Migration and the Welfare of Rural Households in the Developing Countries: Evidence from China

by

Zhongyuan Liu

(Under the Direction of Jeffrey H. Dorfman)

Abstract

Early literature on development economics has documented that the growth path of most advanced economies was accompanied by a process of structural transformation: the real location of labor forces across sectors and regions. Despite the substantial rapid expansion of labor migration in the past decades, emerging economies like China, India, and Vietnam maintained disproportionate employment in agriculture compared to other countries at similar levels of per capita GDP. Therefore, understanding why does the agricultural sector hold so many workers and how do labor distortions households welfare, are especially pressing issues.

My dissertation addresses these issues from three aspects using the evidence from China. The first chapter focuses on the non-separability between the land

market and labor market, and explore whether the imperfection of land markets hinder rural labor migration. The second chapter sheds light on migrant workers' environmental concerns and links migration decision to the poor smog pollution. The last chapter discusses the impact of social isolation on the migrants' risky health behaviors such as smoking and explores the heterogeneous impact across gender.

INDEX WORDS: Migration, property rights, migrant workers, environmental concerns, smoke

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Dedication

To Wenbo and Matthew

Preface

In a world-known economic research institution in US, there exists an unwritten rule: students from other countries, especially developing world are encouraged to develop their dissertation topics based on their own countries. This spirit inspired me on the first day when I enrolled in the University of Georgia.

My research topic is closely related to my own experience: I was born in a remote and poor rural area in Anhui Province. Job opportunities were very limited and farmers rely heavily on their farmland, which can only feed their family. The first 7 years of my life gave me the first-hand impression about what farmland means to households in rural China. Later, I migrated with my family from my hometown to a more developed town in Zhejiang province when I was 7 years old. Surrounded by migrant workers from different provinces, I developed a emotional bonding to migrant population, which inspired my research interest when was able to develop my own research in Nanjing Agricultural University.

Surprisingly, I realized that what happened in my childhood can related to my present state of mind and research interest. I first started to focus on migration

in 2009 to conduct a social survey on returned migrant workers during the global financial crisis. After that, I conducted several surveys and published about 10 papers to discuss migrants' land rights, which is the most basic rights for rural farmers. When I started to think about the topic for my dissertation, I choose the migration in China without any hesitation.

I am very grateful to my major adviser, Jeffrey Dorfman which is very supportive to my research. He encourages and provides tons of help during my research. He even allows me to return to China to collect some data for my research during summers, when I still have research responsibility for him.

I know my contribution to the research of migration is very small, just like myself in the long human history. But fortunately, while pursuing my research, I know who I am and where I want to go.

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I am deeply grateful to my major adviser, Jeffrey H. Dorfman, and the members of my committee: Chen Zhen and Ellen McCullough for their years of support. During the past four years of cooperation, they have become my spiritual pillars and their erudition, modesty and kindness always encourage me to move forward.

I would like to acknowledge Dr. John Bergstrom, Dr. Wojciech J Florkowski and Dr. Huiguang Chen for their valuable guidance. They provided me the great tools and data I needed to complete the dissertation. I would like to single out my colleague Benjamin Leiva for his support and assistance. We have been worked together during my Ph.D. study and we successfully published a paper together, which built great confidence for my research career.

I want to thank the Graduate School and the Office of Global Study to financially support my trip to China to collect some data for my research in the summer of 2018. I also want to thank the Graduate School for its emergency funding during my accident in radius fracture. I would particularly like to thank the Chinese Student and Scholar Fellowship, like Shiyou Chen, Hongxiang Liu,

Zhuofei Hou, Yixin Ning, Xiangji Liu, Mengyao Li and Xie Tong. All of those brothers and sisters provided great help to me during the last four years.

Lastly, I would like to thank my wife who is a true "helper" in my life. She is always there for me with her warm smile and deep love! I also thank our new baby, Matthew. I would also like to thank my parents Jingqian Liu and Zhenmin Fu and my parents-in-law Shengkang Liu and Chunxiang Ju for their years' support!

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Introduction

The optimal allocation of factor inputs across productive units in a frictionless environment requires the equalization of marginal products. Deviations from this requirement represent a misallocation of resources and lead to inefficiency in aggregate productivity and output (David et al., 2016). For most developing countries, institutions and policies giving rise to factor misallocation are highly pervasive in agriculture sectors. Among all factor misallocations, labor misallocation across sectors and spaces has been emphasized as a major obstacle limiting agricultural productivity and plays an important role in understanding differences in income per capita between countries (Duarte and Restuccia, 2010; Restuccia et al., 2008). Studies show that barriers in the labor market generate large cross-country differences in the share of employment and labor productivity in agriculture (Restuccia et al., 2008). Therefore, understanding how labor distortions at the farm-level affect agricultural productivity, as well as households' well-being, is an especially pressing issue.

Transactions in labor markets in China were severely constrained by government policies before the economic reforms in 1978. The cooperative

movement (1953-1956) collectivized land, labor and other resources and made market exchange in land and labor between households impossible. Rural laborers were restricted to work in the agricultural sector under the supervision of a team leader, and any forms of population flow across spaces were illegal. This situation changed when a new policy called the household responsibility system (HRS) was introduced at the end of 1978. The HRS dissolved the collective production teams and restored individual households as units of agricultural production and income distribution. Through the institutional reforms, rural households were endowed the rights to distribute and reallocate household labors to realize households' utility maximum. Since the reforms in the late 1970s, rural-urban migration was allowed by the central government and has gradually grown to become a momentous force promoting market-oriented reform and economic growth.

The economic incentives for migration came from the growing differences in incomes across households and sectors. The HRS stipulates that the ownership of land resides with the state or the collective and use rights of land are distributed to each household in proportion to its size. This fairly egalitarian allocation of land ensures the equalized land-person ratio, but not necessarily equalized land-labor ratio across households because of different endowments of family labor differing levels of family labor resources. Given that peasant households were heterogeneous in the agricultural production function, both the marginal products of labor and the distribution of income across rural households gradually became unequal, which stimulated population migration. Stark elaborated this in his

relative deprivation theory (Stark, 1984; Stark and Bloom, 1985). Meanwhile, too much of the labor force was allocated to the agricultural sector, which resulted in disparities in the marginal product of labor in agricultural and non-agricultural sectors. Earlier studies showed that the ratio of non-agricultural to agricultural income per worker was 4:1 in Shanghai in the late 1980s. This income differential across sectors induced the rural labor force to move out of the agricultural sector.

The vast scale of migration has been one of the driving forces of China's rapid growth. Specifically, the reallocation of rural labor forces across regions provides abundant cheap labor and reduces labor cost for the development of non-agricultural sectors. Meanwhile, high income and remittance from migrant workers can also raise agricultural productivity through agricultural investment and improves rural social and economic well-being (Restuccia et al., 2008). Earlier studies confirm that rural-to-urban migration accounted for roughly 16 to 22 percent of GDP growth since reforms started in the late 1980s in China (Fang and Wang, 2003). Because of this, the integration of migration into development is viewed as one of the important policy tools that enabled the smooth transfer of millions in the rural labor force out of the agricultural sector and that reshaped Chinese socioeconomic structures. Reforms and policies on migration have long aimed at reducing constraints on labor mobility including the household registration system (*hukou*) and labor market segmentation and discrimination against rural migrants. The latest household registration reform tries to establish a uniform household registration system that does not distinguish between

"agricultural" and "non-agricultural" residents and unifies the social welfare and social services nationwide.

However, as institutional barriers for migration are eased, several perplexing migratory phenomena occur: (1) given that restrictions on migration are well alleviated, agricultural productivity is low (only 8.56 percent of GDP) and the urban-rural income gap per capita is still persistent (2.7:1), 42.65 percent of the population still lives and works in rural areas. Does this mean that rural labor supply in China has reached the Lewis turning point [1] or that stubborn misallocation of labor still exists? (2) despite the fact that an urban *hukou* is superior to a rural *hukou*, rural migrants' intention to settle in the city is not as strong as expected and the majority of migrants are opting to straddle and circulate between the city and their rural hometown and wish to return home eventually (Chen and Fan, 2016; Fan and Sun, 2011; Yue et al., 2010). The lack of declared intention of a permanent or long-lasting change in residence not only fails to alleviate the labor misallocation across spaces or sectors, but also leads to problems concerning social security. (3) Rural-to-urban migrants, a new and rapidly expanding subgroup of the Chinese population, constitutes about 1/3 of all tobacco smokers. The overall smoking prevalence and gender shares of smokers among migrant workers are higher than the population at large. Zheng et al.

[1] **?** pointed out that in a dual economy, surplus labor in agricultural sector is transferred to non-agricultural sector (or modern sector) without raising wage rate. The process continues until a point is reached where labor demand succeeds growth of labor supply and further labor transfer increases wage rate.

(2018) showed that 34.1% (55% male and 4% female) of migrants smoked in 2013.

This research is motivated by the observations of income inequality and productivity difference in the agricultural sector across regions and countries, which lead to concerns about misallocation of labor. Instead of focusing on market friction and institutional barriers in the labor market itself, this dissertation starts from the cross-market effect between the labor market and the land market. We examine whether land market reform could further release constraints to the rural labor force and alleviate the misallocation of labor. Specifically, we study the land title program, which launched in 2008 and is scheduled to finish at the end of 2018, as well as its impact on household labor distribution. This helps us to better understand the first migratory phenomena above and constitutes the first chapter of this dissertation.

Migration, or population mobility, is believed to constitute a key channel for reallocating the labor force across sectors and regions. Attracting migration, however, is only half the story, successfully retaining migrants in the regions or countries in ways that contribute to the development of social capital is the other half (Pavlova and Silbereisen, 2015). The second chapter is motivated by the second migratory phenomena and explores what factors affect migrants' willingness to settle in cities. Among all factors, amenities are critical in determining how attractive a location is to live in (Bryan and Morten, 2015). Therefore, this chapter discusses whether migrants care about local air quality

and what factors contribute to the protective activities directed toward their environment.

The last chapter focuses on the health condition of migrant workers. China is the world's largest producer and consumer of tobacco. Despite the progress made in reducing tobacco use in the overall population, marginalized populations, especially migrant workers, are experiencing disproportionate disparities in exposure to tobacco and tobacco-related health. Social isolation from migration may introduce psychosocial stress, which further induces risky health behaviors such as smoking, and the mechanisms may vary across gender.

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Chapter 1

The Role of Land Institutions in Structural Transformation: Evidence from Rural China[1]

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Abstract

In most developing countries, farm households' ability to migrate is constrained not only by failures in labor markets, but also by imperfections of land markets, such as insecure property rights. This chapter examines two mechanisms: *guard labor requirement* and *land misallocation*, through which property rights insecurity hinders household laborers' optimal allocation. Using the rollout of the land titling program in China from 2008 to 2018 and three waves of the China Health and Retirement Longitudinal Study in 2011, 2013 and 2015, we identify a quasi-experiment and apply the difference-in-difference method to estimate the causal effect of land certificates. We find that farm households obtaining land certificates were subsequently 7.7% more likely to have a migrant household member. We also show that the development of the land rental market can increase migration. This chapter adds new empirical evidence for non-separability between land markets and labor markets when market failures exist, and enriches the literature on the channel through which the development of property rights affects economic development.

Keywords: Migration; property rights; LTP; migrant workers

JEL Codes: O13, O17, P14, Q15

1.1 Introduction

Early literature on development economics has documented that the growth path of most advanced economies was accompanied by a process of structural transformation: the reallocation of labor forces across sectors and regions (Todaro, 1969; Harris et al., 1970; Stark and Bloom, 1985). As economies develop, the employment share of the agricultural sector falls, and rural laborers migrate to cities to find employment in the industrial and service sectors (Clark, 1940; Lewis, 1954). From 1960 to 2017, the world's average employment share in agriculture dropped from 43% to 26%, while the proportion in the service sector rose from 34% to 51% (World Bank, 2018). Despite the rapid expansion of labor migration in the past decades, emerging economies like China, India, Thailand, and Philippines maintained disproportionate employment in agriculture compared to other countries at similar levels of per capita GDP (Taylor and Martin, 2001).[2] Evidence shows that if labor in these countries was hypothetically reallocated to equalize marginal products to realize "U.S. efficiency," total factor productivity would increase by 30%-50% (Hsien and Klenow, 2009; Adamopoulos et al., 2017). The misallocation of labor gives rise to certain questions: how does the agricultural sector in emerging economies hold rural laborers given that restrictions in the labor market have largely been alleviated? Answering the question drives the attempt to understand the forces which induce structural

[2]There are about five lists of emerging market economies from different institutions, such as International Monetary Fund, Morgan Stanley Capital International, Standard and Poor's, Russell, and Dow Jones. However, about 15 countries are classified as emerging markets in all five lists which include some countries we mention here.

transformation.

