parameters from bivariate probit model. The derivative dD/dx_i is then given by $dD/dx_i = dF(x/\beta)/dx_i = f(x/\beta)/\beta_i$, with $f(x)$ being the probability density function corresponding to the chosen distribution. The important thing to note here is that $f(x)$ is positive for any point of approximation. Therefore, the sign of the marginal effect will be the same as the sign of β for any point of approximation.

of education attainment also comes from the high schooling while the secondary schooling make the similar impact as high schooling. That is, upgrading of the ratio of laborers with high, secondary and elementary schooling in the sampled households by 10% increases the probability of hiring labor by 9.64%, 9.19% and 4.30%, respectively.

These results imply that improving education attainment, especially the high schooling, and special skills of rural labor is effective in promoting households' participation in labor market. However, the schooling is not linear to hire labor or supply labor off the farm. Although this is not explicitly considered in the empirical analysis, one might further hypothesize that fixed and variable costs of accessing labor markets (i.e., search, transportation, or monitoring costs) for higher-educated farmers are lower than for less-educated farmers. Thus, the effective wage (net of transaction costs) received for off-farm employment is relatively high, so the relative profitability of off-farm participation increases, ceteris paribus. The empirical results also imply that there are non-linear positive impacts of education attainment on hiring labor. Thus, although increasing the number of more educated farmers is expected to be more efficient in production, it is not explicit that the households with higher-educated laborer can afford to hire workers and devote a part of their own labor to managerial tasks or even increasing their leisure. Certainly, the education improvement leads to an increased heterogeneity among family laborers, such that farmers tend to substitute hired labor for family labor on the farm and may supply family labor off the farm, as long as the marginal cost of hired on-farm labor is equal to marginal off-farm income.

In this study, the changes in household composition are measured by changes in the numbers of male and female workers (*M-labor* and *F-labor*) and the numbers of dependents (*Dependent*). Changes in household composition occur for many reasons, including children growing old enough to work, the deaths of the elders, the births of children, and legally splitting the family. Previous literature found that a household's demographic structure significantly influences its labor allocation (BOWLUS and SICULAR, 2003). Focusing on the household composition, it is noted that male and female laborers affect the likelihood of a household's hiring labor in the adverse direction.

Table 5.1: Results of households' labor participation from bivariate probit model

Households' labor participation	**Hiring labor**		**Taking off-farm employment**	
Symbol	Coefficients[a]	dF/dx^b	Coefficients[a]	dF/dx^b
Household Characteristics				
Element	0.2270	0.0430	0.3347***	0.0819
	(1.52)		(3.12)	
Second	0.4848***	0.0919	0.5001***	0.1224
	(3.20)		(4.28)	
High	0.5085***	0.0964	0.6387***	0.1563
	(2.67)		(3.76)	
Skill	0.3601**	0.0683	0.5165***	0.1264
	(2.48)		(3.25)	
M-Labor	0.1788***	0.0339	0.1897***	0.0464
	(3.62)		(3.99)	
F-Labor	-0.0196	-0.0037	0.1339***	0.0328
	(0.41)		(3.03)	
Dependent	0.1271***	0.0241	0.1367***	0.0335
	(3.80)		(4.45)	
Transfer	-0.0164	-0.0031	-0.0119	-0.0029
	(1.38)		(1.10)	
Cadre	0.2494**	0.0533	-0.2766***	-0.0752
	(2.31)		(2.71)	
Pmember	0.3215***	0.0696	-0.2598***	-0.0692
	(3.62)		(3.10)	
Farm characteristics				
Asset	0.0640***	0.0121	-0.0694***	-0.0170
	(3.86)		(3.72)	
Landpc	0.0346***	0.0066	0.0035	0.0009
	(7.97)		(0.70)	
Livestock	0.0019	0.0004	0.0002	0.000049
	(0.26)		(0.03)	
Vegetable	0.1739	0.0330	0.0960	0.0235
	(1.17)		(0.64)	
O/I-ratio	0.0001	0.000015	-0.0010***	-0.0002
	(0.53)		(3.69)	
Village characteristics				
L-rent	0.4910*	0.0931	0.5443*	0.1332
	(1.73)		(1.80)	
Unemp	-0.5177*	-0.0982	0.0895	0.0219
	(1.93)		(0.37)	
Popden	-0.1754***	-0.0333	-0.0589	-0.0144
	(4.33)		(1.55)	

Table 5.1: Continued from previous page

Households' labor participation	**Hiring labor**		**Taking off-farm employment**	
Symbol	Coefficients[a]	dF/dx^b	Coefficients[a]	dF/dx^b
Anipc	0.1054***	0.0200	0.0916***	0.0224
	(5.74)		(4.88)	
Time trend				
Time	-0.0333**	-0.0063	0.0042	0.0010
	(2.19)		(0.32)	
Constant	-2.2998***		-0.3978***	
	(12.88)		(2.84)	
Log Likelihood	-2574.9863			
Wald λ^2	473.16 (40)			
Observation	3304			

Note: [a] This table shows coefficient estimates and Z-value in parentheses with ***, **, and * significant at 1%, 5% and 10% level, respectively. [b] The partial derivative is calculated by the means for continuous variables and captures the difference from 0 to 1 for dummy variables.

Results in Table 5.1 indicate that households with either more male or female laborers show a significantly higher tendency toward off-farm employment. Adding an additional male or female laborer to the household increases the probability of off-farm employment by 4.64% or 3.28%, respectively. The magnitude of marginal effects of laborers implies that the number of male laborer has a greater effect on a household's labor participation decision than that of female workers. This could be interpreted in the two ways. First, a larger number of male labors in a household *ceteris paribus* indicate a labor surplus and a relatively greater time endowment, which encourages laborers to work off the farm or use their own labor resources to substitute the hired labor service. Second, this could be attributed to the traditional role of the female laborer, who generally devoted more time to the household's activities and children rearing. Thus, an additional male laborer is more likely to take off-farm employment compared to an extra female laborer. These findings regarding the response of the household's labor participation by labor force composition confirm the similar studies by LASS and GEMPESAW II (1992) and ZHANG et al. (2001).

The two marginal effects of the dependents (*Dependent*) are positive in the estimations of hiring labor and off-farm employment. With another dependent person, the probability of households' hiring labor will increase 2.41%. This could be explained that family labor should devote efforts to take care of the additional dependent, and thus the hired labor is needed to substitute the family laborers.

Increasing the number of dependents in a household by one member increases the probability of a household's off-farm work by 3.35%. A possible reason is that the number of dependents in the dataset is an aggregated variable and cannot be explicitly classified into elders and children of different ages. The effects of the young and older children and the elder adults on households' labor participation vary. Young children generally need much more care, and thus an additional young child induces a negative effect on a household's off-farm participation. On the other hand, older children and the elders could take over some housework duties so that the adults can more readily work off the farm. Our results mirror the conclusions of previous studies that show the presence of the elders increases the probability of on- and off-farm work (ZHAO, 2003; PANG et al., 2004).

An increasing amount of unearned income leads directly to an increasing demand for leisure, and this in turn leads to a lower supply of family labor. Thus, a high amount of unearned income is expected to lower the probability of supplying labor off the farm.[47] Additionally, households that receive more transfers (*Transfer*) show a lower probability of hiring laborers. However, the magnitude of the amount of unearned income per capita (*Transfer*) turns out to be fairly small and statistically insignificant in the two labor participation estimations. Thus, these results lead us to conclude that the net unearned income has no significant impact on the households' labor participation decisions.

As mentioned in KNIGHT and YUEH (2002), APPLETON et al. (2002), and CHEN et al. (2004), social networks, such as the cadre household or membership in the Communist Party, may influence people's employment decisions and opportunities. KNIGHT and YUEH (2002), for example, find that Communist Party membership significantly raises the income of employees in China, though this study deals with urban labor markets. Furthermore, CHEN et al. (2004) show that the availability of social networks increases the likelihood of rural households taking non-farm jobs.

Following the existing studies, two dummy variables are applied to control for the households' social networks: One is if any family members hold the position of the village or township cadre (*Cadre*); the other is if any family members are members of the Communist Party (*Pmember*). The results demonstrate that being a cadre household does affect the household's probability of participating in hiring labor or off-farm labor markets in contrary directions, as does the membership of the Communist Party. Furthermore, the difference between the effects of the two social network variables on participation in either of the labor markets is quite large. In

[47] Moreover, comparative static results suggest that, assuming labor markets are constrained, the internal wage rate will increase with the amount of unearned income and farmers tend to provide less family labor off the farm.

the estimation of the off-farm participation decision, the negative and significant signs for the two social network variables mean that being a cadre (*Cadre*) or holding the membership in the Communist Party (*Pmember*) reduces the probability of supplying labor off the farm by 7.52% and 6.92%, respectively. Keeping all other factors constant, a household with a member serving as the cadre or holding membership in the Communist Party has an increased probability (5.33% and 6.96%, respectively) of hiring laborers. There is one reasonable explanation for these effects. Membership in the Communist Party or serving as the cadre might provide farm households with more favorable conditions in the farm business, such as better access to restricted inputs markets or preferential treatment in marketing farm products. These priorities undoubtedly lead to a higher profitability of farming and farm labor, respectively, and in turn reduce the likelihood of supplying family labor off the farm but increase the probability of hiring labor.

Farm characteristics Among the variables of farm characteristics, the accumulated value of assets per capita (*Asset*) and land per capita (*Landpc)* are found to be statistically significant. With an increase of assets by 1,000 Yuan per capita at the 1995 constant price, the probability of a household's hiring labor increases 1.21%, but the probability of off-farm employment decreases 1.70%. A relatively high capital stock indicates high labor productivity (low labor intensity) such that hiring on-farm labor might become relatively profitable. Consistent with a *priori* expectation, the probability of hiring laborers is positively and significantly correlated with the farm area per capita (*Landpc*). The marginal effects of farm size in the two participation equations indicate that enlarging the farm size per capita by 1 mu tends to increase the probability of the household's hiring labors by 0.66%. The marginal effect of land per capita (*Landpc*) turn to be statistically insignificant for the off-farm employment. Although the signs of marginal effects of other variables (*Livestock*) and (*Vegetable*) are positive in two participation equations, the estimated parameters of the two variables are not statistically significant. These make us conclude that production structure has implicit impact on households' participation decisions on either of the labor markets. The signs of the ratio of agricultural output to input value are as expected; however, the relatively small magnitudes of marginal effects indicate term of trade in farm business contributes little to the explanation of the behavior of households' labor market participation.

Village characteristics The employment pattern of family members gradually changed with the extension of reform and frequent adjustment of macroeconomic policies. Available evidence suggests an increase in migration and self-employment in response to a decline in local jobs due to the waning of TVEs (ROZELLE et al., 1999; DE BRAUW et al., 2002). Thus, the opportunity cost of farming for many

households undoubtedly rose. It is concerned that land left fallow could lead China losing the capacity to feed itself. Today the loss of arable land due to housing and industrial uses and the land degradation are serious issues in China (SMIL, 1993; LU and BERSTEIN, 1997).

LIN (1991) provides another solution, stating that the labor-saving cropping technologies should be adopted on given areas of land where the on-farm labor endowment of a household is decreasing. However, this could lead to the reduction of agricultural output because typically, the young, healthy and better educated rural laborers are more likely to take off-farm employment opportunities (DE BRAUW et al., 2002). Another potential option is to cut back on labor used on the farm, but it has been observed that agricultural labor was falling throughout the 1980s and 1990s (HUANG and ROZELLE, 1996; LIU and WANG, 2005). The reasonable solution is to sell or rent out land to those households with productivity advantages in farming. However, the former option will not work because the exchange of land is not allowed by the government under the current land right system. Thus, the latter-the functioning of land rental markets is interacted with the agricultural productivity and households' labor allocation.

Some literatures prove that a land rental market is emerging in rural China (BRANDT et al., 2002; KUNG, 2002). During the late 1980s, only 1.5% of cultivated land was rented. As recently as the mid-1990s, land rental activity was up to 3% of cultivated land (BRANDT et al., 2002). An empirical study provides vidence that without a reasonably competitive labor market, the allocation of labor resources depends on land endowment (BENJAMIN and BRANDT, 1997). More recent work shows that the emergence of the two factor markets, labor and land market may be interconnected (KUNG, 2002).

Thus, the following questions arise: Is the household making strategic, *albeit* constrained, labor allocation decisions, taking into account its land endowment? Do land rental activities trigger or constrain off-farm employment? What is the possible relationship between the hired labor market and the land rental market? To our best understanding, previous studies only focus on the link between land rental market and the off-farm labor market, but ignore the importance of the hired labor market. In this study, we ask if the land rental market is active, would the households be more likely to take advantage of off-farm employment opportunities by renting out land to those with a comparative advantage in agricultural production? If the gain from production on rented land is potentially higher than the cost of the land rental transaction and hiring labor to work on the plots of rental land, will the household

hire labor and rent in land simultaneously?[48] Given the active local land market, the households with off-farm employment opportunities may easily transfer land to others without worries of losing cultivated right of contracted land or being reassigned low-quality land in possible land reallocations. We expect that the incidence of land rental activity may prompt a household to integrate into labor markets. Thus, to eschew the endogeneity problem, the share of the household's rented out land to total households in the village (*L-rent*) is used as the proxy to represent the scale of the land rental market in the locality.

The results in Table 5.1 are consistent with the hypotheses. Households are more likely to participate in labor markets in villages with more land rental activities. The positive and significant signs of the variable representing land rental activities in villages mean that, holding all other factors constant, the probabilities of households' hiring laborer and off-farm employment will increase 9.31% and 13.32%, respectively if households are located in the village with 10% more land rental activity. Two important conclusions emerge at this point. First, land market integration significantly enhances households' participation behavior. Second, land rental activity has a greater impact on the off-farm labor market than it does on the hired-labor market, by comparing the magnitudes of the two marginal effects. These results also confirm the findings of the previous studies that the allocation of land and labor resources tends to optimize whichever factor market – land or labor – functions well (BENJAMIN and BRANDT, 1997).

The purpose of including the village characteristics is to examine the impact of the external labor market's function on the households' participation in labor market. Although it is difficult to cover all of the aspects of the external labor market, these data do allow us to pinpoint the effects of limited employment opportunities and potential earning on the households' participation decisions.[49] The unemployment rate (*Unemp*) is approximated as the proportion of the laborers in the whole village who did not work in the on- or off-farm sectors in the surveyed year. In addition, we try to more directly control for differences in external wage levels by using the annual net income per head of the respective villages (*Anipc*).[50] Furthermore, population density is used under the assumption that the greater population density

[48] The gain from rented land may include the profit from agricultural production and the economics of scale by renting the neighboring parcels of land (FLEISHER and LIU, 1992). Under HRS, the cultivated land is allocated to households under the egalitarian rules; thus, households generally own the use right on parcels of good and poor quality land. More details on the allocation of land are found in LIU et al. (1998).

[49] The impacts of the external labor market could also stem from the location of the village, which increases or decreases the transaction cost to access the labor market.

[50] Regional wage levels unfortunately are not reported in the dataset.

(*Popden*) will show much more economic activity and provide more employment opportunities, and hence increase the probability of finding off-farm employment. All of the village-level variables are exogenous to the individual households.

According to the results, as the unemployment rate (*Unemp*) increases within the local village, the availability of local off-farm employment decreases, which may encourage laborers to migrate in hopes of finding off-farm employment.[51] Estimated at the mean level, increasing the local unemployment rate by one unit percentage point will increase the probability of off-farm employment by 2.19%. There are two reasons for the negative and statistically significant effect of the unemployment rate on hiring laborers. First, in general, as the local off-farm employment is depressed agriculture production absorbs the labor by substituting potential hired laborers with family laborers. Second, even with the higher unemployment rate, it is still hard to find capable laborers for the on-farm work because the unemployed are generally the older and less educated, or have medical problems, or lack special skills.

The marginal effect of the average per capita income of the villages (*Anipc*) indicates that increasing the per capita income of the village by 1,000 Yuan improves the likelihood of household's hiring laborers by 2.00%. The positive marginal effect of village income (*Anipc*) on off-farm employment is consistent with the assumption that expected income gains motivate off-farm employment. Our results demonstrate that a relatively greater population density (*Popden*) increases the household's willingness to hire laborers. The effect of population density (*Popden*) can be decomposed into a positive effect due to more economic activities, and a negative effect due to more competitors searching for a job. Greater economic activity indicated by a higher population density might indicate relatively low transaction costs, particularly search costs associated with off-farm employment. Thus, relatively higher economic activities lead to relatively higher general and external wage levels such that working off-farm becomes more attractive and hiring on-farm labor becomes more costly. For a given unemployment rate, it might be easier for family members to find jobs off the farm in regions with high population densities because there are more off-farm employment chances. Conversely, there are more competitors looking for work in a higher population area, and thus it might be more difficult to find a job off the farm. Our results show

[51] According to the location, the off-farm employment could be categorized as local off-farm employment and migration. The information on the location of employment is missing from the data. The previous study concludes that local off-farm employment is prior to the possible migration for the better educated laborers. However, when local off-farm opportunities are limited, the migration increases (ZHAO, 1999).

that compared to the positive effect from active economic activities, the negative effect of population density induced by more job hunters dominates.

Time trend ZHANG et al. (2001) prove that the shifts of labor between off-farm and rural employment were dominated by the economic cycle of boom and recession in the early 1990s. Policy reforms from 1995 to 2002 were multi-dimensional. Therefore, including the time trend could reflect the possible effects of policy shifts and the institutional barrier, as well as the linear components of aggregated impacts of unobserved factors on rural labor markets and the mobility of rural laborers. Being careful to explain the policy and institutional effects, we found that the overall effects of the time variable present adverse directions in the two participation equations. The positive impact of the time trend on the decision regarding off-farm employment might be of particular interest, because the probability of a household engaging in off-farm employment increases yearly by 0.10% during the period of 1995-2002. This points to the conclusion that in spite of the structural reform and a general slowing of economic growth in the later 1990s, the allocation of laborers from the farm sector to the off-farm sector was continuous. Looking at the hiring labor equation, we find that the probability of hiring laborers decreases over time. This indicates that although there has been an increase in hiring of laborer in recent years, the hiring labor market is still thin in rural China.

5.2 Instrumented wages of hired laborers and off-farm workers

In the theoretical discussion in Chapter 3, hired labor demand and off-farm labor supply functions are regressed on the respective expected wages of hired laborer and off-farm workers, as well as other exogenous variables. According to the theoretical framework, the wages of hired laborer and off-farm employees are assumed to be endogenous evaluations of human capital at the household level, and thus the observed wages of hired laborer and off-farm employees could not be applied directly in the time allocation estimations. The problem of endogeneity could be readily solved by predicting the endogenous variables and applying them as the instrumented variables in the hired labor demand functions and off-farm labor supply functions.

Followed HUFFMAN (1980), the predicted wage of hired laborer is the marginal product of hired labor, which should be derived from the estimated parameter of hired labor input in agricultural production. Thus, prior to estimating hired labor demand, we first estimate an agricultural production function to generate the estimated parameter of hired labor. Here, the agricultural production facing Chinese rural households is assumed to be of the Cobb-Douglas (CD) type, which measures the technical relationship between the value of output and several inputs. The CD

function is used because of its simplicity, and the estimated parameter of each input coincides with the corresponding elasticity. The principal inputs are land, fertilizer, capital, expenditures on the intermediate inputs, and the time contribution in the unit of days with respect to family members and hired labor under the assumption of imperfect substitutability of family labor and hired labor.

For comparison, this production function is first estimated with a random-effect specification that assumes the unobservable effects that are incorporated into the error term are uncorrelated with the independent variables. To be consistent with the analytical method, this production function is fitted again with a fixed-effects specification, controlling for the unobservable effects correlated with the independent variables. The choice of the appropriate specification relies on a Hausman test of the null hypothesis of a random-effects model in comparison to the alternative hypothesis of a fixed-effects model. The resulting Chi-square statistic of 32.69 with 12 degrees of freedom strongly rejects the random-effects model at the 1% significance level, suggesting that the unobserved factors are correlated with the explanatory variables in the estimation of the households' agricultural production. The agricultural production with the fixed-effects specification yields elasticities of family labor (*Family-l*) of 0.3146 and hired labor (*Hired-l*) of 0.0433 in Table 5.2. Both estimates are statistically significant at the level of 1%.

Looking at the elasticities of hired labor and family labor, it is noted that labor, as the traditional physical input, still have great impacts on the value of output, holding other inputs constant. The estimated elasticities are quite close to the results of LIU and WANG (2005) as well as BRÜMMER et al. (2006). These results also indicate that, on average, farms in Zhejiang province do not experience hidden unemployment.[52] Based on the elasticity, the marginal product of hired labor is calculated by multiplying it with the average income of hired labor deflated at the 1995 constant price. The formula used for the calculation is as follows: $MP_{Hired-l} = \beta_{Hired-l} \times AP_{Hired-l}$, while the average daily income of hired labor ($AP_{Hired-l}$) could be obtained by dividing the total value of agricultural production by the total working days of hired labor in a household.

[52] Estimates of agricultural surplus labor at the national level vary from 30% to 40% of the agricultural labor force. One main advantage of this micro-level database is the avoidance of possible mismeasurement of rural employment in official statistics (BHATTACHARYYA and PARKER, 1999).

Table 5.2: Production function estimation and wage function for households with off-farm workers

Production function		Off-farm wage function	
Dependent variable	*Ln(Value of output)*	***Dependent variable***	*Ln(Wage-off-farm worker)*
Explanatory variables	Fixed-effects estimation	*Explanatory variables*	Fixed-effects estimation
Ln(Land)	0.1609***	*Element*	0.1808
	(5.16)		(1.13)
Ln(Family-l)	0.3146***	*Second*	0.2980*
	(11.73)		(1.67)
Ln(Hired-l)	0.0433***	*High*	0.2076
	(2.67)		(0.92)
Ln(Capital)	-0.0063	*Skill*	-0.0377
	(0.39)		(0.25)
Ln(Fertilizer)	0.0262	*M-labor*	0.0740
	(1.11)		(1.45)
Ln(Intermediates)	0.4397***	*F-labor*	-0.1475***
	(29.01)		(3.83)
Element	-0.2610**	*Cadre*	0.0521
	(2.34)		(0.45)
Second	-0.1686	*Pmember*	0.3856***
	(1.35)		(2.57)
High	-0.4426***	*Unemp*	-0.2770
	(2.66)		(1.01)
Skill	-0.0267	*Popden*	-0.8529***
	(0.21)		(3.74)
Cadre	0.1993***	*Anipc*	0.0658***
	(2.58)		(2.88)
Pmember	-0.3152***	*Time*	0.0361***
	(2.83)		(3.51)
Constant	3.6649***	*Constant*	3.9990***
	(15.34)		(13.13)
F-test (12, 1512)	234.75	*F-test (12, 2242)*	10.87
Within R^2	0.6401	*Within* R^2	0.0550
Between R^2	0.8469	*Between* R^2	0.0235
Overall R^2	0.7893	*Overall* R^2	0.0112
Observations	1975	*Observations*	2717

Note: T-values in parentheses, ***, **, and * indicate statistical significance at 1%, 5% and 10% levels, respectively.

Using the annual mean of daily output results in a year, marginal products of hired labor in each household that hire labor are presented in column 3 of Table 5.3. The marginal product of hired labor is distributed around a mean of 26.29 Yuan per day. The calculated returns to hired labor, entangled with the unobservable internal

factors within and across households, differ dramatically at the household level by controlling for other inputs such as land, capital, and technology. Tabulating the mean of the marginal product of hired labor against year, it is found that in the surveyed years, the mean of the marginal product of hired labor presents the wave pattern with fluctuation between 13.91 and 38.08 Yuan per day. The means of the marginal product of hired labor later in the 1990s are all larger than 25 Yuan per day except the year of 1998, while in the first two years of 2000, this value dropped nearly 20 Yuan per day. So the temporal development shows no clear trend.

Similarly, wage rates of off-farm workers are assumed to be endogenous to the amount of off-farm work (HUFFMAN, 1980). Thus, the off-farm wage functions often are modelled and used in the labor supply estimation as weakly exogenous variables (HUFFMAN and LANGE, 1989; SUMNER, 1982). The off-farm wage function is directly estimated with these data in the log-linear form, and a consistent test of sample selection bias is applied (HECKMAN, 1974, 1979; SUMNER, 1982). Selection bias is rejected for these data. Thus, the average wage of off-farm workers at household level, which is calculated from the total off-farm income from non-agricultural activities divided by the total off-farm working days, is estimated by the traditional techniques for the panel data. The natural logarithm form of this resulting variable, *Wage-off-farm workers,* is regressed on the education attainment and skill characteristics of the household and gender composition of the family's work force, controlling for social networks and local labor market features. Here, the farm characteristics are excluded from the off-farm wage estimation under the assumption that off-farm wages are not determined by farm characteristics. Both random-effects and fixed-effects specifications are fitted for the off-farm wage function. The Chi-square value of the Hausman specification test is 32.69 with 12 degrees of freedom, strongly rejecting the null hypotheses at the 1% significance level that the unobservable effects are not correlated with the independent variables. This suggests that the fixed-effects specification is preferable because it controls for the correlation of unobservable effects with the independent variables.[53]

[53] The adjusted R^2 is comparatively small because the off-farm wage is aggregated at the household level. Comparing the within-R^2 and the between-R^2 for households' off-farm wage function points to a better explanation of the variation in off-farm wage within households over time than between households. The within-R^2 is similar as the estimation on the wage of off-farm female laborers by HUFFMAN and LANGE (1989).

Table 5.3: Estimated return to labor

Year	*Marginal product of hired labor* [a] (Yuan/day)			*Average wage from off-farm occupation* [b] (Yuan/day)		
	N	Mean	Std. Dev.	N	Mean	Std. Dev.
1995	51	33.98	(49.59)	258	40.72	(29.43)
1996	46	27.15	(56.76)	352	44.81	(26.90)
1997	46	31.86	(52.46)	349	46.21	(30.00)
1998	50	13.91	(27.89)	348	48.06	(30.16)
1999	68	38.08	(110.91)	367	51.70	(33.08)
2000	69	25.15	(53.58)	366	55.37	(35.04)
2001	51	19.14	(49.66)	327	65.81	(37.47)
2002	61	19.28	(39.62)	350	63.98	(41.16)
1995-2002	442	26.29	(61.98)	2717	52.37	(34.26)

Notes: [a] The marginal product of hired labor in agriculture is calculated by multiplying the elasticity of hired labor estimated from the production function (Table 5.2) with the average income of hired labor as $MP_{Hired-l} = \beta_{Hired-l} \times AP_{Hired-l}$. [b] The average income from off-farm occupations for households that supply labor off-farm is the predicted wage from the off-farm income function (Table 5.2).

The results, shown in Table 5.2, support the general hypothesis that educational attainment is positively related to daily earnings, although only the coefficient of secondary education is statistically significant (HUFFMAN and LANGE, 1989; SUMNER, 1982; YANG, 1997a). Increasing the ratio of family members who finish secondary school (*Second*) by 10% will, *ceteris paribus*, significantly raise the household's average off-farm wages by 2.98% at the traditionally accepted level. Elementary education (*Element*) and high schooling education (*High*) have similar effects: 1.81% and 2.07%, respectively, when increasing the ratios of family members who finished elementary education (*Element*) and high schooling education (*High*) by 10% separately. These results, when compared to the rate of illiteracy, indicate that secondary schooling is more important than elementary and high schooling to the earnings of off-farm workers. An additional male laborer in a household increases the off-farm wage level by 7.40%, which implies that the male laborer plays an important role in safeguarding the household's off-farm income by supplying a minimum amount of off-farm work. The addition of a female laborer decreases the average wage of off-farm employees by 14.75%. The strongly negative estimate of female laborers points indicates that an earning difference by gender still exists. Being a cadre household increases the average off-farm wages by 5.21%, and party membership significantly and positively affects off-farm earnings by increasing the off-farm wage 38.56%.

Although wages are expected to be rigidly sticky, the off-farm wage at the household level will be discounted approximately 27.70% if the unemployment

rate in the local village increases 1%. This implies that when the local labor market experiences unanticipated negative shocks it shows a decline in real wage rates (TOKLE and HUFFMAN, 1991). The size of the coefficients of village characteristic variables, including yearly net income per capita (*Anipc*) and population density (*Popden*), implies that the locality has still a great and statistically significant influence on off-farm wages. Given the rise of annual net income per capita in the village for 1,000 Yuan per capita, the off-farm wage will increase by 6.58%. This indicates that the internal wage of family members fluctuates in the same direction as the external wage level. The positive and statistically significant coefficient of the time trend indicates that during the period of adjustment of the rural labor market, the real off-farm wage presents an increasing trend with an average growth rate of 3.61% per year.

From Table 5.3, the expected average wage of a household obtained from the wage function is 52.37 Yuan per day, which is twice the marginal product of hired labor. This significant difference demonstrates a continuing segmentation between agriculture and non-agricultural labor markets (COOK, 1999; FLEISHER and YANG, 2003). During 1995-2002, the gap between the lowest and highest average off-farm wages was around 25 Yuan per day.

It is noted that the average income per capita (*Anipc*) at the village level, as a demand side variable, acts as an exogenous instrument. This is chosen because it is hypothesized that income will affect the off-farm income level (which it does; see Table 5.2) but will not affect the dependent variable of the off-farm labor supply equations (Table 5.4), except through its effect on the wage. Because the village-level income variable is a demand side variable, it should not have a direct effect on supply side decisions. A similar argument is presented by BOWLUS and SICULAR (2003), who state that the inclusion of location characteristics in conjunction with time dummy variables and fixed-effects makes further price variables as instruments redundant.

5.3 Hired labor demand functions

As noted in the theoretical discussion in Chapter 3, interesting and important questions that arise from the estimations are how households allocate their labor time between on- and off-farm work and how this allocation of labor time develops. To answer these questions, a general methodology is constructed to estimate the hired-labor demand and off-farm labor supply functions. Research on labor supply analyzes the off-farm time allocation of the operator or simultaneity of time allocation between the on- and off-farm work of the operator and spouse (HUFFMAN, 1980; SUMNER, 1982; HUFFMAN and LANGE, 1987; TOKLE and HUFFMAN, 1991). However, it is believed that new insight may be gained by considering the

labor demand of hired labor in household production. Hired labor is a type of substitute, *albeit* an imperfect substitute, for family labor. Thus, in an imperfect labor market supported by the previous labor participation results, the demand for hired labor in a household involves the time allocation of the family members between on- and off-farm works. The marginal productivity of hired labor may affect the household's off-farm supply decision by changing the reservation wage through efficiency effects on household production. In the following estimations, working days of hired labor and the family's off-farm labor are regressed on the respectively instrumented expected wages of hired labor and off-farm employees and other exogenous variables.

As mentioned in Section 5.2, the sample selection bias did not appear in these data.[54] Thus, the hired labor demand functions are estimated by limiting the sample to individual households for which $D_h = 1$ in Section 3.1.2 while the traditional econometric techniques are applied to the hired labor demand functions. In Table 5.4, hired labor demand functions are estimated separately by pooling the observations for households that only hire labor (column 1, *h*) and for households that hire and supply labor simultaneously (column 2, *sh*).[55] The demand functions of hired labor for the two types of households are estimated separately in the following reasons. First, according to the theoretical analysis, the predicted wages of off-farm workers will make an impact on the hired labor demand for households in both markets (*sh*), but they will have no influence on the households that exclusively hire labor (*h*). Second, it is assumed that the sensitivity of hired labor demand to an array of economic and statistical variables would vary for the two kinds of households. In hired labor demand functions, the log form of working days of hired labor is used as dependent variables. The determinants of participation decisions are also included as independent variables and the predicted wages of hired laborers and off-farm workers are incorporated into the demand functions of hired labor.

Hired labor demand function is estimated for households that only hire on-farm labor (*h*) by the method of ordinary least squares (OLS). The adjusted R^2-value amounts to 0.6293 for households that exclusively hire labor (*h*). It indicates that the included explanatory variables explain more than half of the variation in hired farm labor demand, although unobservable factors beyond the explanatory

[54] Once sample selectivity bias occurs in the data, we should address the labor allocation's conditional nature, which is whether the household hires labor or not and whether the households supply labor off the farm or not. The households' selectivity adjustment is presented in Appendix A.

[55] We cannot estimate the hired labor's demand function for households that only hire labor by fixed-effects or random-effects specification for the panel data because of the small number of observations. Therefore, we estimate it by pooling the observations.

variables also affect the estimation of hired labor demand (BOWLUS and SICULAR, 2003). For comparison, we fit the hired labor demand function with random-effects or fixed-effects procedures for households in both markets (*sh*) to test the possible correlation between the unobservable effects and the independent variables. The Chi-square statistic of 46.68 with 21 degrees of freedom is statistically significant at the 1% level; thus the fixed-effects specification is explains the results. The measure of goodness of fit with an overall R^2 is 0.2839 for households that participate in both markets (*sh*). In this estimation, comparing the within-R^2 and between-R^2 gives a better explanation of variation in hired labor demand within households over time rather than between households.

It is also noted that the signs of the independent variables in the hired labor demand function and the corresponding participation function indicate that the same independent variables may have adverse effects on the participation decisions and hired labor demand. Furthermore, some estimated parameters associated with the independent variables may significantly impact the households' participation to hire labor but may not significantly contribute to the demand for hired labor in working days, and *vice versa*. This confirms that to a large extent, the matter of households' labor participation behavior as well as demand and supply of labor are different components in the study of labor markets (BENJAMIN et. al., 1996).

Wage Effects Given the log-linear form of hired labor working days to the internal wages, the estimated slope parameters of wage variables are the wage elasticity. The coefficients of the hired labor wage (*Wage-hired labor*) are statistically significant and negative in the two labor demand estimations. This implies that an increase in the hired labor wage (*Wage-hired labor*) leads to a decreasing demand for hired labor days and a possible substitution between hired and households' own labor. Specifically, the negative effect of hired-labor wages on the households' demand for hired labor could be explained in two ways: The cost of hiring labor increases with the rise in hired labor wages, which leads to a decreasing demand for hired labor in working units (hours, days, or weeks, etc.); or, the increased cost of hiring labor that results from increased unit wages may induce the household to use its own labor resources to fully or partially substitute for the contributed time of hired labor.

The coefficients of hired labor wages are -0.2900 and -0.3657, implying that an increase of 1% in the internal wages of hired laborers is followed by a decrease in the hired labor demand by 0.29% and 0.37% for households that solely hire labor (*h*) and households in both markets simultaneously (*sh*), respectively. As expected, households that participate in both markets (*sh*) are more flexible to the shift in the internal wages of hired laborers and show a higher elasticity as suggested by the

absolute magnitudes of the estimated coefficients.[56] This confirms the theory that agents are more flexible if the number of choices in the labor market increases. The positive impact of the off-farm wage (*Wage-off-farm worker*) on the demand for hired labor for households in both markets (*sh*) means that the possibly higher income from off-farm employment encourages households to demand more hired labor service. This indicates that an increase of 1% in the wages of off-farm workers is followed by an increase of 0.82% in the average hired labor demand. Though the impact of off-farm wages (*Wage-off-farm worker*) on hired labor appears to be statistically insignificant in this estimation, the positive sign of the coefficient still provides evidence that the hired labor is a substitute for the off-farm workers, *albeit* an imperfect substitute.

Household characteristics Given the log-lin form of hired labor working days to the independent variables (except the wage variables), the estimated slope parameters measures the constant proportional change or relative change in the working days of hired laborers for a given absolute change in the value of the independent variables. For households that only hire labor (h), the elementary, secondary, and high-schooled households are more likely to demand much more hired labor service than the reference group (the illiterate workers). For households in both labor markets (*sh*), increasing the ratio of family members who finished elementary, secondary, and high school by 10%, the demand for additional hired labor is reduced by 7.49%, 5.79%, and 0.45%, respectively. That the effects of education attainment on the working days of hired laborers are different in the two estimations indicate that the two kinds of households have different demand for hired labor because the educated family members perform differently. Data yield evidence that households with skilled labor tend to demand more working days from hired laborers for households that only hire laborers (*h*) but less for households in both markets (*sh*), compared to the households without skilled laborer.