A farm households' ability to respond to economic incentives in a market without failures can be affected by failures in other markets (de Janvry and Sadoulet, 2003). In the case of household labor distribution, even though constraints from labor markets have been largely dealt with in most developing countries, rural-to-urban migration will not increase if barriers to labor mobility from other imperfect markets remain (Mullan et al., 2011). Farm households in most developing countries are systematically exposed to land market imperfections and constraints (de Janvry and Sadoulet, 2003; Sitko et al., 2014). Property rights insecurity is an especially important land market imperfection. In contrast to developed countries, where property rights are protected by land certificates, developing countries, such as China, Mexico, Kenya, Niger, etc., establish their property rights through customary tenure systems, which usually confer neither land ownership nor fully "individualized" land use rights (Gavian and Fafchamps, 1996; Sitko et al., 2014). The lack of well-defined property rights creates considerable distortions not only in land markets but also in labor allocations, both of which eventually hinder economic performance. Therefore, this paper provides an analysis of the extent to which incomplete property rights can constrain employment transitions from farm to non-farm activities.

This paper is related to a large body of literature studying labor misallocation across sectors (Restuccia and Santaeulalia-llopis, 2017; Adamopoulos et al.,

2017; Restuccia and Rogerson, 2017; Restuccia, 2018). Closely connected is the literature on assessing the economic effects of land registration or land titling programs (Chen et al., 2017; Chen, 2017; Adamopoulos and Restuccia, 2014; Emran and Shilpi, 2015). Past studies of property rights security, especially property title or land registration, have almost exclusively focused on the adverse impact on agricultural investment (Galiani and Schargrodsky, 2004; Place and Migot-Adholla, 1998), the land rental market (Chen et al., 2017; Wang et al., 2018), and the collateral value of land (Field, 2007; Carter and Olinto, 2003; Deininger and Feder, 2009). The impact of land titling programs on structural transformation has not received extensive attention (Field, 2007; de Janvry et al., 2015). Furthermore, the few attempts that address this topic typically treated property insecurity as a tax either on agricultural production or directly on migration choices (Besley, 1995; Besley and Ghatak, 2010; Deininger and Jin, 2006; Mullan et al., 2011). The underlying assumption in those studies is that there exists a hypothetical risk of land expropriation, which connects property rights insecurity to households' reallocation of labor. By contrast, we observe more realistic restrictions from insecure property rights which directly affect household labor reallocation: (1) farm households with insecure property rights typically allocate a portion of household labor in rural areas for contingent use of the land and claiming their land rights; (2) insecurity of property rights impede development of the formal land rental market, which results in either informal land rental behaviors and associated risk of land conflicts, or self-cultivated

production methods with less out-migration in a household.

In this paper, we argue that incomplete property rights can induce cross-market constraints on households' reallocation of labor. Following along the lines of the de Janvry et al. (2015) study of delinking land rights from land use, and extensive studies of the impact of the land rental market and migration (Yao, 2000; Feng and Heerink, 2008; Wang et al., 2018), we identify two causal mechanisms through which land titling programs affect household laborers' reallocations. First, strengthening the security of property rights can eliminate labor misallocation by freeing up labor and/or working time, which we called "guard labor" (Besley and Ghatak, 2010; Field, 2007) in the agricultural sector. That is, the increase of property rights security reduces the need for "guard labor" which was previously devoted to agricultural production principally in order to solidify informal property rights. As de Janvry et al. (2015) state, "delinking land rights from land use through certification hence reduces the opportunity cost of migration." Second, secure property rights activate the development of a formal land rental market, which alleviates land misallocation across farm households and further eliminates labor misallocation. Specifically, the formal land certificate lowers transaction costs in a land rental market and improves the transferability of cultivated land. Thus, farmers who have a strong desire to outmigrate can rent out their contracted land without the risk of land expropriation and land conflicts. In sum, the land titling program could increase the off-farm labor supply by removing the "guard labor requirement" and alleviating land misallocation across

farm households.

To test the two hypothetical mechanisms, we carefully studied the implementation of the land titling program (LTP) in China from 2008 to 2018, and identified a quasi-experiment to estimate the causal effect. We utilized the China Health and Retirement Longitudinal Study (CHARLS) data to form a two-period and two-group panel dataset and applied the difference-in-difference method as the identification strategy to control both time-constant and time-varying confounding factors. We find that farm households obtaining land certifications were subsequently 7.7% more likely to have a migrant household member. We also show that the development of the land rental market can increase migration.

This study offers potential contributions to the literature from two aspects. First, this study systematically examines both theoretically and empirically two potential mechanisms: *guard labor requirement* and *land misallocation*, through which insecure property rights contribute to the misallocation of household labor. Second, this study provides new evidence concerning the relationship between the land titling program and households' reallocation of labor in the context of a country where temporary and unstable migration is predominant. This application in rural China contrasts that of de Janvry et al. (2015) which addressed permanent migration in Mexico.

The remainder of the paper is organized as follows. In Section 1.2, we provide details on the history of land reform in China as well as the research focus which provides the background for this study. Section 1.3 describes the theoretical model that establishes the relationship between land property rights and household labor allocations. Section 1.4 describes the data. Section 1.5 presents the identification strategy and results. Section 1.6 concludes this paper.

1.2 Institutional Background on China

1.2.1 Rural-urban migration in China

The unprecedented labor migration in China from rural to urban areas has been ongoing since the late 1980s. Prior to the tide of migration, the Chinese government vigorously pursued urban-biased policies and strictly constrained rural-to-urban migration. The control of geographic mobility was realized through two fundamental tools, which we label internal and external constraints. The first was the production team system in rural areas in which production teams legally claimed ownership of all aspects of production in rural areas, including land and other productive inputs. Farm household laborers had to participate in farm work to earn *work points* [3] which were used to redeem the net team income at the end of the year. That is, farm households' incomes under the production team system were tied tightly to the quality and quantity of daily collective farm work

[3] In 1957, the Chinese point system was established to form incentives for collective production in the production team system. Farmers who participated in tasks in collective farm work acquired a certain number of points which were used to exchange at the end of the year. See Cremer (1982) and Lin (1988) for details about *work points* system.

(Zhao, 1999; Lin, 1988). Thus, the production team system formed an internal constraint for farm households to out-migrate.

The second tool used by the Chinese government to curb migration has been the *hukou* system (household registration system) which was signed into law in 1958. The *hukou* system was originally designed by the central government to control the flow of population from the countryside to cities when the government prioritized urban industrialization. Specifically, the *hukou* system divided the population into residents with an agricultural *hukou* (*nongmin*) and residents with a non-agricultural *hukou* status (*shimin*), and differentiated state welfare programs according to the *hukou* status. Transfer of *hukou* status from rural to urban, however, was highly restricted. As a result, it was illegal for rural *hukou* holders to live outside their officially registered areas and migrate into cities. Migrants in that period were either ejected by local labor bureaus or lived illegally in cities with far less access to education and other public services. Thus, the *hukou* system formed an external institutional barrier for potential migration and contributed to dualism in the labor market.

Labor mobility was heavily restricted until 1978, when the household responsibility system (hereafter HRS), one of the landmarks of China's economic reform, was launched. The HRS dissolved production teams and restored individual households as units of agricultural production and income distribution. Decollectivization released the internal restriction to labor allocation in the

production team system, and allowed farm households the right to freely distribute household laborers. The HRS boosted both farmers' incentives in farm production and overall agricultural growth significantly between 1978 and 1984 (Lin, 1992). Unsurprisingly, the HRS also resulted in a rural labor surplus in agricultural production given that household land endowments were small. The surplus rural labor supply, together with greater income gaps between rural and urban areas induced a massive and illegal exodus of farmers into urban areas in the late 1980s and early 1990s. With increasing pressure from the tide of unauthorized migration, the central government released the external restriction of the *hukou* system and created temporary residency permits which allowed rural laborers with agricultural *hukou* status to migrate to cities. As a result, the migrant population grew rapidly from 70 million people in 1988, to 100 million by 1997, close to 200 million in 2006 (Chan, 2009), and to 288 million in 2018 (National Bureau of Statistics, 2019).

The supply of rural labor forces following the economic reform in 1978 enabled China's manufacturing sector to maintain a comparative advantage in labor-intensive products. Studies showed that rural-to-urban migration contributed 26.8% to per capita GDP growth from 1982 to 2000 (Cai, 2010). However, starting in 2005, the "labor shortage" phenomenon began appearing in coastal cities, which led to an emerging concern that China had reached the beginning stage of the Lewis Turning Point, meaning there is no longer a rural labor surplus in the economy (Xiaobo et al., 2011; Cai, 2010; Minami and Ma,

2010). It seems that Chinese economic growth is losing its momentum from demographic dividends because of its diminishing labor supply (Cai, 2010). However, 42.65% of the population still lives and works in rural areas while agricultural production accounted for only 8.56% of GDP in 2016. [4] The behavior of these rural labor forces seems contrary to economic logic since the per capita annual urban-rural household income gap ratio grew even wider from 2.57:1 in 1978 to 3.23:1 in 2010. Therefore, it has been highly constrained by some force that restricts farm households from responding to economic incentives.

While rural migrants have strong incentives to migrate and remain in cities, their inclination to change their *hukou* status is much weaker, which is called "China's *hukou* puzzle" (Chen and Fan, 2016). Given that the restrictions on *hukou* conversion were largely removed in recent years, the China Migrants Dynamic Survey indicated that only 11.8% of migrants are willing to convert a rural *hukou* to an urban *hukou* if they are required to return their contract land. Keeping rural land is the most important reason (41%) why rural migrants are not interested in urban *hukou*. These data demonstrate migrants' tight connection with their property rights in rural areas which may contribute to both the labor shortage and "China's *hukou* puzzle". There are two potential explanations. On the one hand, migrants' farmland still provides them with important social security and thus, keeping the rural land is a rational and optimal response to the lack of formal social welfare programs in rural areas. On the other hand, the endowment effect

[4]Data comes from the National Statistical Yearbook of 2017. For further references see: http://www.stats.gov.cn/tjsj/ndsj/2017/indexch.htm

of land resources becomes prominent, and the access and benefits that are tied to property rights, including farming and agricultural income, compensation for land requisition, and free housing land, are considered increasingly valuable. The illiquid wealth in this case is "dead capital" in de Soto's sense (de Soto, 2001). Because of increasing land values and demand tension among villagers in rural areas, rural land conflict has become a major issue in China (Wu and Heerink, 2016; Shan et al., 2017). Claiming property rights under customary tenure systems, however, requires evidence of productive use; thus, many households find it optimal to allocate some household members to the agricultural sector. In other words, it is the incomplete land markets that shape migration patterns as well as farm household behavior. Therefore, it is imperative to review the structure and change of land institutions in China to better understand the complexities of this issue.

1.2.2 Rural land reform in China

The current land system - the HRS - was established in the early 1980s and separated property rights of rural land into a two-level hierarchy: the ownership right and the Land Contractual Management Right (hereafter LCMR) (similar to land use right). The former is collectively owned by a rural community, normally a village administration, and the latter is granted to farm households who contract a piece of land from the village. According to the *Land Management Law* and *Rural Land Contract Law* (hereafter RLCL), the LCMR mainly contains four aspects of property rights that can vary among Chinese villages: residual income rights, unencumbered use rights, transfer rights, and rights to secure possession

(Liu et al., 1998). Compared with property rights in Western countries, however, farm households in China do not possess ownership of property. Meanwhile, the last two aspects of the LCMR - rights to transfer and rights to secure possession - are also not as fully established. Therefore, the land system in China is "quasi-private" and less-protected (Kung, 2002). Insecure property rights in turn induces a high risk of loss of land to farm households during land redistribution, especially when migration happens.

Land allocation in China is built on a highly egalitarian basis (as opposed to a market basis). In order to accommodate demographic changes, such as new-born children, women who get married and move away, and deceased elders, an increasing demand of reallocating land within a village exists to maintain egalitarian land holdings (Rozelle and Li, 1998). Benjamin and Brandt (2002) found that in over two-thirds of all villages, village cadres reallocated land at least once, and on average more than twice during the 1990s. Even after the introduction of the RLCL which disallows large-scale reallocations of land and limits small-scale land reallocations, households remain at continued risk of land reallocation (Deininger and Feder, 2009). Furthermore, migrant workers are more vulnerable to losing property rights during unpredictable land reallocations. Studies show that village officials are more likely to reallocate land from households with family members who work off the farm to households that solely engage in agriculture (Brandt et al., 2002; Kung and Liu, 1997).

Thus, farm households cannot leave land idle when they migrate into cities in search of non-agricultural employment. If farmlands do not present evidence of productive use, they are likely to be taken back by the village cadres, as indicated by Article 37 of the *Land Management Law*:

Where a unit or individual that contracts to operate cultivated land but lets the land lie waste for two years running, the original unit that gave out the contract shall terminate the contract and take back the land under contract.

To compensate for insecure property rights, customary tenure systems around the world and in China usually induce informal institutions to claim land property rights such as allocating "guard labor" (Besley and Ghatak, 2010) or maintaining a minimum agricultural yield (de Janvry et al., 2015). In addition to China, notable examples around the world also include squatters in modern Latin America, who gain some rights to land through prolonged residence (Besley, 1995) - 47% of untitled households in Peru that reported keeping someone at home for property protection (Field, 2007), and land rights in Niger, which are exclusive only for the period of cultivation (Gavian and Fafchamps, 1996). These informal institutions put constraints on farming labor without considering the return to labor in alternative activities. This dispersion in the marginal product of labor across sectors indicates labor misallocation.

Property rights can also distort labor allocation through another mechanism: land misallocation. A lack of well-defined land property rights can lead to a misallocation of land resources within farm households, which has a particularly adverse effect on highly skilled farmers. In theory, if households have the right to rent or lease their property rights to other farmers, the marginal product of the land and labor will be equal among the farmers through factor mobility. In practice, however, incomplete property rights result in thin land rental markets and severe land and labor misallocation. Brandt et al. (2002) found that in 1995, while 71.6% of villages in China reported no restrictions on land rental activity, households rented out less than 3% of their land. Land rentals increased slightly later, but the scope and formality of the land rental market are still underdeveloped, and most contracts remain informal and unwritten. Given that most rentals occurred among family members or close relatives, land resources were not necessarily directed to the best use. Wang et al. (2018) showed that the ratio of land rental in China rose from 17.09% to 24.1% between 2003 and 2013, and 55.05% of farm households did not pay a fee in the land rental process. Since the value of rental property is not sufficient to induce a gain greater than risk for farm households, autarky will be preferred to participation in the land rental market. Autarky in agriculture, in turn, requires households to allocate more labor supply in rural areas for agricultural production and less into migration.

In order to secure the stability of land contracts and encourage agricultural investments, a series of land policies and laws have been passed since the early

1980s. Initially, farm households' right to farm their allocated land was limited to three years. The terms of land contracts were extended to 15 years in 1984, and then extended again to 30 years in 1993 following the expiration of an original land contract. The RLCL was introduced in 2002 to protect long-term land contracts and to legally permit land transfers between households within a village. In 2007, the *Property Law* was passed to define the LCMR as property rights rather than contractual rights. The right to possess, use, transfer, and profit from the land was fulled developed. However, selling or mortgaging land for loans was still prohibited. Meanwhile, land reforms obscured the reform of land ownership, which is the core of property rights. Without clarifying and securing property rights, the misallocation of productive resources can only be corrected to a limited degree.

1.2.3 Property-rights regimes and the Land Titling Program (LTP)

Schlager and Ostrom (1992) provided a remarkable conceptual analysis of property rights which helps review past land reforms and policy orientation in China. In the Schlager and Ostrom (1992) study, a schema for property-rights regimes includes rights of access, withdrawal, management, exclusion, and alienation with an increasing authority to devise future rights. Different levels of property rights define four classes of property-rights holders: authorized user, claimant, proprietor, and owner. In the application of property rights in China, the authorized user only holds rights of access and utilization of land, which authorize farm households to enter a defined land resource and obtain the

products from production activities. Claimants are defined as farm households who possess the same rights as authorized users plus the right of land management which authorizes households to regulate land use patterns, crop selections, and production decisions. If in addition to the rights of claimants, farm households also hold the right of exclusion, then they are defined as proprietors. Proprietors authorize who may access land resources and how land resources may be utilized. Lastly, owners are defined as farm households who possess all property rights, especially the right of alienation which allows them to sell their property rights.

According to the Schlager and Ostrom (1992) theory, the initial land reform in 1978, which established the HRS, authorized farm households the rights of access, utilization, and part of management. Farm households under this property-rights regime can access the contracted land, manage the production pattern, and obtain the agricultural outputs. However, they cannot lease or transfer their access and utilization of land rights to others. Meanwhile, the rights of access to the contracted land were not secure. In other words, they lacked the authority of exclusion. That explains why land reallocation and land expropriation happened frequently in rural areas and most were conducted by village cadres or higher levels of government for the purpose of egalitarian or public interests. The development of property rights later authorized farm households to transfer their land rights. Meanwhile, the extension of land contract terms secured farm households' access to their contracted land. Farm households cannot, however, exclude other individuals or groups access to the property, nor can they sell or mortgage

their property to access credit markets [5]. Thus, farm households in the current property-rights regime are equivalent to the position of claimants in the Schlager and Ostrom (1992) study. The "guard labor" and autarky in agriculture can be understood as a maladaptive coping mechanisms for the lack of rights of exclusion.

The evolution from claimants to proprietors requires the right of exclusion. The right of exclusion can not only produce strong incentives for agricultural investments but can also stimulate participation in the land rental market without worry of loss of property. However, there exist two challenges in the current Chinese property-rights system. First, the expression of the right of exclusion is not clear. Unlike other countries where land ownership conveys the right of exclusion, land in China is collectively owned by a rural community, which has been recorded in China's Constitution since 1982. Second, there are legislative dilemmas about the land contractual management right. Farm households in China only possess the land contractual management right where the claimants have to be the authorized users. Even though the LCMR can be secured and protected which allows exclusion, farmers have to transfer all bundles of rights when they rent out their land. In other words, in the current two-level hierarchy (land ownership and LCMR), farm households in China cannot separate the roles of claimant and authorized user.

[5]The village cadres and local governments townships and countys are the main groups which adjust farm households' properity rights through land reallocation and land explorition. Meanwhile, farmers in the same village may access other households' land rights through informal land transfers.

To endow farm households the right of exclusion, the central government launched two reforms to develop the current property-rights regime. The first reform was the implementation of the Land Titling Program (LTP) in 2008. The LTP started with the third plenary session of the 17th Central Committee of the Communist Party of China in 2008 when the central committee emphasized the importance of the LTP as well as factor mobility. The program was implemented sequentially from pilot villages to pilot counties to pilot provinces and aimed to attain national coverage. The first pilot projects of eight villages from eight different provinces were initiated for LTP in 2009 by the Ministry of Agriculture. Between 2010 and 2012, the pilot projects were expanded to the county level, and there were 50 counties selected to conduct LTP at this level. In 2013, another 105 nationwide counties were selected to expand the pilot programs. With experience from pilot projects at both the village and county levels, three provinces (Anhui, Shandong, and Sichuan) were selected as locations for conducting the first LTP at the province level in 2014. The number of provinces increased to 22 by the end of 2016 and to the entire nation by the end of 2017. The land titling program was completed by the end of 2018.

The second reform aimed to fix the legislative dilemma and stimulate rural land markets. The central government further separated the LCMR into land contractual rights and land operation rights in 2016. Combined with village collective ownership, the three land rights (land ownership, land contractual rights, and land operational rights) constitute the new structure of farmland

rights, which is called the "three rights separation system." The adjustment of the property rights structure makes it possible for farm households to participate in the land rental market as long as their rights of exclusion are well protected. Specifically, village administrations continue to hold farmland ownership and farm households retain land contractual rights over their allotted land with villages and transfer land operation rights if they lease the land to others, mortgage it to banks, or invest it in a cooperative in exchange for shares.

Currently, the difference in property rights between China and most other countries is more clear. The LTP defines land contractual rights in China whereas land ownership itself defines rights in most other countries. Meanwhile, although farm households in China cannot sell their property rights, they can use the titled land as collateral to improve access to credit which improves the efficient use of resources. That is, they possess part of the right of alienation. Thus, a farm household under the three rights separation system and LTP lies between owner and proprietor. Hypothetically, LTP could remove labor constraints from "guard labor" and autarky in agriculture and induce more migration. We will present the theoretical model in the next section.

1.3 Theory

Many discrete decisions are made with consideration of future outcomes. Choices over household's labor distribution are, in part, driven by how these choices affect

future utility or gains (Arcidiacono and Ellickson, 2011). In other words, for a forward-looking household, maximizing the expected present value of future utility from migration decisions does not equate to maximizing current utility from migration in each period. In household labor allocation, there are many ways in which dynamic processes may arise to capture the sequential change. For example, migration decisions in period t result in a change in the land endowment in the following period if the property right is insecure, which in turn affects future migration decisions. Thus, this paper models a household's labor distribution with a dynamic discrete choice model (Keane and Wolpin, 2009; Aguirregabiria and Mira, 2010).

1.3.1 Basic setup

Let us imagine a representative farm household in an agrarian economy which is initially endowed with both laborers and farmland. The household can engage in both agricultural and non-agricultural activities. The non-agricultural activities occur only when household members migrate to cities. In other words, there is no local labor market for non-agricultural employment. Labor endowment in the household, $\bar{L}$, is measured by the total laborers in the household. Land endowment ($\bar{A}$) in this paper refers to pieces of farmland that farmers contract from the collective. If the land rental market exists, the size of cultivated land does not necessarily equal land endowment. The farm household can transfer their contracted land to other farmers, but maintain the contract relationship with the collective unless they exit from the contract and return the farmland to

the collective. We define land endowment for the household as $\bar{A}$ and rented land in period t as A_t^r where $A_t^r > 0$ means the landlords and $A_t^r < 0$ means the renters. Thus, the cultivated farmland A_t is,

$$A_t = \bar{A} - A_t^r. \tag{1.1}$$

Equation (1.1) provides a navigation where two theoretical mechanisms of insured property rights, "guard labor requirement" and "land misallocation," can be discussed. Specifically, the "guard labor requirement" in custom tenure systems affects the land endowment, $\bar{A}$, and "land misallocation" from insecure property rights is marked by the participation of a land rental market.

The decision variables for the household are labor and land allocations. Specifically, in each period, the labor endowment ($\bar{L}$) can be distributed among farming activities, L^f, non-farming employment, L^n, and leisure, l. Meanwhile, the household decides to cultivate the land endowment $\bar{A}$ by household laborers, rent in/out farmland thorough the land rental market, or both. Each activity generates incomes. For example, the farm household earns income in period t from agricultural production with a production function $Y(A_t, L_t^f; \gamma)$ and non-agricultural employment. The γ is the agricultural skill index, which has a range between 0 and 1. $\gamma = 1$ indicates the most skilled farmer. Inversely, $\gamma = 0$ indicates the least skilled farmer. If the household rents out their farmland, they can earn rent which is R per unit. The price of agricultural output goods is

normalized to 1, and the wage rate in non-agricultural employment in period t is w_t.

After setting up the basic framework of the theoretical model, we now explicitly discuss the two theoretical mechanisms, "guard labor requirement" and "land misallocation", which connects insure property rights and labor allocation. The impact of "guard labor requirement" on labor allocation comes from contingent use of the land. We define the expected level of risk of losing land in period t as a function of migratory laborers, L_t^n and agricultural laborers, L_t^f: $\lambda(L_t^n, L_t^f)$. Suppose there is no land rental market which will be released soon, then the household's expected land endowment in period $t+1$ is $E(\bar{A}_{t+1}) = \lambda(L_t^n, L_t^f)\bar{A}$. However, the land certificate will secure the possession of the land endowment. That is, $E(\bar{A}_{t+1}) = \bar{A}$ with LTP. This is the case where the non-separability between the land market and labor market decisions vanishes. Otherwise, the household's land endowment in the following period will be affected by current decisions concerning labor reallocation. Let the land endowment in period $t+1$ have a non-linear functional form as follows:

$$E(\bar{A}_{t+1}) = \phi\bar{A}_t, \text{ where } \phi = \begin{cases} 1, & \text{if with LTP} \\ \lambda(L_t^n, L_t^f), & \text{if without LTP,} \end{cases} \tag{1.2}$$

where $\lambda(L_t^n, L_t^f)$ is restricted to [0, 1) and $\frac{\partial\lambda(L_t^n, L_t^f)}{\partial L_t^n} < 0$ and $\frac{\partial\lambda(L_t^n, L_t^f)}{\partial L_t^f} > 0$.