Table 5.4: Estimated results of labor demand and supply functions

	Labor demand functions		**Labor supply functions**	
Dependent variable	*Ln(hiring-in days)*		*Ln(off-farm working days)*	
Households' participation	*h*	*sh*	*s*	*sh*
Explanatory variables	OLS estimation	Fixed-effects estimation	Fixed-effects estimation	Random-effects estimation
Wage				
Ln(WAGE-hired labor)	-0.2900**	-0.3657***		-0.0692***
	(2.68)	(11.24)		(5.22)

[56] The difference of the effects of hired labor wages on hired labor demand between households that only hire labor (*h*) and those in both markets (*sh*) is significant at 5% using adjusted Wald Test.

Table 5.4: Continued from previous page

	Labor demand functions		**Labor supply functions**	
Dependent variable	*Ln(hiring-in days)*		*Ln(off-farm working days)*	
Households' participation	*h*	*sh*	*s*	*sh*
Explanatory variables	OLS estimation	Fixed-effects estimation	Fixed-effects estimation	Random-effects estimation
Ln(WAGE-off-farm worker)		1.3369	-0.2134	1.3355***
		(0.83)	(0.62)	(3.74)
Household characteristics				
Element	0.3832	-0.7493	-0.1888	-0.2603
	(0.40)	(0.78)	(1.20)	(1.14)
Second	2.2846**	-0.5787	0.0672	-0.4356*
	(2.24)	(0.54)	(0.35)	(1.81)
High	0.3236	-0.0451	0.0131	0.0112
	(0.22)	(0.04)	(0.06)	(0.04)
Skill	2.1706	-0.1125	0.1048	0.3631*
	(1.33)	(0.15)	(0.74)	(1.91)
M-labor	0.1490	0.1091	0.2939***	0.1390*
	(0.22)	(0.35)	(5.51)	(1.86)
F-labor	-0.3026	0.1898	0.2083***	0.5383***
	(0.57)	(0.60)	(3.38)	(6.64)
Dependent	-0.3477	-0.0679	0.0405	0.0622
	(1.14)	(0.40)	(1.39)	(1.34)
Transfer	-0.1121	0.0054	-0.0153**	-0.0055
	(0.81)	(0.14)	(2.43)	(0.33)
Cadre	0.1296	-0.0318	0.0270	-0.2727*
	(0.14)	(0.07)	(0.24)	(1.93)
Pmember	1.5568***	-0.7013	0.0742	-0.4734***
	(1.78)	(0.89)	(0.36)	(2.82)
Farm characteristics				
Asset	1.4115*	0.0723	-0.0175	-0.0233
	(1.95)	(0.91)	(0.66)	(0.85)
Landpc	-0.0106	-0.0212	-0.0117**	-0.0088*
	(0.29)	(0.50)	(1.96)	(1.87)
Livestock	-0.0068	0.0684**	-0.0017	-0.0223**
	(0.11)	(2.47)	(0.30)	(2.29)
Vegetable	2.3473*	0.0190	0.0747	0.0588
	(1.79)	(0.06)	(0.70)	(0.39)
O/I-ratio	-0.0004	0.0055*	-0.0009**	-0.0016
	(1.09)	(1.93)	(2.18)	(1.31)
Village characteristics				
L-rent	-2.6531	-0.2901	0.1764	-0.2257
	(0.79)	(0.51)	(1.17)	(0.83)
Unemp	0.7503	0.7657	-0.7173**	-0.1059
	(0.31)	(0.62)	(2.29)	(0.33)
Popden	0.4301	2.6143	0.0003	1.0418***
	(1.32)	(1.47)	(0.00)	(3.77)

Table 5.4: Continued from previous page

	Labor demand functions		**Labor supply functions**	
Dependent variable	*Ln(hiring-in days)*		*Ln(off-farm working days)*	
Households' participation	*h*	*sh*	*s*	*sh*
Explanatory variables	OLS estimation	Fixed-effects estimation	Fixed-effects estimation	Random-effects estimation
Time trend				
Time	0.1419	-0.0218	0.0280	-0.0655***
	(1.15)	(0.25)	(1.39)	(2.59)
Constant	1.2258	-3.0245	5.9096***	-0.3803
	(1.00)	(0.46)	(4.15)	(0.25)
F-test (df)	4.74 (20, 24)	11.63 (21, 226)	7.02 (20, 1847)	
Wald χ^2 (df)				441.33 (20)
Adj- R^2	0.6293			
Within- R^2		0.5194	0.0706	0.0592
Between- R^2		0.2277	0.2565	0.4070
Overall- R^2		0.2839	0.2009	0.2608
Observations	45	397	2320	397

Note: T-values in parentheses, ***, **, and * indicate statistical significance at 1%, 5% and 10% levels, respectively.

With respect to the variables of family demographic composition, adding one more female laborer, the intensive use of hired laborers decreases 30.26% in households that only hire labor (h). This provides evidence that female labor in a household is a substitute for hired labor. Households with one more dependent decrease the demand for hired labor. A possible reason is that the dependent variable is aggregated of young children and elders, and thus their individual effects on the hired labor demand cannot be fully reflected as the parameter of the aggregated variable. The fact that net transfers (*Transfer*) are small and not robust in both estimations suggests that the intensity of hired labor is not greatly affected by the family's external income.

Now we turn to the variables controlling for the social networks. When a household remains a cadre household, the working days of hired laborers increase 12.96% among households that solely hire labor (*h*) but almost not at all among households in both markets (*sh*). The coefficients of party membership (*Pmember*) indicate that households with a party member (*Pmember*) increase the service of hired labor dramatically among those households that hire labor (*h*), but decrease that for households in both markets (*sh*) by about 70%, compared to the households without a party member.

Farm characteristics All of the farm characteristics included in the econometric analysis which contribute significantly to the explanation of labor demand are positive. In particular, productive assets per capita (*Asset*) increase labor demand significantly among households that only hire farm labor (*h*). Farm structure also makes an impact on the demand for hired labor. Households that only hire labor (*h*) need more working days of hired labor if they expand the vegetable production. A 1% increase of the quantity of livestock output (*Livestock*) by households in regime *sh* raise hired labor demand by 7%. Increasing relative agricultural prices (*O/I-ratio*) also has a positive effect on the use of hired labor, but the effect seems to be very small: The demand for hired labor service is raised by 0.06%, with an increase in the ratio of output to input values (*O/I-ratio*) of 10% for households in regime *sh*. Although it is hard to narrow down the exact use of hired labor if a household participates in both markets (*sh*), these results indicate that specialization in agricultural production has a significant effect on labor demand. The findings of household and farm characteristic variables support the hypothesis that the sensitivity of hired labor demand to an array of statistical variables differs between households that only hire labor (*h*) and those in both markets (*sh*).

Village characteristics and time trend Table 5.4 also shows that the incidence of land rental transactions (*L-rent*) in the local village affects the intensive use of hired labor for households that only hire labor (*h*) or those in both markets (*sh*). Examining the coefficients, it is found that increasing the proportion of households renting in land by 10% reduces the demand for hired labor by more than 25% among households in regime *h* and by 2.9% among households in both markets (*sh*), respectively. Households in localities with more land-rental activities have a lower demand for hired labor. This reaction, which was shown in the two estimations, is consistent with the view that the time allocation of a household is highly related to the development of land rental markets. That is, the emergence of land rental markets in recent years may have played a role in rural households' labor allocation.

Other variables that control for the external labor markets, including unemployment rate (*Unemp*) and population density (*Popden*) are found to affect the demand for hired laborers. If the unemployment rate increases by 10% in the local village, the working days of hired laborers will increase by 7.5% among households that solely hire labor (*h*) and among households in both markets (*sh*). This may be because the higher unemployment rate may cause a reduction in the wage rate for hired labor, and thus the households tend to demand more hired labor at this comparatively lower cost. The larger and positive effect from population density (*Popden*) on demand for hired labor indicates that the demand for hired labor in working days is more highly correlated to labor markets with more economic activities than those

with few economic activities. It should be noted that in 1995-2002, although the participation of households into hiring labor is decreasing over time by 0.08% per year, the demand for hired labor is increasing by 14.19% among households that only hire labor (*h*) but decreasing more than 2% per year among households in both markets (*sh*), if the households has already been hiring labor.

5.4 Off-farm labor supply functions

In Section 5.1, the data provide evidence that the households' participation decisions regarding hiring labor and off-farm employment are nonseparable, which implies that the rural labor market in Zhejiang province is still imperfect. Thus, the labor allocation off the farm is conditional on the households' participation behavior in the labor market. In this section, the labor supply functions are estimated separately for households that only provide off-farm labor (*s*) and households that hire and supply labor simultaneously (*sh*). The aim of the empirical analysis is to answer two questions: Is the households' labor supply sensitive to the internal wage of off-farm workers and hired labor? What are the determinants of households' time allocation off the farm, besides the internal wages? To answer these questions, the log form of working days of off-farm workers at household level is regressed on the internal wages of hired labor and off-farm workers, and the exogenous variables, which represent the characteristics of household and farm, the features of local labor market, and the time trend.

Wage effects As mentioned earlier, the sample selection bias is rejected for this dataset. Thus, the traditional econometric techniques for the panel data are used in the following off-farm labor supply functions while limiting the sample to individual households for which $D_s = 1$ in Section 3.1.2. The off-farm labor supply functions are estimated separately for households in regime *s* and regime *sh* because the theoretical analysis shows that the predicted wages of hired labor make an impact on the off-farm labor supply for households in both markets (*sh*) but they have no influence on the households that only supply labor (*s*).

The two labor supply functions are estimated by random-effects and fixed-effects specifications. Subsequently, Hausman specification tests are conducted to be of the null hypothesis of a random-effects model in comparison to the alternative hypothesis of a fixed-effects model. For households that only supply labor (*s*), the Hausman specification test yields a statistically significant Chi-square result of 57.06 with 20 degrees of freedom. Therefore, we strongly reject the random-effects specification, suggesting that the unobservable effects are dependent on the independent variables. For households in both markets (*sh*), the results of the Hausman test do not reject the random-effects model with the value of Chi-square

test of 32.25. Thus, a random-effects model accurately characterizes the relationship between the working days of off-farm workers and the explanatory variables for households in both markets (*sh*).

Turning to the estimations of households' labor supply functions, the determinants of participation decisions are also included as independent variables, and the predicted wages of hired labor and off-farm workers are applied as instrumented variables in estimations of the working days of off-farm workers. Results in Table 5.4 show a negative but insignificant impact by the internal wages of off-farm workers (*Wage-off-farm workers*) on the labor supply for households that solely participate in off-farm labor markets (*s*). This indicates that households that exclusively supply off-farm labor (*s*) do not respond significantly to off-farm wage changes. This is consistent with findings by LASS and GEMPESHAW II (1992) as well as FINDEIS and LASS (1994) which obtain statistically insignificant uncompensated wage elasticities by analyzing U.S. farm household data.[57] Possible interpretation is that decreasing off-farm wages from non-agricultural activity, which is obviously much higher than the marginal product of labor in agriculture as observed, will still motivate migration out of agriculture or a reduction of leisure for certain households.

Increasing the wages of off-farm workers (*WAGE-off-farm worker*) by 1% will increase the average labor supply by 1.34% for households participating in both markets (sh). The estimated wage elasticity is larger than unity and points to an elastic reaction by households to changes in off-farm earnings.[58] For these households, the hired labor wage is negatively and significantly related to the labor supply of family members in off-farm work. Specifically, increasing the hired-labor wage (*WAGE-hired labor*) by 1% decreases the off-farm labor supply by 0.07%. Again, this confirms the interdependence between families and hired labor. High wages that must be paid to external laborers could convince household members stay on farm rather than work off the farm.

Household characteristics As can be seen from Table 5.4, compared to the illiterate group, secondary (*Second*) and high schooling (*High*) make positive impacts on the off-farm time allocation for households that only supply off-farm labor (*s*). Holding other variables constant, increasing the proportions of members

[57] However, results in previous studies show no clear picture. JACOBY (1993), for example, finds significant own wage elasticities for the labor supply of Peruvian farm households. On the contrary, ROSENZWEIG (1980) obtains a negative elasticity estimating Indian male farmers' labor supply.

[58] The difference of the effects of off-farm worker wages on off-farm labor supply between households that only supply labor off the farm (*s*) and those in both markets (*sh*) is significant at 5% using adjusted Wald Test.

with secondary schooling (*Second*) or high schooling (*High*) by 10%, increases the off-farm labor supply by about 6.72% and 1.31%, respectively. The negative coefficient of elementary schooling indicates that households with more elementary members allocate less labor service to off-farm activities. For households in both markets (*sh*), those with more laborers with high schooling allocate more labor off the farm. Increasing the proportion of family members with high schooling separately by 10% increases the working days of off-farm workers by 1.12%. Elementary and secondary schooling have negative effects on supply off-farm labor. Combined with the results for households in regime *s*, our results mirror the conclusion by DE BRAUW et al. (2002) and ZHAO (2003) that the more educated laborers are more likely to gain employment off the farm and the effect of schooling is nonlinear to the off-farm labor supply in the imperfect labor market. The skill coefficients are 0.1048 and 0.3631 in two off-farm labor supply functions, indicating an elastic response of off-farm labor supply to the change of the proportion of skilled labors. That is, increasing the proportion of skilled laborers by 10%, will increase the off-farm labor supply by 10.48% and 36.31% respectively for the two kinds of households. Thus, from the perspective of economic development, the investment in vocational education is desirable to facilitate labor mobility.

As expected, the coefficients of the male and female laborers (*M-labor* and *F-labor*) are positive for the off-farm labor supply in the two estimations. For households in both markets (*sh*), a larger and significant effect is attained from female laborer than male laborer. This could be explained from two aspects: Either directly though off-farm participation of women or indirectly through substitution of male laborer in household activities. Households with one more female laborer allocate more off-farm labor by 53.83% or 267 days at the mean. This implies that with additional female laborer, the household will supply another full-time or more than one part-time off-farm worker. Adding another male laborer to a household, on average, increases the labor supply off the farm by about 14% or 69 days. This implied that with additional male laborer, the household will only supply another part-time off-farm worker. Among households that exclusively supply labor off the farm (*s*), the coefficient of male laborer increases in magnitude. With an additional male in a household, the off-farm labor supply increase 29.39% or 133 days at the mean by holding other variables constant, while with an additional female laborer, the household's off-farm labor supply increases 94 days at the mean. These results indicate labor composition by gender is an important factor in determining the households' labor allocation by controlling for other household and farm characteristics.

The negative and significant coefficient of net transfer per capita (*Transfer*) in column 3 of Table 5.4 demonstrates that increasing the net transfer by 1,000 Yuan per

capita will decrease the households' off-farm labor supply by 1.53%. An increasing amount of unearned income leads directly to an increasing demand for leisure, and this in turn leads to a lower supply of family labor. Assuming labor markets are constrained, the internal wage rate increases with the amount of unearned income and farmers tend to provide less family labor off-farm. This result provides strong support for the analysis in the comparative static models.

When households remain cadre households, they not only significantly reduce the likelihood of participating in the off-farm labor market, but they also contribute less to the off-farm labor service. By being a cadre household, the off-farm working days are reduced by about 27.27% for households in both markets (*sh*). When any family member is an admitted to be party member (*Pmember*), the off-farm labor supply significantly decreases by approximately half among households participating in both markets (*sh*). For households that only supply labor (*s*), the coefficients of party membership (*Pmember*) and cadre (*Cadre*) are insignificant. These results are consistent with the hypothesis that cadre leadership or party membership provides rural households more favorable conditions in the farm business, and thus undoubtedly reducing the labor supply for off-farm activities.

Farm characteristics A larger accumulation of production assets per capita (*Asset*) and more land per capita (*Landpc*) reduce the off-farm labor supply. For households that exclusively supply labor off the farm (*s*), accumulating the endowment of production assets per capita (*Asset*) by another 1,000 Yuan per capita decreases the off-farm labor supply by 1.75%. Expanding the cultivated land (*Landpc*) by one mu per capita decreases the off-farm labor supply by 1.17%. For households in both markets (*sh*), the off-farm labor supply decreases 0.88% following the expansion of land one mu per capita (*Landpc*). Adding to the accumulation of production assets by 1,000 Yuan per capita (*Asset*) decreases the households' off-farm supply 2.33%. These figures indicate that increasing the production endowment, especially the capital and land, help households adjust their time allocation in the labor market to achieve equity outcome. Furthermore, households in both markets (*sh*) face less constraint due to asset accumulation per capita, indicating a functioning labor market. The empirical results indicate that expanding the husbandry (*Livestock*) reduces both the off-farm participation rate (see Table 5.1) and off-farm labor supply, especially for the households that are in both markets (*sh*). Increasing the term of trade (*O/I ratio*) significantly and negatively influences the off-farm labor supply. This indicates that the time allocation of households in labor markets is influenced by the development of other factor markets.

Village characteristics and time trend The results in Table 5.4 indicate the integration of the land rental market in the locality (*L-rent*) adversely influences

the off-farm supply for households' supplying off-farm labor (*s*) and those in both markets (*sh*). This could be because households in both markets (*sh*) have fewer constraints to access the labor market, and thus they could adjust the time allocation on the off-farm labor supply and hired labor simultaneously, as the land rental market improves. Households in regime *s*, would like to supply more labor off the farm with the improved land rental market.

The higher unemployment rate (*Unemp*) significantly reduces the off-farm labor service among households that only supply the labor market (*s*). This makes sense because when unemployment rates are high, the policy makers shorten the individual working time to provide more employment opportunities. For households in both markets (sh), those located in populated-dense villages (*Popden*) provide more off-farm labor. This supports the general idea that more economic activity demands more labor. The empirical results demonstrate that the off-farm labor supply presents an increasing trend for households that solely supply labor (*s*) and a decreasing trend for households in both markets (*sh*). The coefficients of time trends indicate the off-farm labor supply increases at 2.80% for households that exclusively supply labor (*s*) and decreases at 6.55% for households in both markets (*sh*).