The second channel of insecure property rights on labor allocation is "land misallocation" which indicates participation in a land rental market. Given that

we are only interested in household laborers who prefer to migrate instead of staying in agricultural production, we focus on landlords instead of renters. Thus, the rented-out land in period t is A_t^r where $A_t^r > 0$. Without loss of generality, we assume that the transaction cost in the land rental market because of insecure property rights is exogenous and defined as a fixed amount T. Thus, the total rent from renting out land is $(R-T)A_t^r$. Together with the setup in "guard labor requirement", the cultivated land A_t is

$$A_t = \lambda(L_t^n, L_t^f)\bar{A}_t - A_t^r \tag{1.3}$$

1.3.2 The household's problem

Decisions of labor allocation result in a return given by a twice differentiable, quasi-concave utility function $U(c_t, l_t)$, where c_t and l_t are household consumption and labor allocation in leisure in period t, respectively. The overall objective of the farm household is to select the decision sequence $L_1^n,\ L_2^n,\ ...\ L_T^n,\ L_1^f,\ L_2^f,\ ...\ L_T^f$, and $A_1^r, A_2^r, ...A_T^r$ such that the sum of the expected present discounted value of their lifetime utilities is optimized:

$$\max_{L_j^n \in \mathbf{L}^n, L_j^f \in \mathbf{L}^f, A_j \in \mathbf{A}} \left\{ \mathbb{E}\left[\sum_{j=t}^{T} \beta^{j-t} U(c_j, l_j | L_j^n, L_j^f, A_j) \right] \right\} \tag{1.4}$$

Alternatively, the value function $v_t(c_t, l_t)$ - the optimum value of the labor allocation problem - is the sum of the utility in period t and the value of utility at

the beginning of period $t+1$ discounted by one period:

$$v_t(c_t, l_t|\mathbf{L}^n, \mathbf{L}^f, \mathbf{A}) = \max_{L_j^n \in \mathbf{L}^n, L_j^f \in \mathbf{L}^f, A_j \in \mathbf{A}} \left\{ U(c_t, l_t|L_t^n, L_t^f, A_t) + \mathbb{E}\left[\sum_{j=t+1}^{T} \beta^{j-t} U(c_j, l_j|L_j^n, L_j^f, A_j) \right] \right\}. \tag{1.5}$$

Let L_t^{f*} denote the optimal level of L_t^f, L_t^{n*} denote the optimal level of L_t^n, and A_t^* denote the optimal level of cultivated land. Thus, the optimal decision profile in both labor and land allocation is $\mathbf{D}^* = \{L_t^{f*}, L_t^{n*}, A_t^*|_{t=1}^T\}$ such that: $\mathbf{D}^* = arg \max_{L_j^n \in \mathbf{L}^n, L_j^f \in \mathbf{L}^f, A_j \in \mathbf{A}} v_t(c_t, l_t)$.

Bellman's principle of optimality (Bellman, 1957) shows that an optimal policy obeys the rule that whatever the initial state and initial decision are, the remaining decisions must constitute an optimal policy with regard to the state resulting from the first decision. Therefore, the dynamic discrete choice problem breaks the value function into the utility received today and a value term in the following period that is constructed based on the assumption that optimal decisions will continue to be made in the future. The upper-case $V_t(c_t, l_t)$ denotes the value at the period t if the optimal profile of $\mathbf{L}_t^{f*}, \mathbf{L}_t^{n*}, \mathbf{A}_t^*$ is implemented:

$$V_t(c_t, l_t|\mathbf{L}_t^{f*}, \mathbf{L}_t^{n*}, \mathbf{A}_t^*) \equiv U(c_t, l_t|L_t^{f*}, L_t^{n*}, A_t^*) + \beta V_{t+1}\Big[c_{t+1}, l_{t+1}|\mathbf{L}_{t+1}^{f*}, \mathbf{L}_{t+1}^{n*}, \mathbf{A}_{t+1}(A_t^*, L_t^{n*})\Big], \tag{1.6}$$

where $U(c_t, l_t|\mathbf{L}_t^{f*}, \mathbf{L}_t^{n*}, \mathbf{A}_t^*)$ is the conditional utility function with optimal choice $\mathbf{L}_t^{f*}, \mathbf{L}_t^{n*}, \mathbf{A}_t^*$ at the period t. $\beta V_{t+1}\Big[c_{t+1}, l_{t+1}|\mathbf{L}_{t+1}^{f*}, \mathbf{L}_{t+1}^{n*}, \mathbf{A}_{t+1}(A_t^*, L_t^{n*})\Big]$ is the household's value at period $t+1$ which is discounted to the current period and

contingent upon cultivated land in period $t+1$ which is a function of migration and cultivated land in period t. Thus, Bellman's principle breaks the dynamic processes into a "two-period" model, where the second period represents all of the discounted utilities from behaving optimally along with $\mathbf{L}_t^{f*}, \mathbf{L}_t^{n*}, \mathbf{A}_t^*$ in the future. To be clear, the farm household's decisions and activities are specified in the two periods:

First Period: the household involves both agricultural production and migration and decides labor inputs in agriculture, migration, and leisure. For simplification, there is no rental decision to be made in the first period. The household has both savings and consumption.

Second Period: the household involves both agricultural production and migration and only decides agricultural labor input and leisure consumption. In the land market, the household decides the amount of land to be rented out. The household only has consumption.

Given the activities and decisions in the "two-period" model, the farm household maximizes the value function which is subject to a series of constraints. The first constraint is the budget constraint. That is, in each of the two periods, expenditures on consumption equal income from both agricultural production and non-agricultural employment. A savings in the first period represents household general investment (including savings in banks). This savings only appears in the

first period and produces interest at a rate of r in the second period. Second, in each period, the sum of labor distribution equals household labor endowment which is assumed to be constant in the two periods. We assume that there is no land rental market in the first period. Thus, the cultivated land in the first period equals the land endowment. In the second period, however, cultivated land is more complicated, which is equation (1.3).

Lastly, migration in the first period improves human capital in non-agricultural employment, which is denoted by an index $h_t > 0$. We define a non-linear function H as $h_{t+1} = H(h_t, L_t^n)$ and $H^{'} > 0$. This condition indicates that individuals can accumulate human capital from more work experience. The formulation of the problem is simplified as:

$$\underset{L_1^f, L_2^f, L_1^n, A_1, A_2}{\textbf{Maxmize}} \quad V_1(c_1, l_1) = U(c_1, l_1 | L_1^n, L_1^f, A_1) + \beta V_2\Big[c_2, l_2 | L_2^f, A_2(L_1^n, A^r)\Big]$$

subject to :

$$\begin{aligned}
\text{Income constraints :} \quad & c_1 + s_1 = Y(A_1, L_1^f; \gamma) + h_1 w L_1^n \\
& c_2 = Y(A_2, L_2^f; \gamma) + h_2 w L_2^n + (R - T)A^r + (1 + r)s_1 \\
\text{Labor constraints :} \quad & \bar{L} = L_1^n + L_1^f + l_1 \\
& \bar{L} = \bar{L}_2^n + L_2^f + l_2 \\
\text{Land constraints :} \quad & A_1 = \bar{A} \\
& A_2 = \lambda(L_1^n, L_1^f)\bar{A} - A^r \\
\text{Human capital constraints :} \quad & h_2 = H(h_1, L_1^n).
\end{aligned}$$

Since the purpose of this study is to conduct a comparative static analysis rather than attempting to solve a dynamic programming problem, we assume that $V_2(c_2, l_2)$ can be determined through the process of backward induction with optimal trajectory of labor allocation.

Assume that $U(\cdot)$, $V(\cdot)$, $Y(\cdot)$, $H(\cdot)$, and $\lambda(\cdot)$ can be differentiated and for simplicity the solution is an interior solution. Thus, the necessary conditions for

optimality are:

$$L_1^{n*}: -\frac{\partial U(\cdot)}{\partial l_1} + \beta \frac{\partial V_2}{\partial c_2}\Big[\frac{\partial Y(\cdot)}{\partial A_2}\frac{\partial \lambda(\cdot)}{\partial L_1^n}\bar{A} + \frac{\partial H(h_1, L_1^n)}{\partial L_1^n} w L_2^n + (1+r)h_1 w\Big] = 0 \tag{1.7}$$

$$L_1^{f*}: -\frac{\partial U(\cdot)}{\partial l_1} + \beta \frac{\partial V_2(\cdot)}{\partial c_2}\Big[\frac{\partial Y(\cdot)}{\partial A_2}\frac{\partial A_2}{\partial \lambda}\frac{\partial \lambda(\cdot)}{\partial L_1^f} + (1+r)\gamma \frac{\partial Y(\cdot)}{\partial L_1^f}\Big] = 0 \tag{1.8}$$

$$L_2^{f*}: \beta \frac{\partial V_2(\cdot)}{\partial c_2}\frac{\partial Y(\cdot)}{\partial L_2^f} - \frac{\partial V_2(\cdot)}{\partial l_2} = 0 \tag{1.9}$$

$$A^{r*}: \frac{\partial Y(\cdot)}{\partial A^r} - (R - T) = 0 \tag{1.10}$$

The first condition determines the optimal level of migration labor in the first period where the welfare change in the current period equals total discounted present welfare change. The content of total discounted present welfare change includes (1) "guard labor requirement"(-)[6], (2) human capital accumulation (+), and (3) wage income from migration(+). The second condition determines the optimal level of agricultural labor input in the first period by setting the welfare loss from more labor input equal to the welfare gain from more agricultural income because of more labor input. The third equation determines the optimal migration labor in the second period. The equilibrium requires that welfare gains from more income equal welfare losses from more labor input. The last equation determines the optimal level of rented land in the equilibrium where the marginal change of agricultural value equals land rent minus transaction cost.

Note that our model is a general version of the classical static model and the two-period model. Either a static model or two-period model can be derived from

[6] "-" means a negative impact on migration, where "+" is a positive impact on migration.

equation (1.7) to equation (1.10). Take equation (1.7) for example; in a static model, which does not indicate a connection between the migration decision made in the current period and future utility, both $\frac{\partial Y(\phi A_1, L_2^f)}{\partial A_2}\frac{\partial \lambda(L_1^n)}{\partial L_1^n}\bar{A}$ and $\frac{\partial H(h_1, L_1^n)}{\partial L_1^n} w \bar{L}_2^n$ will vanish. The marginal utility losses because of less leisure time equal the market wage rate. In contrast to a standard two-period model, we have the term $\frac{\partial V_2}{\partial c_2}$ instead of $\frac{\partial U_2}{\partial c_2}$, which captures the total marginal changes from the future stream. That is, although we only consider two periods, the present period and the following period, the second period represents values from all of the future periods that are discounted to period 2. The presentation of all future values could be significant when the marginal change from a single period is small but the accumulated effects are significant. This is very true for property rights in rural areas in which the total value of property rights is much larger than the rent from each period.

1.3.3 LTP and migration

The key question for this research is how property rights change the optimal trajectory beginning with L_1^{n*}. Equation (1.7) shows a restricted optimization of labor allocation when non-separability between the land market and the labor market exists. When property rights are secured by land certification, the constriction of the land market on labor allocation is released. Household laborers can migrate without worrying about losing the future stream from land endowment. Meanwhile, equation (1.10) constructs a restriction from the land rental market on migration. Well-protected property rights promote the

development of the land rental market by reducing transaction cost. Because land and labor are complementary inputs in agricultural production, especially in an Asian agrarian economy (Yao, 2000; Mullan et al., 2011; Deininger and Jin, 2002), the development of the land rental market allows unskilled farmers to rent out their land and free up farming labor forces. We explicitly explain the two channels in the following sections.

A. Delinking land rights from land use

To illustrate the mechanism of "guard labor requirement", we first rearrange equation (1.7):

$$\underbrace{\underbrace{\frac{\partial U(c_1, \bar{L} - L_1^n - L_1^f)}{\partial l_1}}_{\text{Immediate welfare loss}} + \underbrace{\beta \frac{\partial V_2}{\partial c_2} \frac{\partial Y(A_2, L_2^f; \gamma)}{\partial A_2} | \frac{\partial \lambda(L_1^n, L_1^f)}{\partial L_1^n} | \bar{A}}_{\text{Present value of future welfare loss}}}_{\text{Marginal losses}} = \underbrace{\beta \frac{\partial V_2}{\partial c_2} \Big[\frac{\partial H(h_1, L_1^n)}{\partial L_1^n} w \bar{L}_2^n + (1+r) h_1 w \Big]}_{\text{Present value of future welfare gain}}}_{\text{Marginal gains}} \tag{1.11}$$

The left side of the equation is the welfare losses due to migration in the first period. The losses include two parts: immediate welfare losses as a result of less leisure time and the present value of future expected losses from the risk of losing the land endowment. The term $\frac{\partial V_2}{\partial c_2}$ denotes the value of a marginal change in consumption c_2 caused by the change of labor reallocation in period 1, L_1^n. The idea is that, when household laborers outmigrate, the farm household incurs the risk of losing land, which in turn constrains the household's consumption in

the following period. This effect is proportional to the household's initial land endowment, $\bar{A}$, and agricultural skill, γ.

The right side of the equation is the present value of future gains from migration. The total gains come from the present value of higher human capital in the future and the present value of current wage rates. Specifically, $\frac{\partial H(h_1, L_1^n)}{\partial L_1^n} w \bar{L}_2^n$ is the future gain from accumulating human capital such as work experience with more years. $(1 + r)h_1 w$ is the future value of current wages. In sum, equation (1.11) shows that total welfare losses must be balanced against the present value of future welfare gains in determining L_1^{n*}.