5.5 Dynamics of households' participation in labor markets

The above empirical approach assumes a kind of stead-state of labor participation; that is, the process in which households generate the labor participation decision has reached a point of internal equilibrium. Specifically, the probability of a household's participation in the hired labor or off-farm labor markets should remain unchanged, even with the passing of time. However, in this data, it is observed that rural households did not remain in the same labor markets state during the surveyed period but moved among the different labor market states. This implies that the process of the labor participation decision is not a stable equilibrium but evolves over time. Thus, in the following part of empirical study, a hazard framework is applied to analyze the length of time that an rural household remains in a regime of the labor market on the probability of this household moving to another regime in the context of an economy under transition. Another purpose of this empirical analysis is to identity the factors related to the process of the household's participation shifting among the labor market regimes.

To capture the dynamics that appear to typify China's rural labor market, we turn to the labor economics literature outside of China, which has a rich history of studying spells of employment and unemployment. For example, the works assess the individual behavior during unemployment spells (SUEYOSHI, 1995; ADDISON and PORTUGAL, 2003; ROED and NORDBERG, 2003), the probability of a return to employment (CHAN and STEVENS, 2001), the transition between employment

categories (BRADLEY et al., 2003), the influence of unemployment insurance on the duration of unemployment (LIGHT and OMORI, 2004), the probability of labor force transition in the joint decision process of the partners (BLAU and RIPHAHN, 1999), the job turnover by gender (MEITZEN, 1986; LIGHT and URETA, 1992), and finally to model the search of employers (BURDETT and CUNNINGHAM, 1998).

The following study investigates the choice among different labor market participation states of Chinese rural households. In particular, we focus on the probability of transition between such states which are closely related with the length of time spent in the original participation state as stated in Table 3.1. In the sampled data, the information available on the duration is the participation behavior of a household that occurred during a one-year period. This highly discrete property of the data makes the continuous hazard model inappropriate for the empirical analysis. Thus, this study is based on the grouped duration model of PRENTICE and GLOECKLER (1978), which incorporates the potential frailty of gamma distribution. The duration data is conceptualized by grouping it into intervals because the participation status in labor markets is reported in the interval between years for each individual household.[59] Here, a duration or spell is defined as the number of consecutive years a household was reported to remain in a certain participation regime. The length of the spell in the sample (less than or equal to eight years) is relatively long in comparison with the intervals (one year), which also necessitates the application of a discrete model of hazard estimation (KALBFLEISCH and PRENTICE, 2002).

The estimation technique for the discrete hazard model is based on the application of the standard binary dependent variable model under the assumption that the explanatory covariates raise the baseline hazard by a given proportion (JENKINS, 1995). A dichotomous dependent variable is defined to be equal to 1 if the spell of a subject's survival time is completed in the last interval and the subject is not right censored. Otherwise, the dependent variable is equal to 0 if the survival spell of a subject does not yet complete or the subject is right censored. Resorting to ML method, the dichotomous dependent variable is parameterized approximating the log-logistic function form; that is, the hazard ratio of the transition is estimated on the covariates and the log specification for duration dependence.[60]

Much of the literature suggests treating left-censored spells as right-censored is likely to overestimate the duration dependence of spells due to the bias of spell length

[59] Any intermission of participation during the year is ignored, which implies interval censoring with respect to actual non-participation spells. However, this treatment seems appropriate because households that participate during parts of a year can be considered integrated into the labor market.

[60] The Prentice-Gloeckler-Meyer hazard model is primarily estimated using the command of pgmhaz8 in Stata program, which incorporates a gamma distribution of unobserved heterogeneity (JENKINS, 1997).

(SWARTZ et al., 1993; PORTERFIELD, 1998). Thus, right-censored spells are only used in this study. The observation is right censored if its survival spell is longer than the time till the occurrence of the event (BURDETT et al., 1984; KALBFLEISCH and PRENTICE, 2002). Furthermore, the analysis of the functions associated with each of the possible events can be conducted similarly to the previous analysis, considering that all of the observations referring to the events that are distinct from being analyzed should be treated as right censored. For example, when analyzing the starting participation of households in labor markets (***a*** → ***h*** or ***s*** or ***sh***), all of the other observations that remain in the participation should also be right censored. The same treatment should be applied to all of the possible transitions. To perform the estimation, a spell year identifier variable for each subject must be generated and expanded in sequential integer from 1, 2 …to the value of the spell identifier in as many data rows as there are year intervals until the risk of the event occurs for each subject.

Results of the log-logistic hazard models used to estimate the households' participation duration in the labor market regimes are presented in Tables 5.5, 5.6, and 5.7. In Table 5.5, the two models present the estimated coefficients and the hazard ratio into participation (***a*** → ***s*** *or* ***h*** *or* ***sh***) and out of participation (***s*** *or* ***h*** *or* ***sh*** →***a***). Here, the hazard ratio could be explained as the conditional probability of a transition occurring in a small interval Δt after time t if no transition took place until t, when that interval approached zero. The transition between supplying labor off the farm (***a*** *or* ***h*** → ***s*** *or* ***sh***) and giving up off-farm employment (***s*** *or* ***sh*** → ***a*** *or* ***h***) is described in Table 5.6, and it considers the status of the household's hiring labor. Here, these two hazard estimations score the transition between full-time farming and part-time farming. By applying the technique to the household's behavior in the hiring labor market, we also estimate the hazard ratio of starting hiring labor (***a*** *or* ***s*** → ***h*** *or* ***sh***) and quitting from hiring labor (***h*** *or* ***sh*** → ***a*** *or* ***s***) in Table 5.7, considering the potential off-farm employment.

Though many households with right-censored spells are in the unbalanced panel sample, the large sample gains enough observations to be able to stratify the concerned analyses for the households with left-censored and completed spells. In a preliminary work, we include the same independent variables remaining in the bivariate probit analysis for the determinants of the household's dynamic participation in labor markets together with the log form of the duration (*Duration*), referring to the discrete intervals of years. The hazard model provides insights into how the hazard changed with the covariates. It has been noted that time-varying covariates linked with the same households are conceptually straightforward so they can be handled in the framework of the hazard function, though experience with this

model is limited (KIEFER, 1988). There apparently is no simple interpretation of this model in terms of non-linear models. Identification is tricky in that the effect of time-dependent covariates is difficult to separate from possible duration dependence. However, standard asymptotic estimation techniques provide viable means of estimates, the relative hazard parameter β, even when the covariate process includes internal components (KALBFLEISCH and PRENTICE, 2002). Here, the positive estimated parameters demonstrate that the covariates increase the hazard of the potential transition to the destined regime and reduce the duration of remaining in the original regime, and *vice verse*. The hazard ratio, which is calculated as $\exp(\beta)$, can be explained as the relative change in the hazard ratio associated with a unit change of the corresponding covariate where β is the relevant parameter. The z-test of the parameters demonstrates that the majority of the variables, except that representing vegetable production, are statistically significant in at least one of the six duration models. Thus, all of the final specifications of duration models completely refer to the variables tested in the household's participation estimations.

Theoretical literature suggests that ignoring the multiplicative heterogeneity embedded in unobserved characteristics of households and farms poses several problems in the estimation (JENKINS, 1997). First, given the presence of frailty in the data, the non-frailty hazard model demonstrates the bias estimation of the baseline hazard by overestimating the degree of negative duration dependence but underestimating the degree of positive duration dependence.[61] Second, without considering the frailty, the explanatory variables cannot raise the baseline hazard by a constant proportion and remain independent of the survival time. Finally, at any survival time, the proportionate effect of variation of a given explanatory variable on the hazard rate cannot achieve the given potential frailty of the data. This point – that the estimated positive (negative) parameter derived from the wrong no-frailty model will underestimate (overestimate) the 'true' parameter has been proven by LANCASTER (1990).

In this study, it is assumed that some of the households may be more likely to make the transition among the states of labor market because of favorable unobserved characteristics. Thus, in the primary experiments of hazard models, the specifications incorporate the variance of unobserved heterogeneity (*variance of frailty*) with gamma distribution. If the magnitude of the frailty variance of gamma

[61] This is a selection bias. For example, in the negative duration dependence case, keeping other factors constant, the observations with high value of the multiplicative scaling factor fail faster because the unobserved heterogeneity makes a scaling of the non-frailty survivor function. Thus, the survivors at any given survival time are decreasingly composed of observations with high value of multiplicative scaling factor and the lower hazard rate is achieved iteratively.

distribution relative to its standard error suggests that unobserved heterogeneity is statistically significant at the traditional accepted level, the hypothesis of the unobserved heterogeneity cannot be rejected. Then, the reported coefficients of the other covariates will also be attained from the same hazard model controlling for a gamma form of frailty. Otherwise, the final results of hazard models will be reported without unobserved heterogeneity. In these cases, spell-specific effects have been sufficiently captured by controlling for the most influential covariates and the final models could be estimated without accounting for frailty. It is interesting to find that unobserved heterogeneity considerably increases the probability for the move-out direction of transition, including stopping participation and supplying and hiring labor, while the unobserved heterogeneity has no statistically significant impact on the transition of the households' integration into labor markets.

The empirical studies imply that the magnitude of the biases in the non-frailty models relative to the 'true' model diminish if the specification of the baseline hazard is experimented flexibly (JENKINS, 1997). Furthermore, the baseline hazard itself does not remain constant across intervals. In this study, the technique to define the baseline hazard follows the non-parametric estimation, which defines a separate parameter (a log-intergrated baseline hazard) estimated for each interval. This approach allows for full flexibility in evaluating the impacts of baseline hazards (APPLETON et al., 2002).

Table 5.5: Estimated results of the duration model between participation and not participation

Household's transition	***Start participation***		***Stop participation***	
	a $\rightarrow$ ***s*** *or* ***h*** *or* ***sh***		***s*** *or* ***h*** *or* ***sh*** $\rightarrow$ ***a***	
Symbol	Parameter	Hazard ratio	Parameter	Hazard ratio
Duration	-0.4753***	0.6217	0.5725	1.7728
	(2.91)		(1.32)	
Household characteristics				
Element	0.5563*	1.7441	-0.3291	0.7196
	(1.94)		(0.68)	
Second	0.4979	1.6453	-0.1326	0.8758
	(1.51)		(0.25)	
High	1.1705**	3.2235	-2.1427**	0.1173
	(2.50)		(2.46)	
Skill	0.7832*	2.1886	-1.0838*	0.3383
	(1.79)		(1.71)	
M-labor	0.2150*	1.2399	-0.2496	0.7791
	(1.78)		(1.30)	
F-labor	0.1893*	1.2084	-0.4489**	0.6383
	(1.65)		(2.46)	
Dependent	-0.0204	0.9798	-0.3043**	0.7377
	(0.26)		(2.25)	

Table 5.5: Continued from previous page

Household's transition	***Start participation***		***Stop participation***	
	a → ***s*** *or* ***h*** *or* ***sh***		***s*** *or* ***h*** *or* ***sh*** → ***a***	
Symbol	Parameter	Hazard ratio	Parameter	Hazard ratio
Transfer	-0.0866**	0.9170	0.0301	1.0305
	(2.20)		(0.71)	
Cadre	-0.1073	0.8982	0.4247	1.5292
	(0.53)		(1.10)	
Pmember	-0.6187**	0.5387	1.0944**	2.9874
	(2.33)		(2.17)	
Farm characteristics				
Asset	-0.1220*	0.8852	0.0648	1.0669
	(1.73)		(0.73)	
Landpc	-0.0241	0.9762	-0.0423	0.9586
	(1.08)		(1.56)	
Livestock	0.0435***	1.0445	0.0018	1.0018
	(2.81)		(0.08)	
Vegetable	-0.4072	0.6655	0.5469	1.7279
	(0.90)		(1.03)	
O/I-ratio	0.0001	1.0001	0.0074***	1.0074
	(0.23)		(2.61)	
Village characteristics				
L-rent	-1.9403**	0.1437	-2.1588**	0.1155
	(2.00)		(1.97)	
Unemp	2.1075***	8.2278	2.2384**	9.3779
	(3.17)		(2.27)	
Popden	0.2251**	1.2525	0.0800	1.0833
	(2.15)		(0.48)	
Anipc	-0.0538	0.9476	-0.1557**	0.8558
	(1.06)		(2.09)	
Constant	-1.2068***		0.0864	
	(3.14)		(0.12)	
Model selection criterion				
Variance of frailty (gamma distribution)[a]	2.5641		4.3208**	
	(1.53)		(2.35)	
H_0: All covariates except constant=0				
Likelihood ratio statistics	89.1267		126.0447	
p-value	<0.0001		<0.0001	
Percentage of correction predictions				
Change of participation state	66.53		93.39	
No change of participation state	64.05		17.99	
observation	542		2762	

Note: Z-values in parentheses, ***, **, and * indicate statistical significance at 1%, 5% and 10% levels, respectively. [a.] The coefficient of variance of frailty (gamma distribution) attains from the estimation of duration model while controlling for frailty with a gamma distribution. If this coefficient is statistically significant at the traditionally accepted level, the reported results of other covariates will also arise from the same duration model. If not, the reported results of other covariates will arise from the duration model without a gamma frailty.

In each of the models the null hypothesis that all of the slope coefficients are simultaneously zero is clearly rejected by likelihood ratio tests. For reference, Appendix Table A3 reports the estimated hazard models that only include the constants, and the coefficients of the constants are statistically significant in all of the estimations. The models' ability to predict completions and non-completions of spells are calculated as an overall goodness of fit measure. A critical limiting value should be chosen to map predicted hazards of completion (computed as predicted values from the fitted model) on the dichotomous variable. There is no unambiguously best choice, as discussed by GREENE (2002). Following BROSIG et al. (2006), the relative frequency of completions in the respective original sample is used. The models evaluating participation of unspecified kind, i.e. on either or both sides of the labor market, do not reliably predict non-completions (percentages of hits are 64.05% and 17.99%, respectively). This may be due to the fact that participation combines supplying and employing labor, the determinants of which may differ substantially. The predictive power of the models focusing on the more narrowly defined state of supplying off-farm work is satisfactory, with all percentages above 60%.[62]

Table 5.6: Estimated results of the duration model between supplying labor and not-supplying labor

Household's transition	***Start supplying***		***Stop supplying***	
	a *or* ***h*** → ***s*** *or* ***sh***		***s*** *or* ***sh*** → ***a*** *or* ***h***	
Symbol	Parameter	Hazard ratio	Parameter	Hazard ratio
Duration	-0.4744***	0.6223	0.3850	1.4696
	(3.01)		(0.98)	
Household characteristics				
Hiring	0.3860*	1.4711	-0.3120	0.7320
	(1.65)		(1.15)	
Element	0.4809*	1.6176	-0.4280	0.6518
	(1.73)		(0.99)	
Second	0.4069	1.5022	-0.2843	0.7525
	(1.30)		(0.62)	
High	0.8194*	2.2692	-1.7373**	0.1760
	(1.86)		(2.35)	
Skill	0.9180**	2.5044	-0.8513	0.4269
	(2.22)		(1.52)	
M-labor	0.1666	1.1813	-0.1492	0.8614
	(1.44)		(0.89)	
F-labor	0.2570**	1.2930	-0.3982**	0.6715
	(2.30)		(2.40)	
Dependent	-0.0173	0.9829	-0.2399**	0.7867
	(0.23)		(2.04)	

[62] However, here the considered state comprises sub-states of considerable heterogeneity: Non-agricultural self employment, employed work in the village, and migrant work.

Table 5.6: Continued from previous page

Household's transition	***Start supplying***		***Stop supplying***	
	a *or* ***h*** → ***s*** *or* ***sh***		***s*** *or* ***sh*** → ***a*** *or* ***h***	
Symbol	Parameter	Hazard ratio	Parameter	Hazard ratio
Transfer	-0.1004**	0.9045	0.0265	1.0269
	(2.47)		(0.70)	
Cadre	-0.0602	0.9416	0.4455	1.5612
	(0.31)		(1.32)	
Pmember	-0.5370**	0.5845	0.8156**	2.2606
	(2.13)		(2.02)	
Farm characteristics				
Asset	-0.0918	0.9123	0.0838	1.0874
	(1.46)		(1.03)	
Landpc	-0.0048	0.9952	-0.0148	0.9853
	(0.28)		(0.71)	
Livestock	0.0450***	1.0460	0.0050	1.0050
	(2.95)		(0.23)	
Vegetable	-0.1183	0.8885	0.6227	1.8639
	(0.29)		(1.25)	
O/I-ratio	-0.0007	0.9993	0.0052**	1.0052
	(0.88)		(2.56)	
Village characteristics				
L-rent	-2.1875**	0.1122	-2.2781**	0.1025
	(2.33)		(2.26)	
Unemp	2.3401***	10.3822	2.5761***	13.1458
	(3.57)		(2.98)	
Popden	0.3351***	1.3981	0.1617	1.1756
	(3.35)		(1.14)	
	(3.56)		(0.25)	
Model selection criterion				
Variance of frailty (gamma distribution)[a]	2.0189		3.0597**	
	(1.54)		(2.14)	
H_0: All covariates except constant=0				
Likelihood ratio statistics	103.5892		123.8787	
p-value	<0.0001		<0.0001	
Percentage of correction predictions				
Change of participation regime	66.40		92.34	
No change of participation regime	65.87		20.66	
observation	587		2717	

Note: Z-values in parentheses, ***, **, and * indicate statistical significance at 1%, 5% and 10% levels, respectively. [a.] The coefficient of variance of frailty (gamma distribution) arises from the estimation of duration model while controlling for frailty with a gamma distribution. If this coefficient is statistically significant at the traditionally accepted level, the reported results of other covariates will also arise from the same duration model. If not, the reported results of other covariates will arise from the duration model without a gamma frailty.

Estimated coefficients of the log form of duration (*Duration*) appear to be negative and different from zero at any conventional level of statistical significance for the three estimations of starting participation in labor market, or supplying, or hiring labor. The hazard rates to start the participation, or supplying, or hiring labor deceasing about 37% with one more year of duration than households in the original states. These results reveal that increasing persistence is an important characteristic of rural households' behavior in labor markets. The increasing persistence means those households that have not been integrating into the labor market are less likely to participate, or supply, or hire labor. The positive coefficients of duration dependence for the transitions to stop participation, or supplying, or hiring labor indicates the longer households remain in the original regimes, the higher the hazard rate of households to shift out of them. These coefficients are not statistically significant and they contradict the persistence of labor participation behavior. The reasonable interpretation is that the working contract of rural labor in labor markets is generally temporary, and the chance to gain permanent tenure is very low. These results mirror the finding of ZHAO (1999). The former indicates that the weak social service provided to rural-to-urban migrants discourages families from migrating as a unit, and the latter provides evidence that the types of workers who move to the urban area are highly influenced by the kinds of jobs available for the rural laborer.