When farm households enroll in LTP, their land endowment will be maintained unless they want to abandon their land rights by terminating the land contract with the collective. Therefore, the cross-market effects because of land market imperfection will vanish. That is, land endowment in the second period will remain equal with the first period: $A_2 = A_1 = \bar{A}$ (supposing there is no land rental market). The term $\frac{\partial Y(\phi A_1, L_2^f; \gamma)}{\partial A_2} \frac{\partial \lambda(L_1^n, L_1^f)}{\partial L_1^n} \bar{A}$ in equation (1.11) goes to zero.

Figure 1.1 depicts the farm household's labor allocation in different policy scenarios (Details to derive the figure are in the appendix). The gains term is a decreasing function in relation to migration labor, while the loss term is a increasing function. Let us ignore the curve associated with γ_1 for a moment and concentrate on the curves with γ_0. Without LTP, the curve of losses becomes

steeper and has a larger slope. In other words, the farmer suffers increasing losses from migration when there are no secure property rights. The two sets of losses curves define two levels of efficiency migration $L_1^{n*}(0)$ and $L_1^{n*}(2)$. The figure illustrates that the efficiency migration under LTP, $L_1^{n*}(2)$, locates to the right of the efficiency migration without LTP, $L_1^{n*}(0)$. The following lemma is a natural extension.

Lemma 1*: LTP delinks land rights from land use and increases migration.*

The impact of LTP on labor allocation is also affected by the parameter of γ which represents agricultural ability. Now let us compare the two situations under γ_0 and γ_1. We assume that γ_1 is bigger than γ_0. In Figure 1.1, $L_1^{n*}(0)$ is the solution to L_1^n corresponding to a higher γ_1. Given that the difference between $L_1^{n*}(2)$ and $L_1^{n*}(1)$ is larger than the difference between $L_1^{n*}(2)$ and $L_1^{n*}(0)$, we have another lemma:

Lemma 2*: LTP releases more labor constraints for skilled farm households than unskilled farm households.*

B.Land rental market and migration

Land certification secures property rights and accelerates the development of the land rental market by reducing transaction costs. Farm households can

choose to be landlords, renters, or self-sufficient farmers according to their land endowment, farming skills, age, work experience, etc. This paper only focuses on landlords who have great incentive to rent out land if their contracted land is titled. Equation (1.12) from the Appendix shows that when the transaction costs decrease because of LTP, laborers in the agricultural sector will decrease. Note that whether the change of agricultural labor causes the change of migration depends on the labor allocation profile. For Asian agrarian economies where agricultural labor and migration are dominating, agricultural labor input may compete with migration. In other words, increases in agricultural labor input result in decreases in migration. Thus, for potential landlords, we have a lemma:

$$\frac{dL_1^f}{dT} = \frac{1/\gamma}{Y_{L_1^f L_1^f} Y_{A^r A^r} - Y^2_{L_1^f A^r}} > 0 \tag{1.12}$$

Lemma 3*: The development of the land rental market can increase migration.*

Equation (1.12) also indicates that the relationship between agricultural labor input and transaction costs vary for different agricultural abilities. Figure 1.2 displays the relationships graphically. Again, we assume that γ_1 is greater than γ_0. However, the increase of agricultural labor becomes slower for skilled farmers when transaction costs increase. When LTP reduces transaction costs in the land rental market (from T_1 to T_0), the decrease of agricultural labor for unskilled farmers, $\triangle\ L_1^{f*}(0)$, is greater than the decrease of agricultural labor for skilled farmers, $\triangle\ L_1^{f*}(0)$. This observation can be explained by the fact that skilled farm

households have comparative advantage in agricultural production and thus tend to allocate more labor in the agricultural sector regardless of transaction costs in the land rental market. Meanwhile, skilled farmers tend to become renters rather than landlords.

***Lemma 4**: The development of the land rental market can increase more migration for unskilled farmers than skilled farmers.*

1.4 Data

1.4.1 Data description

We utilized the China Health and Retirement Longitudinal Study (CHARLS) data for empirical analyses. The CHARLS is a nationally representative, public micro-database with a wide range of information that covers from socio-economic status to health conditions. The baseline survey was conducted in 2011 and included 10,199 households and 17,705 individuals from 28 provinces/regions (except for Hainan Province, Ningxia Hui Autonomous Region, Tibet Autonomous Region, Hongkong, Macau, and Taiwan). Probability proportional to size (PPS) sampling was implemented to reflect county population size. In order to ensure unbiased and representative data collection, 150 counties from 28 provinces and 3 villages/communities from each county were randomly selected.

It is assumed that the individuals and households will be followed up on every two years. Among the 10,199 households that were interviewed in the 2011 survey, 8,984 and 8,207 households were successfully interviewed in the 2013 survey and in the 2015 survey, respectively. The successful tracking rates were 88.1% and 91.4% at the family level in 2013 and in 2015, respectively. Although the total surveyed households increased to 10,803 and 12,221 in 2013 and 2015, respectively, we are only interested in households that were interviewed in all three waves of the survey. The three-year panel database has 81.1 % of households from rural areas and 18.9 % from urban areas. [7]

The complexity of the social system is reflected in dynamic interactions across multiple levels and domains. Community, family, and individual are three important levels of the survey. This survey collects community-, family- and individual-level longitudinal data to provide comprehensive and objective data on Chinese society. Specifically, the CHARLS questionnaire includes the following modules: demographics, family structure/transfer, health status and functioning, biomarkers, health care and insurance, work, retirement and pension, income and consumption, assets (individual and household), and community-level information.

Because this research only focuses on farm households that own farmland in rural areas, we excluded households that have urban *hukou* residency or do

[7]The urban-rural definition here is defined as urban if it is located in a city, suburb of a city, a town, suburb of a town, or other special areas where nonfarm employment constitutes at least 70% of the work force, such as a special economic zone, state-owned farm enterprise, etc.

not own farmland. We also restricted the respondents' ages to between 45 and 70. While combining different datasets, observations would drop from the final dataset if they only existed in one dataset. Additionally, two provinces/regions, Heilongjiang Province and Xinjiang Uygur Autonomous Region, were dropped because the households from these provinces/regions had fewer than 50 households surveyed in each year. All these efforts lead to a balanced panel of 3,249 households in each of 2011, 2013, and 2015, and 9,747 observations in total. Figure 1.3 shows the distribution of samples in the 28 provinces as well as the three pilot provinces.

1.4.2 Validity of treatment and counterfactual

The review of LTP policy shows that Anhui, Shandong, and Sichuan provinces were selected by the central government to implement the LTP at the province level in 2014. The concern is whether the LTP treatment assignment in 2014 is a quasi-experimental design. If not, bias would exist in the treatment effect estimation. Geographically, the three provinces seem to be randomly selected to represent eastern, central, and western China, which are the Shandong province in eastern China, the Anhui Province in central China, and the Sichuan Province in western China. However, self-selection or reverse causality may exist, which could result in bias in estimating the effect of interest. First, the state explained that "the three provinces were selected based on the pilot projects conducted on the county's level". If provinces have extensively conducted LTP at the village and county levels before 2014, they are more likely to be selected as a pilot at the

province level. Evidence shows that the Shandong Province was the first province to implement LTP, [8] and almost all the counties (131 out of 139) in this province had already implemented LTP by the end of 2013. [9] Thus, it is self-explanatory that the Shandong Province only entitled 98.1% of the farmland one year after being selected as one of the pilot provinces, and was the first province to complete the LTP at the province level. Therefore, it is not feasible to use Shandong Province as a treatment group in 2014.

Another concern comes from the variation in the outcome; that is, migration in households that are included in this study. If the migration ratio of a household in the treatment group is consistently low or high both pre-intervention and post-intervention, the observation may be dropped from the estimation and does not contribute to any of the estimated coefficients (Gunasekara et al., 2014). In our potential treatment group, the Anhui Province is the biggest rural labor supply in China and provided 1.78 million migrant workers in 2013. Since the Anhui Province is geographically close to Shanghai City, Zhejiang Province, and Jiangsu Province (which constitute the most developed area in China, the Yangtze River Delta Economic Zone, and has provided rich rural labor resources to the economy since the early 1990s), 70% of migrant workers from the Anhui Province migrated to these areas. Our data confirms the high migration ratio

[8] Information comes from http://sd.ifeng.com/a/20171023/6085869_0.shtml

[9] Information comes from https://www.chinacourt.org/article/detail/2014/01/id/1208242.shtml. The county with LTP is not necessary the pilot county. In the pilot county, all the villages/communities implemented LTP, while the 131 counties in Shandong Province implemented LTP in only some selected areas.

in the Anhui Province which shows that about 94% of households in Anhui Province in 2011 had at least one migrant worker. This ratio remains high in 2013 and 2015. Thus, the Anhui Province is also not suitable for treatment in 2014.

The Sichuan Province had 7 counties/districts involved in pilot county projects in LTP in 2013. In the pilot projects, about 1% of farmland was titled. The whole province was selected to implement LTP in 2014. The province implemented the LTP in all 183 counties and planned to entitle 50% of farmland by the end of 2014. The LTP was implemented to a greater extent in 2015 throughout the province and about 75% of farmland was entitled in the same year. The project was completed in 2017. The low percentage of LTP implementation in 2013 and about 75% of LTP implementation in 2015 in Sichuan Province provided an ideal timing to match the two waves of the CHARLS survey in 2013 and 2015. In other words, the implementation of LTP in the Sichuan Province and the CHARLS surveys helped to identify the changes in exposure status that resulted from changes in policy. Additionally, as one of the largest labor supplying provinces, the Sichuan Province provided about 2.2 million migrants to the country. Our data also confirms that about 79% of respondents from Sichuan Province had at least one member who migrated outside the family. Although the migration ratio is rather high, the variation of outcomes can be used in estimation.

A good counterfactural is fundamentally important for policy evaluation. Thus, the last concern in this study is whether the rest of the provinces/regions

as well as respondents from these provinces/regions are suitable counterfactual substitutes for what would have happened to farm households without LTP. This question can be answered from two viewpoints. First, in the years before 2014, the LTP was conducted under strict control in pilot villages or pilot counties in the rest of the provinces/regions. On average, each province in the control group had 6 to 8 counties conducting LTP before 2014. That is, the number of counties which implemented LTP before 2014 consisted of only about 5.4% of total counties in each province (including treated and control provinces). The percentage was small enough to ignore.

Second, the treated and control groups should evidence parallel trends in the outcome in the pre-period. This assumption indicates that trends in the migration ratio among the control provinces in the post-period provide a good counterfactual for what would have happened to the treated group in the absence of LTP. Since our dataset has two periods before the LTP, the parallel trends in migration ratios can be investigated. Figure 1.4 shows the change migration ratio between treated and control groups, and the parallel trend before LTP (from 2011 to 2013) can be identified. The baseline inequivalence of the migration ratios is not necessary since the difference of time-constant explanatory variables could contribute to the inequivalence, and these variables are easily controlled.

1.4.3 Descriptive analysis

In order to interpret the causal effect of a policy change, one should make a convincing argument that the treated group and control group are exchangeable in terms of observed characteristics. Table 1.2 shows the summary between the treated and the control group in 2013 and 2015. As displayed in figure 1.1, migrations in 2013 for the two groups were systematically different. The rent ratios were low in the two groups, with rent ratios in the treated group even lower than the control group. Household land endowment in the treated group is significantly smaller than the control group, which can be partly explained by the fact that the main terrain/topography of the Sichuan Province is hilly and mountainous. The cultivable farmland is smaller than in other agricultural provinces. The number of sick parents and family income are statistically similar between the treated group and the control group.

There were substantive differences among villages and provinces characteristics. Because these differences are likely to persist over time between the two groups, they will be controlled by difference-in-difference estimation and need not be a threat to the estimation.

1.5 Estimation

We apply the DD method to estimate the causal effect of LTP using two-period and two-group panel data. The dependent variable is a binary indicator with

value 1, meaning at least one farm household participating in non-agricultural employment. The estimation model is:

$$Y_{ijt} = \delta LTP_{jt} + \gamma_j + \alpha_t + X_{ijt}\beta + \varepsilon_{ijt}, \tag{1.13}$$

where Y_{ijt} is an indicator for whether household i in province j has a migrant member by year t. LTP_{jt} is a dummy variable to indicate the exposed states in province j at year t. Specifically, LTP_{jt} is equal to one if the province (including all farm households in this province) has LTP in 2014, and equal to zero if not. δ is the causal coefficient of LTP to be estimated. γ_j is a province fixed effect and α_t is a time fixed effect. X_{ijt} are the household-level time-varying covariates for household i from province j at year t, and ε_{ijt} is the error term.

The estimations of equation (1.13) using the DD method and the panel data are presented in table 1.3. Column 1 shows that the probability of a household having a migrant member significantly increases by 0.077 after the implementation of LTP. Both time and province fixed effects are controlled in this scenario. When household fixed effects replace province fixed effects, the estimated coefficient of LTP remains almost the same. The robust standard error of LTP changes slightly. Column 3 includes household- and province-level covariates which control time-varying characteristics. The estimated coefficient of LTP decreases slightly to 0.075 but is still statistically significant. The result also shows that households with high household income are more likely to have migrant members.