Figure 5.1 and Appendix Figure B1 predict the hazard rate and survival probability at different durations with adherence to the six types of households' transitions in labor markets. Based on the estimated coefficients, the predictions are derived by assuming that each of the covariates specified in the estimations is set equal to its mean value, except the variable for duration dependence. Because the link function for parameter estimation takes the log-log form, the predicted hazard rate for a duration of *t* years is given by the equation as $\lambda_t = 1 - \exp\{-\exp[\sum_{k \neq Duration} \beta^k \overline{X}^k + \beta^{Duration} \ln(t)]\}$ with $\overline{X}^k$ as the mean of the *k*-th covariates. Here the predicted survival probability is graphed as $\exp\{sum[\ln(1-\lambda_t)]\}$ while λ_t is stored from the predicted hazard rate.

The dashed, diamond marked graph (start participation) represents the predicted average hazard of integrating into the labor market (***a*** → ***h*** *or* ***s*** *or* ***sh***). This probability is greater than 40% after a single year of autarky in the labor market, and itdecreases if households remain in autarky less than three years. However, if the households remain in autarky in agricultural production for acontinuous four to five years, the probability of integrating into the labor market returns to around 20%, and then decreases thereafter. A possible explanation is that technological improvements in agricultural production are motivating increasing numbers of

households to take jobs for short spells to earn money for their households' cash expenditures or to add variety to household's income resource and their lives. The results mirror the findings in Section 5.1 of a comparatively stable persistence of labor supply for households but increased participation of households in labor markets.

Table 5.7: Estimated results of the duration model between hiring labor and not-hiring labor

Household's transition	***Start hiring***		***Stop hiring***	
	a *or* ***s*** → ***h*** *or* ***sh***		***h*** *or* ***sh*** → ***a*** *or* ***s***	
Symbol	Parameter	Hazard ratio	Parameter	Hazard ratio
Duration	-0.4720***	0.6237	1.8577	6.4089
	(3.87)		(1.41)	
Household characteristics				
Supplying	0.4173	1.5179	1.5453**	4.6896
	(1.58)		(2.11)	
Element	0.1381	1.1481	-0.4744	0.6223
	(0.32)		(0.35)	
Second	0.4905	1.6331	-3.0438*	0.0477
	(1.13)		(1.75)	
High	0.7904	2.2043	-0.4299	0.6506
	(1.46)		(0.27)	
Skill	0.1252	1.1334	-1.1268	0.3241
	(0.30)		(0.90)	
M-labor	0.2755**	1.3172	0.3394	1.4041
	(2.08)		(0.72)	
F-labor	-0.1033	0.9018	-0.5921	0.5532
	(0.79)		(1.20)	
Dependent	0.1110	1.1173	-0.1974	0.8209
	(1.13)		(0.72)	
Transfer	0.0248	1.0251	-0.0481	0.9531
	(0.89)		(0.47)	
Cadre	0.6259***	1.8699	-1.0479	0.3507
	(2.60)		(1.41)	
Pmember	0.1243	1.1323	-0.2849	0.7521
	(0.41)		(0.35)	
Farm characteristics				
Asset	-0.0023	0.9977	-0.3207**	0.7256
	(0.04)		(1.75)	
Landpc	0.0391***	1.0399	0.0331	1.0337
	(4.54)		(0.94)	
Livestock	0.0296	1.0300	0.0141	1.0142
	(1.56)		(0.26)	
Vegetable	0.1495	1.1613	0.2411	1.2727
	(0.36)		(0.26)	

Table 5.7: Continued from previous page

Household's Transition	***Start hiring***		***Stop hiring***	
	a *or* ***s*** → ***h*** *or* ***sh***		***h*** *or* ***sh*** → ***a*** *or* ***s***	
Symbol	Parameter	Hazard ratio	Parameter	Hazard ratio
O/I-ratio	0.0004	1.0004	0.0028	1.0028
	(1.17)		(0.62)	
Village characteristics				
L-rent	1.4719*	4.3573	-3.2858*	0.0374
	(1.75)		(1.85)	
Unemp	1.3392*	3.8159	3.3753*	29.2324
	(1.82)		(1.79)	
Popden	-0.3203**	0.7259	0.1871	1.2057
	(2.38)		(0.57)	
Anipc	0.1160**	1.1230	-0.3165*	0.7287
	(2.33)		(1.68)	
Constant	-4.4172***		2.6653	
	(8.18)		(1.19)	
Model selection criterion				
Variance of frailty (gamma distribution)[a]	0.1627		3.4477*	
	(0.19)		(1.74)	
H_0: All covariates except constant=0				
Likelihood ratio statistics	117.9002		74.4691	
p-value	<0.0001		<0.0001	
Percentage of correction predictions				
Change of participation regime	61.22		96.48	
No change of participation regime	70.02		15.67	
observation	2862		442	

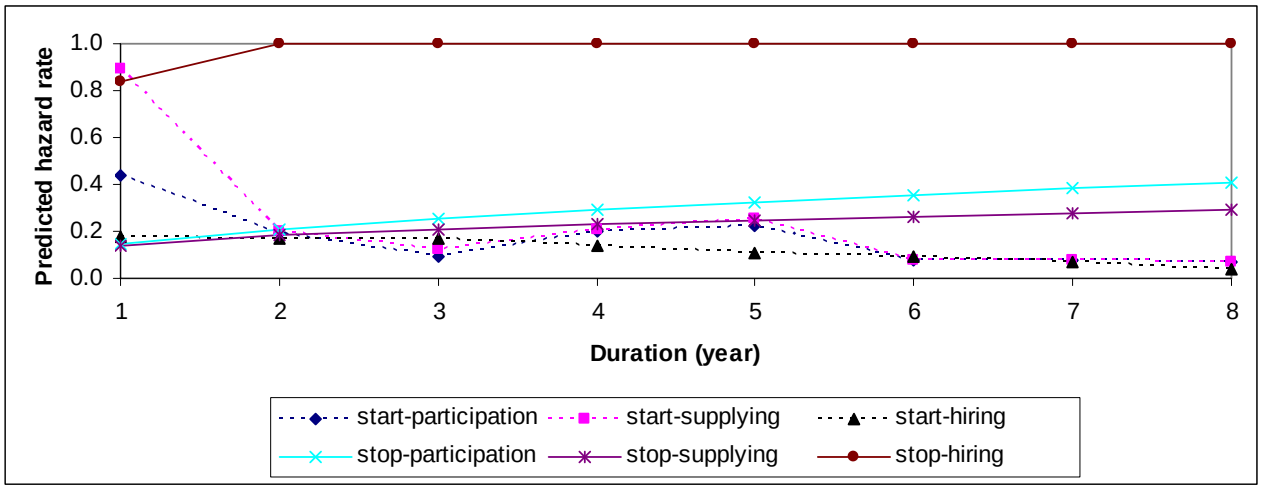
Note: Z-values in parentheses, ***, **, and * indicate statistical significance at 1%, 5% and 10% levels, respectively. [a.] the coefficient of variance of frailty (Gamma distribution) attains from the estimation of duration model with controlling for frailty with a gamma distribution. If this coefficient is statistically significant at the traditional accepted level, the reported results of other covariates will also attain from the same duration model. If not, the reported results of other covariates will attain from the duration model without a gamma frailty.

The predicted hazards of households' starting to supply labor off the farm (***a*** *or* ***h*** → ***s*** *or* ***sh***) demonstrate a pattern similar to that of households that move into the labor market. The probability is greater than 80% after a single year of being in autarky or hiring labor. For full-time farming households (*a, h*), which represent a relatively small group in Zhejiang, it is more likely that one of their members will take up off-farm employment. This probability decreases to around 7% after engaging in full-time farming for a continuous five years. A possible explanation is that the supply of potentially capable workers with the prerequisite education or skills for off-farm employment and good social networking decreases over time.

At the same time, specialization in on-farm work may optimize the farming structure, and hence enhance the efficiency of agricultural production. In that way, off-farm employment becomes less attractive.

The dashed triangle marked graph (***s*** *or* ***a*→*h*** *or* ***sh***) refers to the transition into hiring labor from engaging in part-time farming or autarky in labor market. The predicted hazard rates demonstrate that there is a negligible difference in starting to hire labor after one year or after two or three continuous years in autarky or part-time farming. The increasing persistence is reflected in the participation behavior of autarky or part-time farming households as the hazard rates to start hiring labor decrease slowly from around 17% to 4% over the spells of one to three years to eight years. This points to a conclusion that part-time or self-sufficient farming is still the most dominant type of agricultural production in rural China.

Figure 5.1: Predicted hazards for the transition of households in labor markets



The solid graph marked with multiplication signs (***h*** *or* ***s*** *or* ***sh*→*a***) represents the predicted hazard rate of entering into autarky in labor markets from any form of integration into the labor market. This probability is close to 15% for being involved in labor market for one year, and increases to around 40% for participating in the labor market for a continuous eight years. However, the estimated duration parameter is not significant at the conventionally accepted level. A possible explanation is that the transition begins from the completely different aspects of labor markets, and hence the behavioral tracks that are grouped together are not sufficiently homogenous.

The predicted hazard rates to return to full-time farming (***s*** *or* ***sh*→*a*** *or* ***h***) increase from 14% after a single year of employment off the farm to a figure that is doubled after eight years. The decreasing persistence of off-farm workers could be explained by the fact that rural workers still face discrimination in off-farm employment, and

therefore the permanent off-farm employment of rural workers is limited. Furthermore, the denial of public education to rural workers' children and remaining restrictions on meeting healthy targets and being involved in other social security systems also affect the length of off-farm employment.

The predicted hazard to quit hiring labor (***h*** *or* ***sh*→*a*** *or* ***s***) is close to 1 after a single year of hiring labor, while the duration dependence is not statistically significant at the conventional level. Hazard rates for duration greater than two years weakly support the end of hazard functions, which have been fitted largely based on considerably shorter spells.

Figure 5.1 illustrates the duration dependence of the movement of households among the labor market regimes. In the following paragraphs, the impacts of the covariants on the households' dynamic behavior in labor markets are explained.

Household characteristics Regarding the proxies of education attainment of family members, the estimated results imply that the transition decisions of households in labor markets depends on the changes of ratios of family members who are educated and have special skills (*Skill*). Using the illiterate group as reference group, the parameters of education variables are all positive in the three estimations of the households' integration into labor markets (*Start participation, supplying* and *hiring)*. These indicate that better educated households show higher probabilities to start the integration into the labor market. The negative coefficients of education variables in the remaining three estimations demonstrate that better educated households lower the likelihood of stopping these integrations (*Stop participation, supplying* and *hiring)*. These findings are consistent with the results of labor participation in Section 5.1 and the studies of COOK (1999), ZHANG et al. (2001), and DE BRAUW et al. (2002) that show better education increases the probability of off-farm employment.

However, looking more carefully, one can see that the difference of the effects of elementary, secondary, and high schooling on the transition behavior of households in labor markets is quite large. The parameters of secondary schooling appear to be statistically insignificant in five to six estimations, while increasing the ratio of family members with secondary schooling significantly lowers the probability of households' stopping hiring labor. The absolute magnitudes of the parameters of high schooling are larger than those of elementary schooling in the estimations of transitions between participation and non-participation, or between full-time farming and part-time farming. These imply that higher schooling is most effective in aiding the households' transition in the labor market. This is consistent with the finding of DE BRAUW et al. (2002), in which rural workers with higher schooling are more likely to take off-farm employment. These results also imply that the transition into off-farm employment may be driven by the greater return to education associated

with the upgrading of off-farm employment, as well as more competition in the off-farm employment market. The variable of skill has similar effects as high schooling in the six estimations. One conclusion could be drawn that increasing the high schooling and skill training will promote the rural households' integration in labor markets.

In view of the household's demographic structure, the numbers of labor force by gender make a significant impact on the households' transition among labor market regimes. By adding another male or female laborer to a household (*M-labor* or *F-labor*), the hazard rates of households' integrating into any form of labor market (*Start participation*) increase around 23.99% or 20.84%, respectively, while the hazard rates of households that move out of labor markets into autarky production (*Sopt participation*) are reduced by about 22.09% and 35.17%, respectively. This indicates that adding an adult laborer to a household leads to the reallocation of time in various production activities, which is consistent with the study on the nonseparability of rural labor markets in China (BOWLUS and SICULAR, 2003).

Now turning to the transition between the full-time and part-time farming, it is noted that the parameters of the female laborer (*F-labor*) are significant and positive in the transition to part-time farming (*Start supplying*) but negative in the transition to full-time farming (*Stop supplying*). This could be explained by the fact that women generally exhibit intermittent off-farm employment to raise children or engage in household work (MEITZEN, 1986). Due to the imperfect labor markets in China, the different access to off-farm employment by gender persists, though women's shares in off-farm jobs are increasing quickly (ZHANG et al., 2004).

The coefficients of the dependent variable (*Dependent*) only appear to be statistically significant and negative in the transition to stopping participation (*Stop participation*) and farming full-time (*Stop supplying*). This indicates that increasing the numbers of dependent people will increase the persistence of households to be integrated into labor markets, especially the off-farm labor markets. One possible reason is that in this dataset, the dependents cannot be explicitly decomposed into elders and children of different ages. These groups of people certainly have different impacts on the labor allocation of households.

It is expected that households which receive higher transfers per capita (*Transfer*) exhibit a lower mobility to be integrated into labor markets (*Start participation*) and shift to part-time farming (*Start supplying*). The quantitative effect of this is, however, relatively small. An additional 1,000 Yuan per capita approximately increases the probability to retain autarky production (*Start participation*) or full-time farming (*Start supplying*) by 10%.

Social networks captured by the variable *Pmember* are demonstrated to be statistically significant and have a negative impact on the probability of integrating into labor markets and turning to part-time farming, and positive impact on the hazard to move in the opposite directions. These results are consistent with the hypothesis that good social connections put households in a favorable situation to conduct successful agricultural activities. This finding is consistent with the conclusion drawn by KNIGHT and YUEH (2002) and our results in the analysis of static labor market participation in Section 5.1 that show party member households can better access land, water, and other input factor markets or preferential treatment in marketing farm products. Considering the influence of being a cadre household (*Cadre*) on the households' transition in labor market, it is noted that this only makes a robustly positive impact on the probability of starting to hire labor (*Start hiring*). This indicates that being a cadre household also favors work on the farm, and thus raises the probability of hiring additional workers for agricultural activities.

Farm characteristics Farm characteristics, especially the production asset per capita (*Asset*), the husbandry production (*Livestock*), and relative price term (*O/I ratio*), influence the probability of a household's mobility in labor markets. With an increase of production asset per capita (*Asset*) by 1,000 Yuan, the hazard rate of households' starting to integrate into labor markets is reduced by 11.48%. A relatively large capital stock (*Asset*) implies that agricultural production becomes more profitable and non-agricultural employment is less attractive to rural laborers. This finding is also confirmed by the higher probability to starting hiring labor (*Start hiring*) and the lower hazard rate to engage in part-time farming (*Start supplying*), although the latter is statistically insignificant.

Controlling for the effect of the ratio of output to input value (*O/I ratio*), it is found that this ratio has a statistically significant and positive effect on households to stop participation and transfer to full-time farming (*Stop supplying*). This indicates that the adjustment of the comparative price of agricultural inputs and outputs likely reflects reallocation of time between agricultural production and off-farm employment.

Village characteristics Households' transitions in labor markets are also more responsive to the land rental market (*L-rent*), which is represented by the fraction of households that lease cultivated land in the local village. This variable is statistically significant in all six estimations. Note that multiple factor markets exist imperfectly in rural China, so the allowance of land rental transactions helps to equalize marginal products across rural households with different land-labor endowments and makes the specialization in agricultural production possible. As a result, this

also has an important impact on the labor reallocation behavior of rural households. The vivid rental market obviously eases the transactions of renting land in and out. These transactions could release labor capacities in some households and create additional demand for labor in others. As is demonstrated in KUNG (2002), households' allocation of labor between on-farm activities and off-farm employment interacts with the emergence and development of the land rental market.

The role of the external labor market on households' transitions is captured in the estimations by three variables representing the unemployment rate (*Unemp*), population density (*Popden*), and annual income per capita (*Anipc*). The parameters of the unemployment rate are statistically significant and positive in the six estimations and the magnitude of the hazard rates is extremely large. This indicates that households' decisions on labor reallocation are influenced by the local employment environment, as measured by the unemployment rate in the local community (Unemp). Economic incentives reinforce the geographic concentration of production activity, and thus local economic activities could be reflected in the population density (Popden), which is also a good component of the local labor market. Higher population density, indicated by an active labor market, increases the likelihood of households integrating into labor markets (*Start participation*) as well as supplying labor off the farm (*Start supplying*), but reduces the hazard rate to hiring labor (*Start hiring*). Households located in wealthier villages (*Anipc*) are less likely to stop hiring labor and more likely to start hiring labor. When village income per capita (*Anipc*) increases by 1,000 Yuan, the hazard rates decrease by around 15% for households that shift out of the labor market (*Stop participation*) or the off-farm employment market (*Stop supplying*). Though the annual income per capita (*Anipc*) also reduces the probability of households integrating into labor markets *(Start participation)* and gaining employment in part-time farming *(Start supplying),* the coefficients are statistically insignificant.

6 Conclusion

Liberalization of rural labor markets has been an important component of China's rural reform since 1978 (BENJAMIN and BRANDT, 1997; ZHANG et al., 2001; DE BRAUW et al., 2002). With the inception of the Household Responsibility System, decisions on the time allocations of family members were transferred from collectives to households. Thus, households are allowed to achieve their desired levels of leisure and work, given the endowment of labor resources and other factors. With the development of Township and Village Enterprises and the encouragement of households to establish non-farm businesses, the employment of rural labor diversified and an increasing integration of farm households into rural labor markets began to take place (BENJAMIN and BRANDT, 1997; ROZELLE et al., 1999; DE BRAUW et al., 2002). Abolishing the procurement quota on grain and loosening the restrictions on migration from rural areas to urban cities made labor mobility possible. However, the process can be stalled by rural households' abilities to access labor market, high transaction costs, and other poorly developed factor markets, especially the land market.

The extent to which different factors affect households' decisions on labor allocation depend in part on the performance of the labor markets and on the institutional changes that constrain or facilitate on- and off-farm employment opportunities. Many researchers have contributed to evaluate the emergence and development of rural labor markets in China; however there are still disagreements concerning how well rural labor markets function and the labor allocation behavior of households in the labor market (BENJAMIN and BRANDT, 1997; COOK, 1999; ROZELLE et al., 1999; MENG, 2000; DE BRAWN et al., 2002; BOWLUS and SICULAR, 2003). The disagreement arises, in part, because most existing analyses consider only part of the labor market – the off-farm labor market, and ignore the emergence of the hired labor market and the dynamics of rural households' participation behavior.

This study is devoted to the continuing debates over households' behavior in the wake of China's efforts to develop the rural labor markets in a manner conductive to the nation's transition to a market economy. Given the emergence of hiring in rural labor markets and the fact that off-farm employment appears to be general, the primary motivation of this study is to assess both dimensions of the labor market in

rural China in a completely theoretical framework. We seek to use the agricultural household model as the theoretical framework because it provides us with a unifying microeconomic framework for understanding agricultural households' decisions on various production activities, consumption, and time allocation of rural laborers. This theoretical model is appropriate for the analysis of labor allocation of Chinese agricultural households because consumption and the utility-maximizing amount of labor employment in production are vested in agricultural households. Furthermore, the modified agricultural household model can cover either perfect or imperfect rural labor markets in the transitional economy. The agricultural household model demonstrates that the different responses of hired laborers and off-farm workers to the endogenous wages will lead to different behaviors of households in labor markets through the interaction of households and farm characteristics with external labor markets. The predictions drawn from the theoretical analysis are tested in the econometric estimations. Specifically, three different but interrelated contexts are highlighted: Qualitative participation behavior in hiring labor and supplying labor off the farm, the decisions regarding the quantity of hired labor demand and off-farm labor supply, and the dynamics of rural households' participation in labor markets.

Empirical analysis of households' behavior regarding labor allocation and documentation of the development of labor markets relies on the more recent fixed-point survey collected across ten villages in Zhejiang province from 1995 to 2002. Although this study examines only one province, we believe our choice offers both informative and interesting results and may portend what will happen in the rest of China in the coming years. Before conducting the empirical studies, we evaluate the emergence and development of rural markets by descriptive analysis. The results illustrate that labor markets have allowed off-farm employment to become the dominant form of employment and that once a household supplies labor off the farm, on average, the number of off-farm workers in a household is at least two. Most notably, we find that the hired labor market emerged during transition and households began to hire labor and supply labor off the farm simultaneously, though the contributed working days of hired labor fluctuated substantially. From the data, we also observe that households' participation behavior in the labor market is characterized as the dynamics between participation and autarky in labor markets, between part-time and full-time farming, and between hiring and non-hiring labor.

To conduct empirical estimations, we first derive a joint model to explore the determinants of households' labor participation decisions and identify which factors enable or constrain the households' ability to hire labor or join the off-farm labor

market, with special attention to households in both markets. In particular, we test whether households' participation decisions regarding the two labor markets is joint or completely separate behavior. Evidence is found to support the behavioral assumption that hiring and supplying labor is a joint decision within a household. The outcome of this decision is positively correlated; the likelihood to participate in any off-farm occupation increases with hiring labor, and vice versa. This supports the hypothesis that the rural labor market is still functioning imperfectly despite more than two decades of economic reform and market liberalization. That market imperfections may still exist is also indicated by a significantly higher participation in labor markets in villages with more land leasing activity and by the fact that social networking plays an important role in households with access to hired-labor and off-farm employment markets. These results suggest that being cadre households or holding party membership may lead to favorable conditions in input and output factor markets and the functioning of labor market is related to other factor markets, especially the land rental market. The improving labor market is proven by the evidence that the households with larger proportions of educated or skilled members are more likely to participate in off-farm employment market.

Next, we analyze the labor allocation of rural households by quantitatively assessing the response of the households' demand for hired laborers and the supply of off-farm workers to the endogenous price of time value of rural labor and other exogenous household and village characteristics, while the shift of the households' production structure occurs inseparably. To derive the endogenous measure of the wages of hired labor, we seek to analyze the agricultural production function by separating labor inputs into hired labor and family labor, under the assumption that hired labor and family labor are substitutes, *albeit* imperfect substitutes (COOK, 1999). To estimate the expected wages of off-farm workers, we follow HECKMAN (1974, 1979) and SUMNER (1982) as the off-farm wage function is regressed in log-linear form with the education attainment and skill characteristics of households, households' demographic composition, social networking, and other community variables. The expected average off-farm wage of a household is twice the marginal product of hired labor. This result mirrors the conclusions drawn by BENJAMIN (1992) and COOK (1999) that the internal wages of off-farm workers are evidently much higher than those of on-farm workers.

By including the endogenous wages of hired laborers and off-farm workers, we are able to analyze how hired labor demand and off-farm labor supply respond to changes in wage rates. Hired labor demand functions are estimated separately for households that only hire on-farm labor and for those that hire and supply labor simultaneously. Similarly, we estimate two off-farm labor supply functions: One for households

that exclusively supply labor off the farm and the other for households in both markets. The major results indicate statistically significant effects of the wages of off-farm workers or that of hired laborers on the corresponding hired labor demand and off-farm labor supply functions. It should be noted that households that both hire and supply labor respond much more sharply to the change of wages, compared to households that only participate in one of the two markets. This confirms the theory that agents are more flexible when they have more decision-making options. The wages of hired laborers have a statistically significant and negative effect on the off-farm labor supply. This suggests that hired labor and off-farm labor are substitutes, *albeit* imperfect substitutes, in rural China.

The estimated results also demonstrate that Chinese rural households' time allocation reacts not only to endogenous value of labor, but also to household, farm, and local characteristics and indicates functioning labor markets in rural China. The expansion of livestock production has increasing effects on labor demand but reducing effects on a household's off-farm labor supply. Land market integration enhances participation significantly but appears to have no impact on quantitative decisions regarding labor allocation. Furthermore, the results suggest non-separability between off-farm labor supply and household structure as well as social networks, confirming again that the rural labor market in Zhejiang province is still functioning imperfectly.

Finally, the panel data also allow us to evaluate the dynamics of households' participation in labor markets by applying discrete hazard models. In particular, we investigate the movements between participation and autarky in labor markets, between part-time and full-time farming, and between hiring or not hiring labor. We also attempt to identify the factors that determine the length of time a household spends in the labor market states. We find that education attainment of family members, households' demographic structures, social networks, and endowment with agricultural land are particularly influential.

From a policy perspective, the setting of framework conditions that ease the institutional impediment and the land rental market should be given a high priority to enhance the integration and mobility of rural households in labor markets. Furthermore, education attainment and skill training play critical roles in households' labor allocation decisions, and thus investment in human capital is an attractive and promising measure for enhancing households' capabilities to flexibly adapt to the transition economy. Finally, efforts should particularly address large households' access to information about labor market conditions and improvements in regional job opportunities, which undoubtedly would encourage rural labor employment off the farm.

References

Agra EuropeGermany, 2005. Labor Excess in Chinese Agriculture. 42, L14.

Addison, T. John, Portugal, Pedro, 2003. Unemployment Duration Competing and Defective Risks. *Journal of Human Resources* 38, 156-191.

Ahituv, Avner, Kimhi, Ayal, 2002. Off-farm Work and Capital Accumulation Decisions of Farmers over the Life-cycle: The Role of Heterogeneity and State Dependence. *Journal of Development Economics* 68, 329-353.

Ahituv, Avner, Kimhi, Ayal, 2006. Simultaneous Estimation of Work Choices and the Level of Farm Activity Using Panel Data. *European Review of Agricultural Economics* 33, 49-71.

Appleton, Simon, Knight, John, Song, Lina, Xia, Qingjie, 2002. Labor Retrenchment in China – Determinants and Consequences. *China Economic Review* 13, 252-275.

Barkley, P. Andrew, 1990. The Determinants of the Migration of Labor out of Agriculture in the United States, 1940-85. *American Journal of Agricultural Economics* 72, 567-573.

Barnum, N. Howard, Squire, Lyn, 1979. A Model of an Agricultural Household – Theory and Evidence. World Band Staff Occasional Papers 27, The Johns Hopkins University Press, Baltimore and London.

Becker, S. Gary, 1965. A Theory of the Allocation of Time. *Economic Journal* 75, 493-517.

Benjamin, Catherine, Corsi, Allessandro, Guyomard, Hervé, 1996. Modelling Labour Decisions of French Agricultural Households. *Applied Economics* 28, 1577-1589.

Benjamin, Catherine, Kimhi, Ayal, 2003. Farm Work, Off-farm Work, and Hired Farm Labor: Estimating a Discrete-choice Model of French Farm Couples' Labor Decision. *American Economics Association Annual Meeting, Montreal, Canada*, July 27-30, 2003.

Benjamin, Dwayne, 1992. Household Composition, Labor Markets and labor Demand: Testing for Separation in Agricultural Household Models. *Econometrica* 60, 287-322.

Benjamin, Dwayne, Brandt, Loren, 1997. Land, Factor Markets, and Inequality in Rural China: Historical Evidence. *Explorations in Economic History* 34, 460-494.

Benjamin, Dwayne, Brandt, Loren, 2002. Property Rights, Labour Markets, and Efficiency in a Transition Economy: The Case of Rural China. *Canadian Journal of Economics* 35, 689-716.

Benjamin, Dwayne, Brandt, Loren, Giles, John, 2005. The Evolution of Income Inequality in Rural China. *Economic Development and Cultural Change* 53, 769-824.

Benjamin, Dwayne, Brandt, Loren, Glewwe, W. Paul, Li, Guo, 2002. Markets, Human Capital and Inequality: Evidence from Rural China. *Inequality around the World*, edited by Richard Freeman. Basingstoke: Palgrave MacMillan, 87-127.

Bhattacharyya, Arunava, Parker, Elliott, 1999. Labor Productivity and Migration in Chinese Agriculture: A Stochastic Frontier Approach. *China Economic Review* 10, 59-74.

Blau, M. David, Riphahn, Regina, 1999. Labor Force Transition of Older Married Couples in Germany. *Labor Economics* 6, 229-251.

Bowlus, J. Audra, Sicular, Terry, 2003. Moving Toward Markets? Labor Allocation in Rural China. *Journal of Development Economics* 71, 561-584.

Bradley, Steve, Crouchley, Rob, Oskrochi, Reza, 2003. Social Exclusion and Labour Market Transitions: A Multi-state Multi-spell Analysis Using the BHPS. *Labour Economics* 10, 659-679.

Brandt, Loren, Huang, Jikun, Li, Guo, Rozelle, Scott, 2002. Land Rights in China: Facts, Fictions and Issues. *The China Journal* 47, 67-97.

Brosig, Stephan, Glauben, Thomas, Herzfeld, Thomas, Rozelle, Scott, Wang, Xiaobing, 2006. The Dynamics of Chinese Rural Households' Paricipation in Labor Markets. *26th Conference of the International Association of Agricultural Economists (IAAE), Brisbane, Australia*. August 12-18, 2006.

Brümmer, Bernhard, Glauben, Thomas, Lu, Wencong, 2006. Productivity and Efficiency in Chinese Agriculture: A Distance Function Approach. *Journal of Development Economics* 81, 61-79.

Buchenrieder, Gertrud, Knüpfer, Judit, Heidhues, Franz, 2002. A Cross-Country Comparison of Non-Farm Employment in the Balkans. Research in Development Economics and Policy, Discussion Paper No. 03/2002, University of Hohenheim.

Burdett, Kenneth, Cunninhamg, J. Elizabeth, 1998. Toward a Theory of Vacancies. *Journal of Labor Economics* 16, 445-478.

Burdett, Kenneth, Kiefer, M. Nicholas, Mortensen, T. Dale, Neumann, R. George, 1984. Earnings, Unemployment, and the Allocation of Time over Time. *Review of Economic Studies* 51, 559-578.

Carter, R. Michael, Yao, Yang, 2002. Local versus Global Separability in Agricultural Household Models: The Factor Price Equalization Effect of Land Transfer Rights. *American Journal of Agricultural Economics* 84, 702-715.

Chan, Sewin, Stevens, H. Ann, 2001. Job Loss and Employment Patterns of Older Workers. *Journal of Labor Economics* 19, 484-521.

Chaplin, Hannah, Davidova, Sophia, Gorton, Matthew, 2004. Agricultural Adjustment and the Diversification of Farm Households and Corporate Farms in Central Europe. *Journal of Rural Studies* 20, 61-77.

Chayanov, V. Alexander, 1986. The Theory of Peasant Economy. Madison, WI: University of Wisconsin Press.

Chen, Z. Adam, Huffmann, E. Wallace, Rozelle, Scott, 2004. Migration and Local Off-farm Working in Rural China. Contributed paper to *the Annual Meeting of the AAEA, Denver, USA*, August 1-3, 2004.

Chesher, Andrew, Irish, Margaret, 1987. Residual Analysis in the Grouped and Censored Normal Linear Model. *Journal of Econometrics* 34, 33-61.

China.org.cn. 2004. China Publishes a White Paper on Employment. Available at http://www.china.org.cn/english/2004/Apr/93983.htm. China Internet Information Center, Beijing.

Cleves, A. Mario, Gould, W. William, Gutierrez, G. Roberto, 2003. *An Introduction to Survival Analysis Using Stata*. Stata Press.

Cook, Sarah, 1999. Surplus Labor and Productivity in Chinese Agriculture: Evidence from Household Survey Data. *Journal of Development Studies* 35, 16-44.

Corsi, Alessandro, Findeis, L. Jill, 2000. True State Dependence and Hetergeneity in Off-farm Labor Participation. *European Review of Agricultural Economics* 27, 127-151.

de Brauw, Alan, Huang, Jikun, Rozelle, Scott, 2000. Responsiveness, Flexibility, and Market Liberalization in China's Agriculture. *American Journal of Agricultural Economics* 82, 1133-1139.

de Brauw, Alan, Huang, Jikun, Rozelle, Scott, Zhang, Lunxiu, Zhang, Yigang, 2002. The Evolution of China's Rural Labor Markets during the Reforms. *Journal of Comparative Economics* 30, 329-353.

de Brauw, Alan, Giles, John, 2006. Migrant Opportunity and the Education Attainment of Youth in Rural China. IZA Discussion Papers 2326, *Institute for the Study of Labor (IZA).*

de Janvry, Alain, Fafchamps, Marcel, Sadoulet, Elisabeth, 1991. Peasant Household Behavior with Missing Markets: Some Paradoxes Explained. *The Economic Journal* 101, 1400-1417.

Deolalikar, B. Anil, Vijverberg, P. M. Wim, 1987. A Test of Heterogeneity of Family and Hired Labor in Asian Agriculture. *Oxford Bulletin of Economics and Statistics* 49, 291-305.

Dong, Xiao-Yuan, Putterman, Louis, 2000. Prereform Industry and State Monopsony in China. *Journal of Comparative Economics* 28, 32-60.

Du, Rengsheng, 1988. Rural Employment in China: The Choices. *International Labor Review* 127, 371-380.

Fafchamps, Marcel, 1992. Cash Crop Production, Food Price Volatility, and Rural Market Integration in the Third World. *American Journal of Agricultural Economics* 74, 90-99.

Fahrmeir, Ludwig, Tutz, Gerhard, 1994. *Multivariate Statistical Modelling Based on Generalized Linear Models*, Springer, New York.

Fang, Cheng, Wailes, Eric, Cramer, Gail, 1998. China's Rural and Urban Household Survey Data: Collection, Availability and Problems. Contributed paper to *AAEA Annual Meeting, Salt Lake City, USA*, August 5, 1998.

Findeis, L. Jill, Lass, A. Daniel, 1994. Labor Decisions by Agricultural Households: Interrelationships between Off-farm Labor Supply and Hired Labor Demand. PRI Working Paper 94-08. *University Park, Pennsylvania*.

Finkelshtain, Israel, Chalfant, A. James, 1991. Marketed Surplus under Risk: Do Peasants Agree with Sandmo?. *American Journal of Agricultural Economics* 73, 557-567.

Fleisher, M. Bleton, Yang, D. Tao, 2003. China's Labor Market. *Conference on China's Market Reforms, Stanford Center for International Development*, September 19-20, 2003.

Giles, John, 2006. Is Life More Risky in the Open? Household Risk-Coping and the Opening of China's Labor Markets. *Journal of Development Economics* 81, 25-60.

Glauben, Thomas, 2000. Besteuerung im Agrarsektor: Eine theoretische und empirische Analyse (Taxation in Agriculture: A theoretical and empirical analysis). Wissenschaftsverlag Vauk, Kiel.

Glauben, Thomas, Herzfeld, Thomas, Tiejie, Hendrik, Wang, Xiaobing, 2004. Labor Market Participation of Chinese Agricultural Households: Evidence from Zhejiang Province. *Chinese Economics Society (CES) 2004 Annual Conference, Atlanta, USA*. July 30-31, 2004.

Glauben, Thomas, Herzfeld, Thomas, Wang, Xiaobing, 2005. Labor Market Participation of Chinese Agricultural Households. *XIth European Association of Agricultural Economists (EAAE) Congress, Copenhagen, Denmark*, August 24-27, 2005.

Goetz, J. Stephan, 1992. A Selectivity Model of Household Food Marketing Behavior in Sub-Sahara Africa. *American Journal of Agricultural Economics* 74, 444-452.

Gould, W. Brian, Saupe, E., William, 1989. Off-farm Labor Market Entry and Exit. *American Journal of Agricultural Economics* 71, 960-969.

Green, H. William, 2002. *Econometric Analysis*. Prentice Hall.