The last column of table 1.3 includes land rent behavior in the estimation, which identifies the relationship between migration and the rural land rental market. First, the results confirm the causal effects of LTP on migration. That is, if households involve LTP, the probability of having a migrant household member increases by 7.6%. Second, households who rent out their land increase the probability of having a migrant household member by 5.6%. This confirms the lemma that the development of the land rental market can further increase migration.

1.6 Conclusion

Incomplete property rights in most developing countries induce cross-market constraints on household labor allocation, which seems contrary to economic logic. In the case of China, without a viewpoint of cross-market constraint, we fail to understand why rural areas in China hold 42.65% of the population and the significant productivity gap among agricultural sector and non-agricultural sector.

This paper uses the rollout of the land titling program in China from 2008 to 2018 and three waves of longitudinal surveys in 2011, 2013, and 2015 to identify a quasi-experiment of the program. By applying the difference-in-difference method, we find that farm households who obtained land certificates were subsequently 7.7% more likely to have a migrant household member. We also show that the development of the land rental market can increase migration. This paper adds

new empirical evidence for non-separability between land markets and labor markets when market failures exist, and enriches the literature on the channel through which the development of property rights affects economic development.

We admit, however, there are a couple of limitations in this study. First, the identification strategy in this study is not fulled developed. For example, we have not put too much effort in arguing that the policy change is (conditionally) exogenous. The implementation of LTP may be driven by pre-policy outcomes or some unobserved/unmeasured time-varying variables. This can be empirically checked by estimating the causal relationship between pre-policy outcomes and policy changes (Strumpf et al., 2017). Additionally, to control the unobserved time-varying confounders, one may apply a weighted DD regression model, with weights chosen as inverse propensity scores (Stuart et al., 2014).

Second, although we presented the causal effect of the rental market and migration decision, the estimates of the land rental market fail to prove the causal effect between LTP and development of the land rental market. Thus, lemma 2 is not fully tested.

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Tables

Table 1.1: Observations in Difference-in-Difference analysis

	before	after	total
control	2915	2915	5830
treated	300	300	600
total	3215	3215	6430

Table 1.2: Summary statistics by year

	Treated Group		Control Group		t-test	
Variable	2013	2015	2013	2015	2013	2015
Migration	0.81 (0.39)	0.90 (0.30)	0.87 (0.33)	0.89 (0.31)	0.06**	-0.01
Rent land	0.06 (0.24)	0.07 (0.26)	0.11 (0.31)	0.14 (0.35)	0.05**	0.07**
Age	60.28 (7.06)	62.28 (7.06)	58.74 (6.81)	60.74 (6.81)	-1.53***	-1.53***
Land area	3.45 (2.50)	3.20 (6.44)	6.58 (11.76)	5.84 (8.36)	3.12***	2.64***
Sick parents	0.23 (0.57)	0.17 (0.46)	0.29 (0.62)	0.24 (0.55)	0.07	0.08*
Ag assets	1.08 (1.06)	0.98 (1.07)	0.63 (0.90)	0.59 (0.87)	-0.45***	-0.38***
Total income(ln)	8.15 (2.52)	7.14 (3.01)	8.49 (2.56)	7.05 (3.59)	0.34*	-0.10
Train station(km)	140.14 (247.76)	140.14 (247.76)	61.63 (75.38)	61.63 (75.38)	-78.51***	-78.51***
Enterprises in villages	0.77 (2.13)	0.77 (2.13)	3.51 (8.70)	3.51 (8.70)	2.74***	2.74***
Plain or not	0.00 (0.00)	0.00 (0.00)	0.37 (0.48)	0.37 (0.48)	0.37***	0.37***
GDP(ln)	10.18 (0.00)	10.31 (0.00)	9.98 (0.70)	10.10 (0.71)	-0.21***	-0.21***
Land quality	8.01 (0.00)	8.01 (0.00)	7.00 (2.37)	7.00 (2.37)	-1.01***	-1.01***

a coefficients; sd in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 1.3: Estimation of difference-in-difference

VARIABLES	Migration	Migration	Migration	Migration
LTP	0.077***	0.077***	0.075**	0.076**
	(0.030)	(0.025)	(0.031)	(0.030)
Age			-0.001*	-0.001*
			(0.001)	(0.001)
Land area			-0.000	-0.000
			(0.000)	(0.000)
Rent out				0.056***
				(0.010)
Sick parents			0.001	0.001
			(0.007)	(0.007)
Ag assets			0.008*	0.010**
			(0.005)	(0.005)
Total income(ln)			0.010***	0.009***
			(0.001)	(0.001)
GDP(ln)			-0.262	-0.260
			(0.178)	(0.178)
Time fixed effects	Yes	Yes	Yes	Yes
Province fixed effects	Yes	No	Yes	Yes
Household fixed effects	No	Yes	No	No
Observations	6,430	6,430	6,285	6,272
R-squared	0.017	0.565	0.028	0.031

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Figures

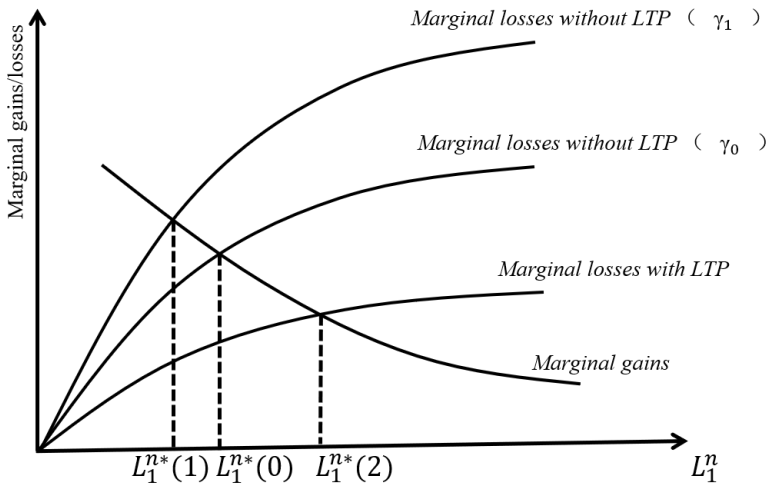


Figure 1.1: Migration with/without LTP

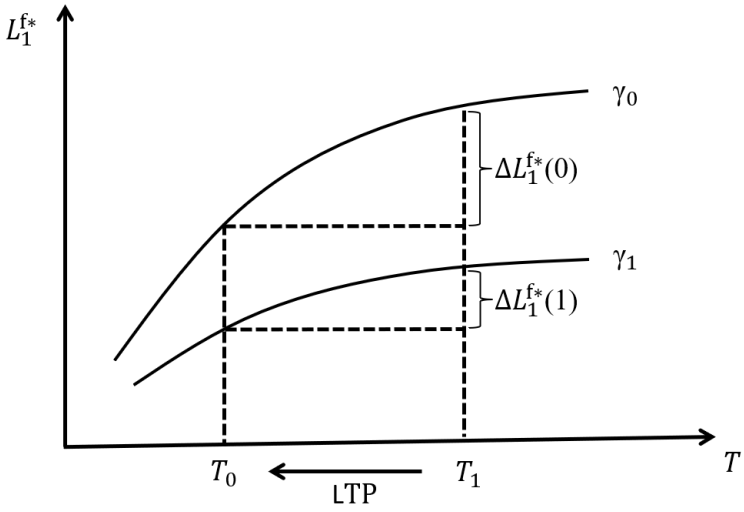
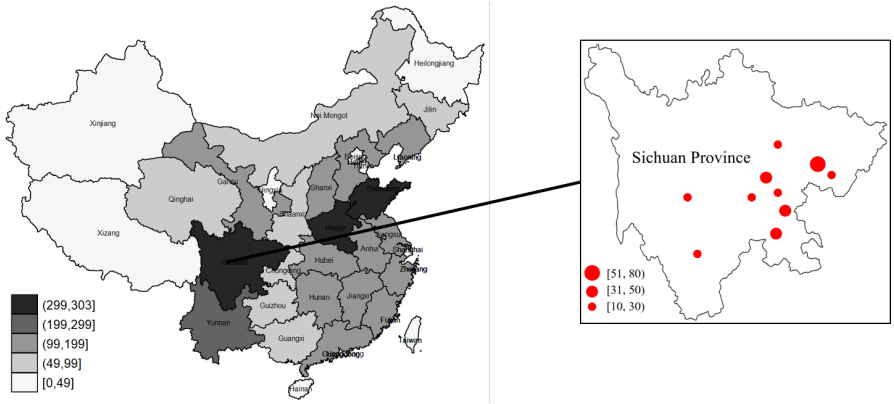


Figure 1.2: The relationship between agricultural labor input and transaction costs for different agricultural skills



Note: the left graph shows the panel data distribution at the national level. Sichuan, Henan, and Shandong provinces contributed the most. The right graphs is sample distributions from Sichuan provinces, which implemented LTP in 2014.

Figure 1.3: The sample distribution of CHARLS at the national level and in the three provinces

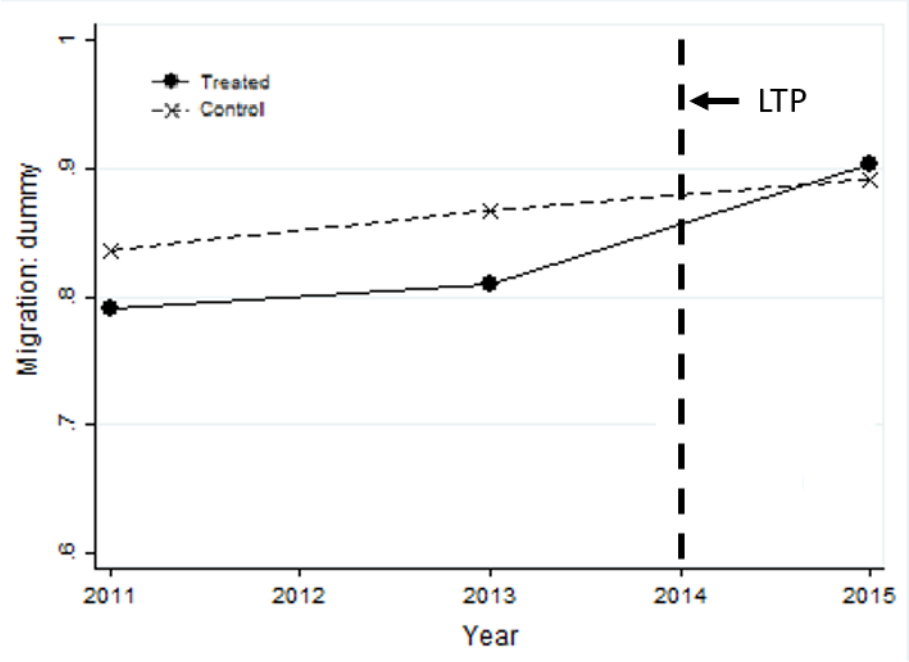


Figure 1.4: The trend between treated and control group

Appendix

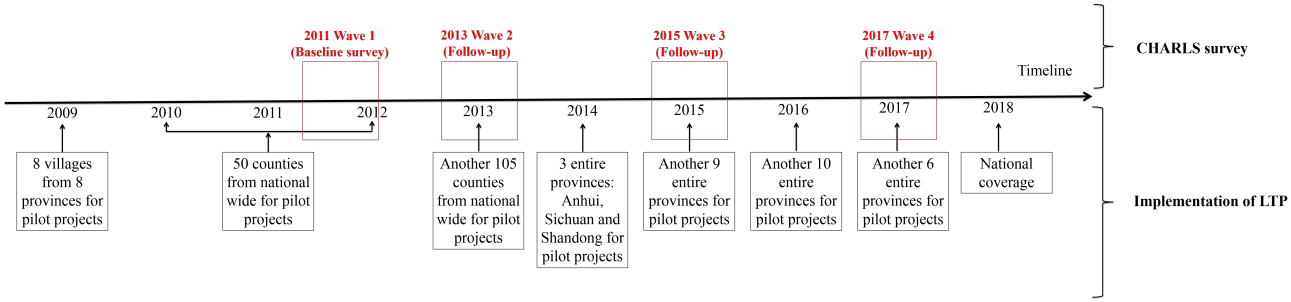


Figure 1.5: The timeline of CHARLS and implementation of LTP

Based on the model setup, the decision problem for the farm household is:

$$\underset{L_1^f, L_2^f, L_1^n, A_1, A_2}{\textbf{Maxmize}} \quad V_1(c_1, l_1) = U(c_1, l_1 | L_1^n, L_1^f, A_1) + \beta V_2\Big[c_2, l_2 | L_2^f, A_2(L_1^n, A^r)\Big]$$

$$\begin{aligned}
&\textbf{subject to}: \\
\text{Income constraints}: \quad & c_1 + s_1 = Y(A_1, L_1^f; \gamma) + h_1 w L_1^n \\
& c_2 = Y(A_2, L_2^f; \gamma) + h_2 w L_2^n + (R - T)A^r + (1 + r)s_1 \\
\text{Labor constraints}: \quad & \bar{L} = L_1^n + L_1^f + l_1 \\
& \bar{L} = \bar{L}_2^n + L_2^f + l_2 \\
\text{Land constraints}: \quad & A_1 = \bar{A} \\
& A_2 = \lambda(L_1^n, L_1^f)\bar{A} - A^r \\
\text{Human capital constraints}: \quad & h_2 = H(h_1, L_1^n).
\end{aligned}$$