Gutiérrez-Domènech, Maria, 2005. Employment Transition after Motherhood in Spain. *Labor* 19, 123-148.

Hallberg, C. Milton, Findeis, L. Jill, Lass, A. Daniel, 1991. Multiple Job-holding among Farm Families. Iowa State University Press, Ames.

Hare, Denise, 1994. Rural Nonagricultural Activities and Their Impact on the Distribution of Income: Evidence from Farm Households in Southern China. *China Economic Review* 4, 59-82.

Hausman, A. Jerry, 1980. The Effect of Wages, Taxes, and Fixed Costs on Women's Labor Force Participation. *Journal of Public Economics* 14, 161-194.

Hayami, Yujiro, Ruttan, W. Vernon, 1985. Agricultural Development: An international Perspective. Baltimore: The Johns Hopkins University Press.

Heckman, J. Jame, 1974. Shadow Prices, Market Wages, and Labor Supply. *Econometrica* 42, 679-693.

Heckman, J. Jame, 1979. Sample Selection Bias as a Specification Error. *Econometrica* 47, 153-161.

Hertel, Thomas, Zhai, Fang, 2006. Labor Market Distortions, Rural-urban Inequality and the Opening of China's Economy. *Economic Modelling* 23, 76-109.

Hill, M. Anne, 1989. Female Labor Supply in Japan: Implications of the Informal Sector for Labor Force Participation and Hours of Work. *Journal of Human Resources* 24, 143-161.

Huang, Jikun, Rozelle, Scott, 1995. Environmental Stress and Grain Yields in China. *American Journal of Agricultural Economics* 77, 853-864.

Huffman, E. Wallace, 1980. Farm and Off-farm Work Decision: the Role of Human Capital. *Review of Economics and Statistics* 62, 14-23.

Huffman, E. Wallace, Lange, D. Mark, 1989. Off-farm Working Decisions of Husbands and Wives: Joint Decision Making. *Review of Economics and Statistics* 71, 471-480.

Huffman, E. Wallace, 1991. Agricultural Household Models: Survey and Critique. In: Hallberg, C. Milton, Findeis, L. Jill, Lass, A. Daniel, (Eds.), Multiple Job-holding among Farm Families, Iowa State University Press, Ames, 79-111.

IFPRI (International Food Policy Research Institute). 2004. China: Government Expenditure, Growth, Poverty, and Infrastructure, 1952-2001. Washington, D. C.

Jacoby, G. Hanan, 1993. Shadow Wages and Peasant Family Labor Supply: An Econometric Application to the Peruvian Sierra. *Review of Economic Studies* 60, 903-921.

Jacoby, G. Hanan, Li, Guo, Rozelle, Scott, 2002. Hazards of Expropriation: Tenure Insecurity and Investment in Rural China. *American Economic Review* 925, 1420-1447.

Jarvis, Lovell, Vera-Toscano, Esperanza, 2004. Seasonal Adjustment in a Market for Female Agricultural Workers. *American Journal of Agricultural Economics* 86, 254-266.

Jenkins, P. Stephen, 1995. Easy Estimation Methods for Discrete-time Duration Models. *Oxford Bulletin of Economics and Statistics* 57, 129-138.

Jenkins, P. Stephen, 1997. Discrete Time Proportional Hazards Regression. *Stata Technical Bulletin* 39, 22-32. College Station, TX.

Jorgenson, Dale, Lau, Lawrence, 1969. An Economic Theory of Agricultural Household Behavior, *4th Eastern Meeting of the Econometric Society, Tokyo, Japan*.

Juvancic, Luka, Erjavec, Emil, 2005. Intertemporal Analysis of Employment Decisions on Agricultural Holdings in Slovenia, *Agricultural Economics* 33, 153-161.

Kalbfleisch, D. John, Prentice, L. Ross, 2002. The Statistical Analysis of Failure Time Data. 2nd ed., John Wiley and Sons.

Kahn, M. Lawrence, Low, A. Stuart, 1982. The Relative Effects of Employed and Unemployed Job Search. *Review of Economics and Statistics* 64, 234-241.

Key, Nigel, Sadoulet, Elisabeth, de Janvry, Alain, 2000. Transaction Costs and Agricultural Household Supply Response. *American Journal of Agricultural Economics* 82, 245-259.

Kiefer, M. Nicholas, 1988. Economic Duration Data and Hazard Functions. *Journal of Economic Literature* 26, 646-679.

Kimhi, Ayal, 1994. Quasi Maximum Likelihood Estimation of Multivariate Probit Models: Farm Couple's Labor Participation. *American Journal of Agricultural Economics* 76, 828-836.

Kimhi, Ayal, 2006. Plot Size and Maize Productivity in Zambia: Is there an Inverse Relationship?. *Agricultural Economics* 35, 1-9.

Krishna, Raj, 1964. Theory of the Firm: Rapporteur's Report. *Indian Economic Journal* 11, 514-525.

Knight, B. John, Song, Lina, 1995. Towards a Labor Market in China. *Oxford Review of Economic Policy* 11, 97-117.

Knight, B. John, Yueh, Linda, 2002. The Role of Social Capital in the Labour Market in China. Discussion Paper No 121. *Department of Economics, University of Oxford*.

Kuhn, Peter, Skuterud, Mikal, 2004. Internet Job Search and Unemployment Durations. *American Economic Review* 94, 218-232.

Kung, K. Jame, 2002. Off-farm Labor Markets and the Emergence of Land Rental Markets in Rural China, *Journal of Comparative Economics* 30, 395-414.

Lancaster, Tony, 1990. The Econometric Analysis of Transition Data, Econometric Society Monograph No. 17, Cambridge University Press, Cambridge.

Lass, A. Daniel, Gempesaw II, M.Conrado, 1992. The Supply of Off-farm Labor: A Random Coefficients Approach. *American Journal of Agricultural Economics* 74, 400-411.

Lee, Myungheon, 1998. Off-farm Labor Supply and Various Related Aspects of Resource Allocation by Agricultural Households. Dissertation zur Erlangung des Doktorgrades der Falkultaet Fuer Agrarwissenschaften der Georg-August-Universitaet Goettingen.

Li, Hongbin, Rozelle, Scott, 2004. Insider Privatization with a Tail: The Screening Contract and Performance of Privatized Firms in Rural China. *Journal of Development Economics* 75, 1-26.

Light, Audrey, Ureta, Manuelita, 1992. Panel Estimates of Male and Female Job Turnover Behavior: Can Female Nonquitters be Identified? *Journal of Labor Economics* 10, 156-181.

Light, Audrey, Omori, Yoshiaki, 2004. Unemployment Insurance and Job Quits. *Journal of Labor Economics* 22, 159-188.

Lin, J. Yifu, 1991. Prohibition of Factor Market Exchanges and Technological Choice in Chinese Agriculture. *Journal of Development Studies* 7, 1-15.

Lin, J. Yifu, 1992. Rural Reforms and Agricultural Growth in China. *American Economic Review* 82, 34-51.

Liu, Shouying, Carter, Michael, Yao, Yang, 1998. Dimension and Diversity of Property Right in Rural China: Dilemmas on the Road to Further Reform. *World Development* 26, 1789-1806.

Liu, Yunhua, Wang, Xiaobing, 2005. Technological Progress and Chinese Agricultural Growth in the 1990s. *China Economic Review* 16, 419-440.

Lopez, E. Ramon, 1994. Estimating Labor Supply and Production Decisions of Self-employed Farm Producers. *European Economic Review* 24, 61-82.

Lohmar, Bryan, 2000. The Effect of Land Tenure and Grain Quota Policies on Farm Households Labor Allocation. Ph.D Dissertation, University of California, Davis.

Lovell, Jarvis, Esperanza, Vera-Toscano, 2004. Seasonal Adjustment in a Market for Female Agricultural Workers. *American Journal of Agricultural Economics* 86, 254-266.

Low, Allan, 1986. Agricultural Development in Southern Africa: Farm-Household Economics and the Food Crisis. James Currey, London.

Lu, Xiaobo, Bernstein, Thomas, 2000. Taxation without Representation: Chinese State and Peasants in the New Reform Era. *The China Quarterly* 163, 111-132.

Maddala, S. Gangadharro, 1983. Limited-dependent and Qualitative Variables in Econometrics. Econometric Society Monographs No. 3, Cambridge University Press, Cambridge.

Maechler, Andréa, Roland-Holst, W. David, 1995. Empirical Specifications for a General Equilibrium Analysis of Labor Market Policies and Adjustments. OECD Working Papers 3 (35). *OECD, Paris*.

Mallee, Hein, 2000. Agricultural Labor and Rural Population Mobility: Some Observations. In: West, Loraine A., Zhao, Yaohui (Eds.), *Rural Labor Flows in China*, University of California Press, Berkley, pp. 34-66.

Maurer-Fazio, Margaret, 1999. Earnings and Education in China's Transition to a Market Economy: Survey Evidence from 1989 to 1992. *China Economic Review* 10, 17-40.

McMillan, John, Whalley, John, Zhu, Lijing, 1989. The Impact of China's Economic Reforms on Agricultural Productivity Growth. *Journal of Political Economy* 97, 781-807.

Meitzen, E. Mark, 1986. Differences in Male and Female Job-quitting Behavior. *Journal of Labor Economics* 4, 151-167.

Meng, Xin, 2000. Labor Market Reform in China. Cambridge University Press, Cambridge.

Meyer, D. Bruce, 1990. Unemployment Insurance and Unemployment Spells, *Econometrica* 58, 757-782.

Mills, S. Edwin, 1972. *Urban Economics*. Glenview, IL: Scott, Foresman, 1972.

Mishra, K. Ashok, Goodwin, K. Barry, 1997. Farm Income Variability and the Supply of Off-farm Labor. *American Journal of Agricultural Economics* 79, 880-887.

Mohapatra, Sandeep, Huang, Jikun, Rozelle, Scott, 2006. Climbing the Development Ladder: Economic Development and the Evolution of Occupations in Rural China. *Journal of Development Studies* 42, 1023-1055.

Nakamura, Alice, Nakamura, Masao, 1985. Dynamic Models of the Labor Force Behavior of Married Women Which Can Be Estimated Using Limited Amounts of Past Information. *Journal of Econometrics* 27, 273-298.

New York Times, 2005. China to Drop Urbanite-Peasant Legal Differences. November 3, 2005.

Ooms, L. Daan, Peerlings, H. M. Jack, 2005. On- and Off-farm Labour Supply of Dutch Dairy Farmers: Estimation and Policy Simulations. Contributed paper to *XIth EAAE Conference, Copenhagen, Denmark*, August 24-27, 2005.

Orazem, F. Peter, Vodopivec, Milan, 1997. Value of Human Capital in Transition to Market: Evidence from Slovenia. *European Economic Review* 41, 893-903.

Pang, Lihua, de Brauw, Alan, Rozelle, Scott, 2004. Working until You Drop: the Elderly of Rural China. *The China Journal* 52, 73-94.

Park, Albert, Jin, Hehui, Rozelle, Scott, Huang, Jikun, 2002. Market Emergence and Transition: Arbitrage, Transaction Costs, and Autarky in China's Grain Markets. *American Journal of Agricultural Economics* 84, 67-82.

Porterfield, L. Shirley, 1998. On the Precipice of Reform: Welfare Spell Durations for Rural, Female-Headed Families. *American Journal of Agricultural Economics* 80, 994-999.

Prentice, R. L., Gloeckler, L. A., 1978. Regression Analysis of Grouped Survival Data with Application to Breast Cancer Data. *Biometrics* 34, 57-67.

Roed, Knut, Nordberg, Morten, 2003. Temporary Layoffs and the Duration of Unemployment. *Labor Economics* 10, 381-398,

Rosenzweig, R. Mark, 1980. Neoclassical Theory and the Optimizing Peasant: An Econometric Analysis of Market Family Labor Supply in a Developing Country. *Quarterly Journal of Economics* 94, 31-55.

Rozelle, Scott, 1994. Decision-making in China's Rural Economy: The Linkage between Village Leaders and Farm Households. *The China Quarterly* 137, 99-124.

Rozelle, Scott, Li, Guo, Shen, Minggao, Hughart, Amelia, Giles, John, 1999. Leaving China's Farms: Survey Results of New Paths and Remaining Hurdles to Rural Migration. *The China Quarterly* 158, 367-393.

Rozelle, Scott, Brandt, Loren, Li, Guo, Huang, Jikung, 2002. Land Rights in China: Review of the Facts, Fictions, and Issues. *The China Journal* 47, 67-97.

Rozelle, Scott, Swinnen, Johan, 2004. Success and Failure of Reform: Insight from the Transition of Agriculture. *Journal of Economic Literature* XLII, 404-456.

Rozelle, Scott, Huang, Jikun, Paggi, Mechel, Sumner, A. Daniel, 2006. Supply, Demand and Trade for Horticultural Commodities in China. Working Paper, Department of Agricultural and Resource Economics, *University of California, Davis*.

Sadoulet, Elisabeth, de Janvry, Alain, Benjamin, Catherine, 1998. Household Behavior with Imperfect Labor Markets. *Industrial Relations* 37, 85-108.

Schmitt, Gerhard, 1991. Why is the Agriculture of Advanced Western Economies still Organised by Family Farms? Will this Continue to be in the Future? *European Review of Agricultural Economics* 18, 443-458.

Sicular, Terry, 1995. Redefining State, Plan and Market: China's Reforms in Agricultural Commerce, *China Quarterly* 144, 1020-1046.

Skoufias, Emmanuel, 1994. Using Shadow Wages to Estimate Labor Supply of Agricultural Households. *American Journal of Agricultural Economics* 76, 215-227.

Singh, Inderjit, Squire, Lyn, Strauss, John, 1986. A Survey of Agricultural Household Models: Recent Findings and Policy Implications. *World Bank Economic Review* 1, 149-179.

Smil, Vaclav, 1992. China's environment in the 1980s: Some critical changes. *Ambio* 21, 431-436.

Sonntag, H. Bernard, Huang, Jikung, Rozelle, Scott, Skerritt, H. John, 2005. China's Agricultural And Rural Development in the Early 21st Century. *ACIAR.*

Sonoda, Tadashi, Maruyama, Yoshihiro, 1999. Effects of the Internal Wage on Output Supply: A Structural Estimation for Japanese Rice Farmers. *American Journal of Agricultural Economics* 81, 131-143.

Sorm, Vit, Terrell, Katherine, 2000. Sectoral Restructuring and Labor Mobility: A Comparative Look at the Czech Republic. *Journal of Comparative Economics* 28, 431-455.

SSB (State Statistical Bureau). China Statistical Yearbook, various issues. Beijing.

Stark, Oded, Bloom, David, 1985. The New Economics of Labor Migration. *American Economic Review* 75, 173-178.

Sueyoshi, Glenn, 1995. A Class of Binary Response Models for Grouped Duration Data. *Journal of Applied Econometrics* 10, 411-431.

Sumner, A. Daniel, 1982. The Off-farm Labor Supply of Farmers. *American Journal of Agricultural Economics* 64, 499-509.

Sumner, A. Daniel, 1991. Useful directions for research on multiple job-holding among farm families. In M.C. Hallberg, J.L. Findeis and D.A. Lass (eds), *Multiple Job-holding among Farm Families*. Ames, IA: Iowa State University Press, 149-160.

Swartz, K. Marcotte, J. McBride, T.D. 1993. Spells Without Health Insurance: The Distribution of Durations when Left Censored Spells are Included. *Inquiry* 30, 77-83.

Taylor, J. Edward, Rozelle, Scott, de Brauw, Alan, 2003. Migration and Incomes in Source Communities: A New Economics of Migration Perspective from China. *Economic Development and Cultural Change* 52, 75-101.

Ter Berg, Peter, 1994. Deductibles and the Inverse Gaussian Distribution. *Astin Bulletin* 24, 319-323.

Tian, Guoqiang, 2000. Property Rights and the Nature of Chinese Collective Enterprises. *Journal of Comparative Economics* 28, 247-268.

Tokle, G.J., Huffman, E. Wallace, 1991. Local Economic Conditions and Wage Labor Decisions of Farm and Rural Nonfarm Couples. *American Journal of Agricultural Economics* 73, 652-670.

Tuan, Francis, Somwaru, Agapi, Diao, Xinshen, 2000. Rural Labor Migration, Characteristics, and Employment Patterns: A Study Based on China's Agricultural Census. TMD Discussion Paper No. 63, *IFPRI,* Washington, D. C.

Waldman, Cliff, 2004. The Labor Market in Post-reform China: History, Evidence, and Implications. *Business Economics* 39, 50-62.

Wang, Xiaobing, Herzfeld, Thomas, Glauben, Thomas, 2007. Labor Allocation in Transition: Evidence from Chinese Rural Households. *China Economic Review* 18, 287-308.

Weersink, Alfons, Rozelle, Scott, 1997. Marketing Reforms, Market Development, and Agricultural Production in China. *Agricultural Economics* 17, 95-114.

Weiss, Christoph, 1997, Do They Come Back Again? The Symmetry and Reversibility of Off-farm Employment. *European Review of Agricultural Economics* 24, 65-84.

Wooldridge, M. Jeffrey, 2002. *Econometric Analysis of Cross Section and Panel Data*. MIT Press, Cambridge.

Yang, D. Tao, 1997a. Education and Off-farm Work. *Economic Development and Cultural Change* 45, 613-632.

Yang, D. Tao, 1997b. China's Land Arrangements and Rural Labor Mobility. *China Economic Review* 8, 101-116.

Yang, D. Tao, Zhou, Hao, 1999. Rural-urban Disparity and Sectoral Labor Allocation in China. *Journal of Development Studies* 35, 105-133.

Yang, D. Tao, 2004. Education and Allocative Efficiency: Household Income Growth during Rural Reforms in China. *Journal of Development Economics* 74, 137-162.

Yao, Yang, 2000. The Development of the Land Lease Market in Rural China. *Land Economics* 76, 252-266.

Zhai, Fan, Hertel, Thomas, Wang, Zhi, 2003. Labor Market Distortions, Rural-Urban Inequality and the Opening of China's Economy. GTAP Working Paper No. 27, *West Lafayette*.