Plug land constraints and human capital constraints into the second income constraint, and combine two income constraints together through the connection of saving, we have

$$c_2 = Y[\lambda(L_1^n, L_1^f)\bar{A} - A^r, L_2^f; \gamma] + H(h_1, L_1^n) w L_2^n + (R - T)A^r + (1 + r)[Y(A_1, L_1^f; ; \gamma) + h_1 w L_1^n - c_1]. \tag{1.14}$$

Plug into the value function with consumption, labor, land endowment and human capital constraints, we have:

$$\begin{aligned}
\underset{L_1^f, L_2^f, L_1^n, A_2}{\text{Maxmize}} \quad V_1(c_1, l_1) = U(c_1, \bar{L} - L_1^n - L_1^f) + \beta V_2\Big\{ & Y[\lambda(L_1^n, L_1^f)\bar{A} - A^r, L_2^f; \gamma] + H(h_1, L_1^n) w L_2^n \\
& + (R - T)A^r + (1 + r)[Y(A_1, L_1^f; \gamma) + h_1 w L_1^n - c_1], \bar{L} - \bar{L}_2^n - L_2^f \Big\}
\end{aligned} \tag{1.15}$$

Assuming that $U(\cdot)$, $V(\cdot)$, $Y(\cdot)$, $H(\cdot)$, and $\lambda(\cdot)$ can be differentiated, and for simplicity, the solution is an interior solution. Thus, the necessary conditions for optimality are:

$$L_1^{n*}: -\frac{\partial U(\cdot)}{\partial l_1} + \beta \frac{\partial V_2}{\partial c_2}\Big[\frac{\partial Y(\cdot)}{\partial A_2}\frac{\partial \lambda(\cdot)}{\partial L_1^n}\bar{A} + \frac{\partial H(h_1, L_1^n)}{\partial L_1^n} w L_2^n + (1+r)h_1 w\Big] = 0 \tag{1.16}$$

$$L_1^{f*}: -\frac{\partial U(\cdot)}{\partial l_1} + \beta \frac{\partial V_2(\cdot)}{\partial c_2}\Big[\frac{\partial Y(\cdot)}{\partial A_2}\frac{\partial A_2}{\partial \lambda}\frac{\partial \lambda(\cdot)}{\partial L_1^f} + (1+r)\gamma \frac{\partial Y(\cdot)}{\partial L_1^f}\Big] = 0 \tag{1.17}$$

$$L_2^{f*}: \beta \frac{\partial V_2(\cdot)}{\partial c_2}\frac{\partial Y(\cdot)}{\partial L_2^f} - \frac{\partial V_2(\cdot)}{\partial l_2} = 0 \tag{1.18}$$

$$A^{r*}: \frac{\partial Y(\cdot)}{\partial A^r} - (R - T) = 0 \tag{1.19}$$

To show that the value of utility function $V_1(c_1, l_1)$ reaches the maximum at the point of L_1^{n*}, we need to further specify the sign of the second order condition. Thus, we have

$$\frac{\partial^2 V_1(\cdot)}{\partial L_1^{n2}} = \frac{\partial^2 U(\cdot)}{\partial l_1^2} + \beta \frac{\partial^2 V_2}{\partial c_2^2}\frac{\partial^2 Y(\cdot)}{\partial A_2^2}\frac{\partial^2 \lambda(\cdot)}{\partial L_1^{n2}}\bar{A} < 0 \tag{1.20}$$

Channel 1: "Guard labor requirement"

To evaluate the impact of LTP on labor allocation, we first rearrange the first condition about L_1^n:

$$\underbrace{\underbrace{\frac{\partial U(\cdot)}{\partial l_1}}_{\text{Immediate marginal welfare loss}} + \underbrace{\beta \frac{\partial V_2}{\partial c_2}\frac{\partial Y(\cdot)}{\partial A_2}|\frac{\partial \lambda(\cdot)}{\partial L_1^n}|\bar{A}}_{\text{Present value of future marginal welfare loss}}}_{\text{Marginal losses}} = \underbrace{\beta \frac{\partial V_2}{\partial c_2}\Big[\frac{\partial H(\cdot)}{\partial L_1^n} w L_2^n + (1+r)h_1 w\Big]}_{\text{Present value of future marginal welfare gain}}_{\text{Marginal gains}} \tag{1.21}$$

The left side of the equation is the welfare losses due to migration in the first period and the the right side of the equation is the present value of future gains from migration. This equation shows that total utility losses must be balanced against the present value of future gains in determining L_1^{n*}.

To measure the effect of LTP on labor allocation, we define two variables, *Gains* and *Losses* and discuss how do they change when migrant laborers change.

$$MG(Marginal \quad gains) = \beta \frac{\partial V_2}{\partial c_2} \Big[\frac{\partial H(h_1, L_1^n)}{\partial L_1^n} w L_2^n + (1+r) h_1 w \Big] \tag{1.22}$$

$$MLMarginal \quad losses = \frac{\partial U(c_1, \bar{L} - L_1^n - L_1^f)}{\partial l_1} + \beta \frac{\partial V_2}{\partial c_2} \frac{\partial Y(A_2, L_2^f; \gamma)}{\partial A_2} | \frac{\partial \lambda(L_1^n, L_1^f)}{\partial L_1^n} | \bar{A} \tag{1.23}$$

To figure out the solutions of optimal migration under different policy scenarios, functional characteristics of both $marginal \quad gains$ and $marginal \quad losses$ need to be discussed. The partial derivative of *Gains* over migration is:

$$\frac{\partial MG}{\partial L_1^n} = \beta \frac{\partial^2 V_2(\cdot)}{\partial c_2^2} \Big[\frac{\partial H(h_1, L_1^n)}{\partial L_1^n} w L_2^n + (1+r) h_1 w \Big] < 0. \tag{1.24}$$

That is, when laborers in migration increase, welfare gains from migration decreases. Insecure property rights only affects farmers' *Losses* function. Thus, the expression of partial derivative of *Losses* over migration has two forms as

$$\frac{\partial ML}{\partial L_1^n} = \begin{cases} M_0 = \frac{\partial^2 U(\cdot)}{\partial l_1^2}(-1) + \beta \frac{\partial^2 V_2(\cdot)}{\partial c_2^2} \frac{\partial^2 Y(\cdot)}{\partial A_2^2} | \frac{\partial \lambda(\cdot)}{\partial L_1^n} | \bar{A} > 0, & \text{without LTP} \\ M_1 = \frac{\partial^2 U(\cdot)}{\partial l_1^2}(-1) > 0, & \text{with LTP} \end{cases}, \text{ and } M_0 > M_1$$

Channel 2: Land misallocation

For land rental market, we combine the first order conditions of agricultural labor and rental land together and rearrange the equations, then we have

$$-\frac{\partial U(\cdot)}{\partial l_1}+\beta\frac{\partial V_2(\cdot)}{\partial c_2}\Big[\frac{\partial Y(\cdot)}{\partial A_2}\frac{\partial A_2}{\partial \lambda}\frac{\partial \lambda(\cdot)}{\partial L_1^f}+(1+r)\frac{\partial Y(\cdot)}{\partial L_1^f}\Big]=0$$

$$\Rightarrow \quad \frac{\partial Y(A_r^*, L_1^{f*};\gamma)}{\partial L_1^f}=\frac{\partial U(\cdot)/\partial l_1}{\beta(1+r)\partial V_2(\cdot)/\partial c_2}-\frac{\partial Y(A_2, L_2^f;\gamma)}{\partial A_2}\frac{\partial A_2}{\partial \lambda}\frac{\partial \lambda(\cdot)}{\partial L_1^f} \tag{1.25}$$

$$\frac{\partial Y(\cdot)}{\partial A^r}-(R-T)=0 \quad \Rightarrow \quad \frac{\partial Y(A_r^*, L_1^{f*};\gamma)}{\partial A^r}=R-T \tag{1.26}$$

Given that both A_r^* and L_1^{f*} are functions of transaction costs, T, we have the second order conditions of agricultural production on transaction costs:

$$Y_{L_1^f L_1^f}\frac{dL_1^f}{dT}+Y_{L_1^f A^r}\frac{dA^r}{dT}=0 \tag{1.27}$$

$$Y_{A^r A^r}\frac{dA^r}{dT}+Y_{A^r L_1^f}\frac{L_1^f}{dT}=-1 \tag{1.28}$$

Given that $Y_{L_1^f L_1^f}Y_{A^r A^r}-Y_{L_1^f A^r}^2>0$, we have

$$\frac{dL_1^f}{dT}=\frac{1}{Y_{L_1^f L_1^f}Y_{A^r A^r}-Y_{L_1^f A^r}^2}>0 \tag{1.29}$$

Chapter 2

Income, Belonging and the Economic Value of Environmental Amenities: Evidence from Migrant Workers in China[1]

[1] Liu, Z., Dorfman, J., Bergstrom, J., and Chen, H. Submitted to *Journal of Environmental Economics and Management*, 06/15/19.

Abstract

The second chapter sheds light on migrant workers in urban areas and their environmental attitude towards air pollution. We examine how migrant workers value environmental amenities and what factors contribute to their environmental concerns. Survey data from Jiangsu Province is used to measure migrant workers' willingness to pay to protect local environmental amenities. The results show that about 72.5% of migrant workers have an interest in protecting local environmental amenities with an average willingness-to-pay (WTP) of 22.63 yuan. Place attachment, in forms such as good life satisfaction, relationships with local citizens, owning property, and more years living in the local community all contribute to higher WTP. We also find more environmental knowledge would increase migrant workers' concerns over local air quality. Results suggest that education programs and other policies oriented to improve place attachment can increase the willingness-to-pay by up to 3.74 billion yuan per month for the migrant worker population in Jiangsu.

Keywords: Migration; environmental concerns; income; place attachment; WTP

JEL Codes: O15, Q51, R11

2.1 Introduction

Large labor mobility, either from rural to urban areas or from lower to higher productivity sectors, erases differences in productivity and income per capita across regions and sectors (Lagakos et al., 2018; Restuccia et al., 2008; Duarte and Restuccia, 2010). Attracting outmigration which has been long emphasized in literature, however, is only half the story. Successfully retaining migrants in the regions or countries in ways that contribute to the development of social capital is the other half (Pavlova and Silbereisen, 2015). In contrast to unstable and temporary migration, settlement in a migrant city or country is a long-term decision and is attributed to many factors, such as income, work opportunity, education and quality of life. Environmental quality, an important component of the quality of life, is critical in determining how attractive a location is to live in (Bryan and Morten, 2015). Most emerging countries like India, Saudi Arabia, and China who have experienced large labor mobility, are suffering from severe environmental degradation in recent years (Tao et al., 2014; Wang et al., 2014; Greenstone and Hanna, 2014). The adverse environmental amenities like air pollution not only reduce "subjective well-being" (Levinson, 2012), but also cause severe diseases such as lung cancer, strokes, and ischemic heart disease (Pope and Dockery, 2006; Lepeule et al., 2012; Kloog et al., 2014). While a great deal of research has addressed environmental issues, very little effort has been expended on investigating what and how much the migrant population knows about the

environment as well as their environmental attitudes.

Public environmental awareness has been documented as a primary driving force in protecting environmental amenities (Arcury, 1990; Huang et al., 2006), and public participation determines the achievements of environmental protection. Migrant workers in China, a mushroomed subgroup population (286 million in 2017), have made up a considerable proportion of local residents[2] in most big cities, i.e., 37.2 percent in Beijing and 40.5 percent in Shanghai as of 2016.[3] Large proportion as it is, migrant workers often experience social and occupational segregation by the *hukou* system (the household registration system). The *hukou* system classifies each citizen into an agricultural or non-agricultural *hukou* (commonly referred to as rural or urban). This two-fold residency structure is linked to many social policies and benefits, and those residents with non-agricultural (i.e.urban) *hukou* status received benefits not available to their rural counterparts and migrants. Rural migrants are allowed to live and work in cities, but have limited channels to obtain urban *hukou* as well as the associated benefits ranging from children's education to housing and health care. The segregation of residency status could shape unique feelings of belongingness as well as environmental attitudes to migrant cities. Studies on public environmental awareness, however, focus almost exclusively on local permanent residents who

[2]For clarity, local residents includes citizens and non-citizens(e.g., migrant workers) depends on where their household registration are.