Zhang, Jian, Zhang, Linxiu, Rozelle Scott, Boucher Steve, 2006. Self Employment: The Forgotten Engine of Rural China's Growth. *Contemporary Economic Policy* 24, 446-458.

Zhang, Linxiu, Rozelle, Scott, Huang, Jikun, 2001. Off-farm Jobs and On-farm Work in Periods of Boom and Bust in Rural China. *Journal of Comparative Economics* 29, 505-526.

Zhang, Linxiu, de Brauw, Alan, Rozelle, Scott, 2004. China's Rural Labor Market Development and Its Gender Implications. *China Economic Review* 15, 230-247.

Zhao, Yaohui, 1999. Labor Migration and Earnings Differences: The Case of China. *Economic Development and Cultural Change* 47, 767-782.

Zhao, Yaohui, 2002. Causes and Consequences of Return Migration: Recent Evidence from China. *Journal of Comparative Economics* 30, 376-394.

Zhao, Yaohui, 2003. The Role of Migrant Networks in Labor Migration: The Case of China. *Contemporary Economic Policy* 21, 500-511.

Appendix A

Because demand and supply of labor time is conditional on participation in the respective labor market, a selectivity bias in the error terms of the labor demand and supply equations may be possible (HECKMAN, 1974, 1979). In this estimation procedure, the demand for hired labor and supply of off-farm work, which are conditional on households' labor market participation decisions (13) and (15), are estimated as the first step using probit estimation techniques. To be consistent with labor participation decison, the resulting means of demand and supply function involve the conditional nature of dependent variables D_h and D_s and could be expressed as:

$$E(L_h \mid z^1, D_h^* > 0, D_s^* < 0) = r_h^1 z^1 + E(u_h \mid D_h^* > 0, D_s^* < 0) \tag{A1}$$

$$E(L_s \mid z^2, D_h^* < 0, D_s^* > 0) = r_s^2 z^2 + E(u_s \mid D_h^* < 0, D_s^* > 0) \tag{A2}$$

$$E(L_h \mid z^3, D_h^* > 0, D_s^* > 0) = r_h^3 z^3 + E(u_h \mid D_h^* > 0, D_s^* > 0) \tag{A3}$$

$$E(L_s \mid z^3, D_h^* > 0, D_s^* > 0) = r_s^3 z^3 + E(u_s \mid D_l^{h*} > 0, D_l^{s*} > 0) \tag{A4}$$

Here the vector z^1, z^2, and z^3 represent the sets of exogenous variables for each of the identified regimes.

Given the interactive nature of households' participation decision with the multiple choice indicators (16a) and (16b), the second-stage Heckman time demand and supply functions should be corrected by the inverse Mill's ratio, due to the possible non-zero distribution of μ^1, μ^2, and μ^3, if sample selection problem occurs in the data (HECKMAN, 1979; LASS and GEMPESAW II, 1992).[63] The demand and supply functions estimated in the second stage take the following form:

$$L_{hi} = r_h^1 z_i^1 + \mu_{hi}^1, \quad \forall i \in n^1 \tag{A5}$$

$$L_{si} = r_s^2 z_i^2 + \mu_{si}^2, \quad \forall i \in n^2 \tag{A6}$$

$$L_{hi} = r_h^3 z_i^3 + \mu_{hi}^3, \quad \forall i \in n^3 \tag{A7}$$

$$L_{si} = r_s^3 z_i^3 + \mu_{si}^3, \quad \forall i \in n^3 \tag{A8}$$

[63] The inverse Mills' ratio for each household *i* is the quotient of the probability density and cumulative probability function attained from Heckman first stage estimation, that is expressed as $\lambda_{li} = \phi(z_{li}) / \Phi(z_{li})$

where n^1, n^2, and n^3 represent the subsets of sample households for the respective regimes. Factors to correct the sample selectivity bias have been involved in the corresponding independent variables and parameters (LASS and GEMPESAW II, 1992; GREENE, 2002).

Appendix B

Table B1: Static distribution of households' labor participation

Labor participation state	*h*[a]	*s*	*sh*	*a*	*Total*
Year	No.	No.	No.	No.	No.
1995	2	209	49	55	315
1996	8	314	38	81	441
1997	6	309	40	84	439
1998	13	311	37	63	424
1999	4	303	64	68	439
2000	3	300	66	70	439
2001	3	279	48	58	388
2002	6	295	55	63	419
1995-2002	45	2320	397	542	3304

Source: Survey conducted by RCRE survey team in Zhejiang province from 1995 to 2002.

Note: [a.] *h, s, sh* and *a* represent hiring labor force, working off-farm, demand and supply labor simultaneously and autarky, respectively.

Table B2: Education attainment and Skill of the labor force

Year	Share of laborers with different levels of education attainment (%)								Share of labor with skill (%)	
	Illiterate		Elementary schooling		Secondary schooling		High schooling and above			
1995	15.91	(27.02)	44.34	(36.35)	33.04	(32.31)	6.71	(17.49)	11.02	(22.34)
1996	16.51	(26.20)	43.62	(33.41)	32.63	(30.55)	7.24	(18.72)	8.81	(19.44)
1997	16.38	(27.30)	42.96	(33.03)	34.40	(31.01)	6.26	(17.66)	8.93	(19.18)
1998	15.58	(25.84)	42.87	(33.05)	34.00	(31.35)	7.54	(18.67)	8.65	(19.06)
1999	15.23	(26.18)	42.14	(33.25)	34.61	(31.23)	8.03	(19.54)	8.83	(19.01)
2000	15.44	(26.48)	41.33	(33.03)	34.48	(31.41)	8.74	(19.97)	8.40	(18.20)
2001	12.03	(24.25)	42.10	(33.48)	36.92	(32.59)	8.94	(20.06)	8.58	(18.44)
2002	11.26	(22.12)	41.30	(34.05)	37.67	(32.87)	9.77	(21.26)	8.76	(19.09)

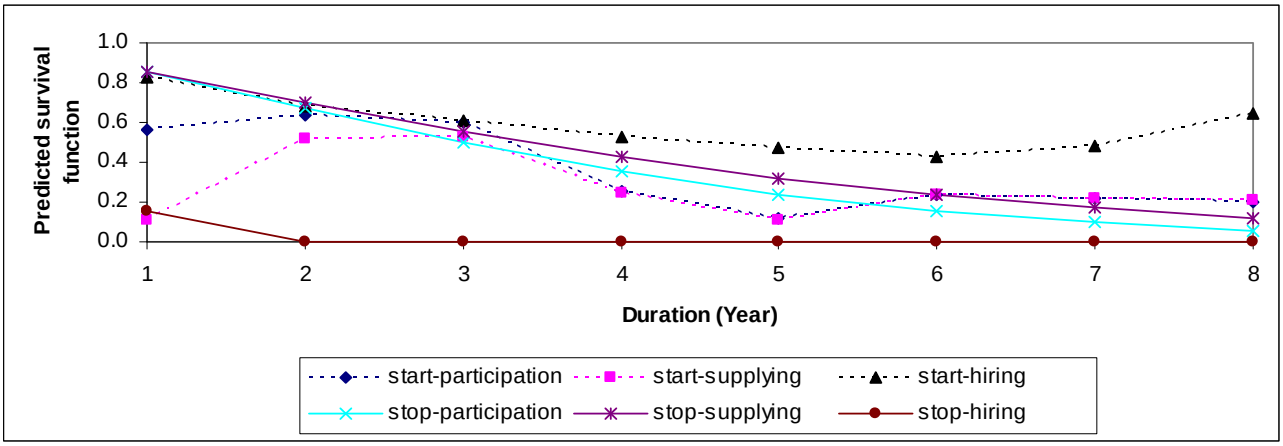
Source: Survey conducted by RCRE survey team in Zhejiang province from 1995 to 2002.

Table B3: Maximum likelihood estimated results of the constant-only duration model

Household's transition	Start participation	Stop participation	Start supplying	Stop supplying	Start hiring	Stop hiring
Symbol	***a*** → ***h*** *or* ***s*** *or* ***sh***	***h*** *or* ***s*** *or* ***sh*** → ***a***	***a*** *or* ***h*** → ***s*** *or* ***sh***	***s*** *or* ***sh*** → ***a*** *or* ***h***	***a*** *or* ***s*** → ***h*** *or* ***sh***	***h*** *or* ***sh*** → ***a*** *or* ***s***
Constant	-0.5592***	-2.4562***	-0.5729***	-2.3464***	-2.9426***	-0.9480***
	(8.47)	(36.99)	(8.99)	(36.94)	(35.67)	(11.23)
Log likelihood	-371.1528	-784.6238	-401.2709	-829.9966	-579.5785	-277.4968
Observation	542	2762	587	2717	2862	442

Note: Z-values in parentheses, ***, **, and * indicate statistical significance at 1%, 5% and 10% levels, respectively.

Figure B1: Survival functions for the transition of households in labor markets



Studies on the Agricultural and Food Sector in Central and Eastern Europe
edited by Leibniz Institute of Agricultural Development in Central and Eastern Europe (IAMO)
ISSN 1436-221X

Vol. 1 **The importance of institutions for the transition in Central and Eastern Europe with emphasis on agricultural and food industry**
ed. by Klaus Frohberg and Witold-Roger Poganietz
1998, 137 pages, ISBN 3-8175-0258-3

Vol. 2 **The significance of politics and institutions for the design and formation of agricultural Policies**
ed. by Klaus Frohberg and Peter Weingarten
1999, 254 pages, ISBN 3-8175-0289-3

Vol. 3 **Food processing and distribution in transition countries. Problems and perspectives**
ed. by Monika Hartmann and Jürgen Wandel
1999, 349 pages, ISBN 3-8175-0293-1

Vol. 4 **Die private Nachfrage nach Nahrungsmitteln im Transformationsprozeß Tschechiens und Polens**
Stephan Brosig (PhD)
2000, 171 Seiten, ISBN 3-8175-0319-9

Vol. 5 **Integrating Estonia into the EU: Quantitative analysis of the agricultural and food sector**
Achim Fock (PhD)
2000, 286 pages, ISBN 3-8175-0320-2

Vol. 6 **Competitiveness of agricultural enterprises and farm activities in transition countries**
ed. by Peter Tillack and Frauke Pirscher
2000, 216 pages, ISBN 3-8175-0322-9

Vol. 7 **Конкурентоспособность сельскохозяйственных предприятий и фермерской деятельности в странах переходного периода**
под редакцией Петера Тиллака и Фрауке Пиршер
2000, 253 страницы, ISBN 3-8175-0324-5

Vol. 8 **Perspectives on agriculture in transition: Analytical issues, modelling approaches, and case study results**
ed. by Witold-Roger Poganietz, Alberto Zezza, Klaus Frohberg and Kostas G. Stamoulis
2000, 433 pages, ISBN 3-8175-0323-7

Vol. 9 **Land ownership, land markets and their influence on the efficiency of agricultural production in Central and Eastern Europe**
ed. by Peter Tillack and Eberhard Schulze
2000, 485 pages, ISBN 3-8175-0325-3

Vol. 10 **Landwirtschaft und Industrie in Russland – Der Transformationsprozeß in der Ernährungsindustrie**
Jürgen Wandel (PhD)
2000, 361 Seiten, ISBN 3-8175-0334-2

Vol. 11 **Food consumption in Russia. An econometric analysis based on household data**
Karin Elsner (PhD)
2001, 256 pages, ISBN 3-8175-0335-0

Vol. 12 **Alexander Wasiljewitsch Tschajanow – Die Tragödie eines großen Agrarökonomen**
hrsg. u. übers. von Eberhard Schulze
2001, 192 Seiten, ISBN 3-8175-0342-3

Vol. 13 **Analysis of food consumption in Central and Eastern Europe: Relevance and empirical methods**
ed. by Stephan Brosig and Monika Hartmann
2001, 253 pages, ISBN 3-8175-0349-0

Vol. 14 **Wettbewerbsprozesse und Firmenwachstum in der Transformation am Beispiel der polnischen Fleischindustrie**
Agata Pieniadz (PhD)
2002, 291 Seiten, ISBN 3-8175-0360-1

Vol. 15 **Agricultural enterprises in transition: Parallels and divergences in Eastern Germany, Poland and Hungary**
ed. by Ludger Hinners-Tobrägel and Jürgen Heinrich
2002, 455 pages, ISBN 3-8175-0366-0

Vol. 16 **Agricultural technology and economic development of Central and Eastern Europe. Results of the workshop in Halle, 2nd-3rd July 2001**
ed. by Peter Tillack and Ulrich Fiege
2002, 160 pages, ISBN 3-86037-199-1

Vol. 17 **Региональные аспекты аграрных преобразований: Политика, реструктуризация, рыночная адаптация**
под редакцией Петера Тиллака и Виталия Зиновчука
2003, 236 страницы, ISBN 3-928466-55-0

Vol. 18 **Alexander Vasilievich Chayanov – The tragedy of an outstanding agricultural economist**
ed. by Eberhard Schulze
2003, 188 pages, ISBN 3-86037-201-7

Vol. 19 **Development of agricultural market and trade policies in the CEE Candidate Countries**
by the Network of Independent Agricultural Experts in the CEE Candidate Countries
2003, 72 pages, ISBN 3-86037-212-2

Vol. 20 **Large farm management**
ed. by Alfons Balmann and Alexej Lissitsa
2003, 396 pages, ISBN 3-86037-213-0

Vol. 21 **Success and failures of transition – The Russian agriculture between fall and resurrection**
ed. by Eberhard Schulze, Elke Knappe, Eugenia Serova, Peter Wehrheim
2003, 521 pages, ISBN 3-9809270-1-6

Vol. 22 **Subsistence agriculture in Central and Eastern Europe: How to break the vicious circle?**
ed. by Steffen Abele and Klaus Frohberg
2003, 233 pages, ISBN 3-9809270-2-4

Vol. 23 **Pfadabhängigkeiten und Effizienz der Betriebsstrukturen in der ukrainischen Landwirtschaft – Eine theoretische und empirische Analyse**
Andriy Nedoborovskyy (PhD)
2004, 197 Seiten, ISBN 3-86037-216-5

Vol. 24 **Nichtmonetäre Transaktionen in der ukrainischen Landwirtschaft: Determinanten, Spezifika und Folgen**
Olena Dolud (PhD)
2004, 190 Seiten, ISBN 3-9809270-3-2

Vol. 25 **The role of agriculture in Central and Eastern European rural development: Engine of change or social buffer?**
ed. by Martin Petrick and Peter Weingarten
2004, 426 pages, ISBN 3-9809270-4-0

Vol. 26 **Credit rationing of Polish farm households – A theoretical and empirical analysis**
Martin Petrick (PhD)
2004, 254 pages, ISBN 3-9809270-6-7

Vol. 27 **Drei Jahrhunderte Agrarwissenschaft in Russland: Von 1700 bis zur Gegenwart**
Alexander Alexandrowitsch Nikonow und Eberhard Schulze
2004, 232 Seiten, ISBN 3-9809270-8-3

Vol. 28 **Russlands Weg vom Plan zum Markt: Sektorale Trends und regionale Spezifika**
Peter Voigt (PhD)
2004, 270 Seiten, ISBN 3-9809270-9-1

Vol. 29 **Auswirkungen des Transformationsprozesses auf die sozio-ökonomischen Funktionen ukrainischer Landwirtschaftsunternehmen**
Helga Biesold (PhD)
2004 182 Seiten, ISBN 3-938584-00-9

Vol. 30 **Agricultural policies and farm structures – Agent-based modelling and application to EU-policy reform**
Kathrin Happe (PhD)
2004, 291 pages, ISBN 3-938584-01-7

Vol. 31 **How effective is the invisible hand? Agricultural and food markets in Central and Eastern Europe**
ed. by Stephan Brosig and Heinrich Hockmann
2005, 361 pages, ISBN 3-938584-03-3

Vol. 32 **Erfolgsfaktoren von landwirtschaftlichen Unternehmen mit Marktfruchtanbau in Sachsen-Anhalt**
Kirsti Dautzenberg (PhD)
2005, 161 Seiten, ISBN 3-938584-06-8

Vol. 33 **Agriculture in the face of changing markets, institutions and policies: Challenges and strategies**
ed. by Jarmila Curtiss, Alfons Balmann, Kirsti Dautzenberg, Kathrin Happe
2006, 544 pages, ISBN 3-938584-10-6

Vol. 34 **Making rural households' livelihoods more resilient – The importance of social capital and the underlying social networks**
ed. by Gertrud Buchenrieder and Thomas Dufhues
2006, 106 pages, ISBN 3-938584-13-0

Vol. 35 **Außerlandwirtschaftliche Diversifikation im Transformationsprozess. Diversifikationsentscheidungen und -strategien ländlicher Haushalte in Slowenien und Mazedonien**
Judith Möllers (PhD)
2006, 323 Seiten, ISBN 3-938584-14-9

Vol. 36 **Accessing rural finance – The rural financial market in Northern Vietnam**
Thomas Dufhues (PhD)
2007, 166 Seiten, ISBN 3-938584-16-5

Vol. 37 **Страхование посевов в Казахстане: Анализ возможностей эффективного управления рисками**
Раушан Бокушева, Олаф Хайдельбах, Талгат Кусайынов
2007, 82 Seiten, ISBN 3-938584-17-3

Vol. 38 **Rethinking agricultural reform in Ukraine**
Zvi Lerman, David Sedik, Nikolai Pugachov, Aleksandr Goncharuk
2007, 167 Seiten, ISBN 3-938584-18-1

Vol. 39 **Sustainable rural development: What is the role of the agri-food sector?**
ed. by Martin Petrick, Gertrud Buchenrieder
2007, 293 pages, ISBN 3-938584-22-X

Vol. 40 **Efficiency of selected risk management instruments – An empirical analysis of risk reduction in Kazakhstani crop production**
Olaf Heidelbach (PhD)
2007, 223 Seiten, ISBN 3-938584-19-X

Vol. 41 **Marktstruktur und Preisbildung auf dem ukrainischen Markt für Rohmilch**
Oleksandr Perekhozhuk (PhD)
2007, 274 Seiten, ISBN 978-3-938584-24-8

Vol. 42 **Labor market behavior of Chinese rural households during transition**
Xiaobing Wang (PhD)
2007, 140 Seiten, ISBN 978-3-938584-25-5