[3]For further references the next url: http://www.bjstats.gov.cn/tjsj/tjgb/ndgb/201702/t20170227_369467.html and http://www.stats-sh.gov.cn/html/sjfb/201703/293816.html

have urban *hukou*. Without further documentation, there is no reason to believe the environmental preference of migrant workers should be identical to the preference of the urban citizens.

To improve the understanding of environmental concerns, considering the context within which migrants develop environmental concerns, may be important (Vorkinn and Riese, 2001). Studies suggest that the public's environmental attitudes are potentially related to various socio-demographic factors, such as education, income, environmental knowledge, and residence (Arcury, 1990; Alberini, 1997; Loehman and De, 1982). Residents with high education levels typically possess a strong ability to acquire environmental knowledge and thus take more preventive measures against air pollution (Wang et al., 2016). In addition, economic theories explain that when people live in a more developed region or have higher incomes, they are willing to pay more to improve environmental quality (Huang et al., 2006; Del Saz-Salazar and Garcia-Menendez, 2001). One salient contextual variable related to migrants' environmental attitude is place attachment, which deals with human bonding to a specific physical environment. Place attachment, a widely researched concept in psychology, describes the values people confer on their surroundings, together with associated behavioral relationships with the place (Lin and Lockwood, 2014; Vorkinn and Riese, 2001; Brehm et al., 2012). Studies show that place attachment can influence individuals' environmental concerns and environmental action within a community (Wakefield et al., 2001; Vorkinn and Riese, 2001). That is, residents with higher levels of

place attachment are more likely to take action to protect local environmental amenities. Therefore, it is worth incorporating place attachment into the discussion of migrant workers' environmental attitude.

This paper aims to shed analytical and empirical light on the environmental concerns of a subgroup: migrant workers. In particular, the paper studies whether or not migrants have concern for local environmental amenities like air quality, and what factors contribute to their environmental concerns. We combine survey data from 2016 with air quality monitoring data, and model individuals' willingness-to-pay (WTP) as a function of income, education, air quality, place attachment, etc. The results show that about 72.5 percent of migrant workers have an interest in protecting local environmental amenities with an average WTP of 22.63 yuan. Place attachment, in forms of multiple indexes including good life satisfaction in migrant cities, relationships with local citizens, owning a property, and more years living in the local community all contribute to higher WTP. We also find a positive connection between environmental knowledge and environmental attitude over local air quality. This indicates that enhancing migrants' environmental education and providing accessible environmental knowledge to migrants for tackling smog pollution are of great importance. Results suggest that education programs and other policies oriented to improve place attachment can increase migrants' WTP by up to 3.74 billion yuan per month.

Our paper is closely related to the latest literature on misallocation of labor (Restuccia and Rogerson, 2017; Bento and Restuccia, 2017; Asker et al., 2016). We enrich the literature by specifically focusing on settlement decisions which is the key step to eliminate misallocation across sector and places. We differ from Qin and Zhu (2018) who also focus on the impact of air pollution on migration in that we study internal migration rather than international emigration using survey data. Importantly, according to our knowledge, this paper is the first to incorporate place attachment into migrants' economic valuation in the context of China. Finally, air improvement programs are always costly. Learning how migrant workers benefit from improved air quality could estimate the contributions of migrant workers toward environmental protection.

This paper is organized as follows: Part 2.2 is the theoretical valuation model. We use the compensating surplus to measure the WTP which incorporates place attachment. Part 2.3 is about the data structure: we present the survey information, sample representation and air quality measurement. Part 2.4 and part 2.5 are the empirical model and estimation where we mainly use the zero-inflated negative binomial model to estimate. Robustness checks and policy analysis are provided in Part 2.6 and Part 2.7, respectively. Finally, a conclusion and discussion are included.

2.2 Valuation Model and Option price

Air quality can affect local residents' subjective well-being and is one of the determinants in their utility function. Estimating the economic values of air quality requires specifications of groups or individuals who benefit from air quality improvement. Like other local residents, migrant workers' economic assessment of improved air quality depends on demographic characteristics, incomes, and air quality status. However, migrants may also experience severe demand uncertainty due to their frequent migration and institutional obstacle for local settlement, such as *huku* system.

Migrants can generate utility from both market goods and non-market goods such as air quality. Preferences are represented by an increasing, quasi-concave indirect utility function, $V = V(P, M, q_j, Q_{-j}|D)$, where P is the vector of prices for market goods, M is the money income, q_j denotes the air quality from a set of non-market goods Q, and Q_{-j} is the vector of all other public goods left after removing q_j. D represents a vector of all socioeconomic and demographic variables. A simplifying assumption is that without an air protection program, local air quality tends to be worse on average.

Although each migrant worker cannot unilaterally choose their preferred level of air quality, it can change due to the society's choices. The improvement of air quality could represent acres of open space preserved, air protection regulation,

or support of pollution prevention research. Let the price of the air protection program be equal to R which is the reduction in income that is just sufficient to maintain utility level when air quality increases. We define the initial air quality as q_j^0 and the improved air quality as q_j^1 and $q_j^1 > q_j^0$. Therefore, the migrant's utility with the protection program is $V^1 = V(P, M - R, q_j^1, Q_{-j}|D)$.

The impact of individual demand uncertainty should be considered in the economic valuation of environmental protection. The most significant component of uncertainty that migrants have is their future moving plan. Specifically, they are uncertain about which of the two states of migration: move or stay will be realized and are not indifferent to which state occurs in terms of local protective activities. Let an individual migrant's subjective estimation of future demand of local air quality be denoted by γ.

The future moving plan of migrant workers critically depends on the interactive connection between migrant workers and local communities involving physical and social dimensions (Gunderson and Watson, 2007). More specifically, places provide the conditions and features (such as jobs and high wage) that migrant workers need, which is called place dependence (Anton and Lawrence, 2016). Meanwhile, places can also become elements of identity subject to the pressure to maintain self-esteem, self-efficacy, continuity and distinctiveness (Breakwell, 1993). This deeper tie to place provides a fundamental component of a person's relationship with a place, which is named as place identity (Anton and Lawrence, 2016; Lin

and Lockwood, 2014). Let the individual's subjective estimation of future demand γ be a function of place attachment involving two dimensions: place dependence: wage(w) and place identity (I).

$$\gamma = \gamma(w, I|D). \tag{2.1}$$

Normalize γ to (0,1) where $\gamma = 1$ means that migrant workers will continue to reside in the communities and thus their demand of improved air quantity is q_j^1, whereas $\gamma = 0$ indicates that migrant workers are more likely to more out from the region where they are currently reside in in the future, and their demand of improved air quality becomes zero.

Theoretically, there also exists supply uncertainty which indicates the possibility of implementation of intended air protection policy. The perspective of supply uncertainty, however, depends on various variables, such as the trust in government, cooperation among regional governments and technical feasibility which is not our primary interest. To rule out concerns about supply uncertainty, we inform respondents in the survey that the money they contribute to protect environment will be used properly. Therefore, the expected utility with with the program is:

$$EV^1 = \gamma(w, I|D)V(P, M - R, q_j^1, Q_{-j}|D) + [1 - \gamma(w, I|D)]V(P, M - R, Q_{-j}|D). \tag{2.2}$$

The second part of equation 2.2 on right side indicates that a migrant cannot gain utility from local improved air quality if he/she moves to an other place (including return to their hometown). The change in expected utility caused by the implementation of an air quality protection program as well as the demand uncertainty is defined by $(EV^1 - V^0)$ which is:

$$\begin{aligned}\Delta EV &= EV^1 - V^0 \\ &= \gamma(w, I|D)V(P, M - R, q_j^1, Q_{-j}|D) + [1 - \gamma(w, I|D)]V(P, M - R, Q_{-j}|D) \\ &\quad - V(P, M, q_j^0, Q_{-j}|D) \\ &= f(\triangle q_j, Y, R, w, I, D)\end{aligned} \tag{2.3}$$

The equation shows that the change in expected utility is a function of change of air quality, income, wage, price of the program place attachment and demographic factors. Given the duality in consumer theory, we can infer that

$$\begin{aligned}OP = WTP &= E[P^0, q_j^1, Q_{-j}^0, U^0, \gamma(w, I|D)] - E[P^0, q_j^0, Q_{-j}^0, U^0, \gamma(w, I|D)] \\ &= g(\triangle q_j, Y, w, I, D)\end{aligned} \tag{2.4}$$

where $\triangle q_j$ represents the hypothetical change of air quality, Y is household income, w is the wage rate in the current location. I represents migrant workers'

place identity and D denotes the household and individual characteristics. The function form of g will be discussed later in estimation part.

2.3 Survey and data description

2.3.1 Survey area

The data used in this paper were collected in a survey of the southeast Jiangsu Province of China in 2016. Figure 2.1 shows the survey areas in a map of China. Jiangsu Province, especially the southeast part is one of the most developed regions in China with a GDP of 4152 billion RMB (USD 639 billion, about 6% of China's total GDP) in 2015. The southeast cities, mainly referring to Nanjing, Changzhou, Zhenjiang, Wuxi and Suzhou, are the birthplaces of Chinese light industry such as textiles and the food industry. Because of the prosperous development in labor-intensive industries, the southern regions have attracted about 8 million migrant workers from around the country. Meanwhile, the rapid industrialization in these regions caused serious air pollution. The annual average PM2.5 and average of the maximum daily PM2.5 for these five cities are 73.0 and 334.4 $\mu g \cdot m^{-3}$, respectively. These averages rank the five cities among the 40 most polluted areas in China [4].

We applied a stratified sampling method and selected Wuxi, Changzhou and Suzhou on the city level. Three districts or county-level cities were randomly

[4]For further references the next url: http://www.greenpeace.org/eastasia/news/blog/bad-to-worse-ranking-74-chinese-cities-by-air/blog/48181/

selected. They are Wujin district from Changzhou city, Huishan district from Wuxi city and Changshu city from Suzhou city. The sample sizes in each district or city were calculated based on the population of migrant workers in each location, confidence level, and suitable margin of error [5]. Table 2.5 in the Appendix shows details for sample size calculation, recommended sample size and actual sample size for three survey locations. Each respondent was surveyed by the investigators through face-to-face interviews. The questionnaire included (1) household and individual characteristics, (2) place attachment variables, (3) environmental attitude and WTP for air quality protection, etc.

2.3.2 Environment condition and air quality index

We could not survey respondents about their experience with a change in air quality because the scenario of improved air quality is hypothetical. Instead, we observed the air quality and weather conditions on the date and at the place respondents were surveyed. The China National Environmental Monitoring Center releases SO_2, NO_2, CO, O_3, PM_{10}, and $PM_{2.5}$ as well as a comprehensive air quality index (AQI) every hour. AQI is a popular representative index to convert raw values for criteria pollutants into a single index to reflect air quality. The calculation of AQI may vary across countries because of the different components of pollutants, calculation formulas, as well as scale standards based

[5]The sample size calculation formula here is $n = \frac{\frac{z^2 p(1-p)}{e^2}}{1+(\frac{z^2 p(1-p)}{Ne^2})}$ where N is the population size, e is margin of error, $z_{\alpha/2}$ is the critical value for the confidence level c, p is the fraction of responses.

on their own environmental conditions. There is a comparison between the standards of two countries in the Appendix, and generally, the Chinese AQI scale is much "looser" than the U.S. standard.

The Figure 2.1 shows the distribution of air quality monitoring stations around the survey location. The geographically closest monitoring stations to each survey location were selected to record daily maximum AQI. Most surveys were conducted from noon to the evening during which the AQI index reaches its daily peak (most polluted) in a day. To reflect respondents' intuitive sense of air quality, this paper uses the maximum value of AQI on the day before the survey day as the air quality measurement. The reason is that the maximum value of AQI gives migrant workers the freshest and deepest perception of air pollution risk. Several different measurements of air quality are proposed for robustness check later.

2.3.3 Place attachment

Recent empirical research on place attachment has heavily relied on the psychometric scales to evaluate the affective and cognitive content of the person place bonds from the perspective of sociology and environmental psychology (Jorgensen and Stedman, 2001; Billig, 2006). Typically, interviewees were asked about a dozen questions approved by a consensus of the analysts-judges with 7-point or 5-point Likert-type response scales. To reduce the number of analysable variables and detect their relationships, most research applied principal component analysis and factor analysis. While the psychometric scales

provide valuable insights to place attachment, they are less able to link residential behavior to the content of place attachment. Meanwhile, factor analysis, along with principal component analysis have been criticized for decades because of ambiguous results and methodological issues (Fabrigar1999).

Although there is no consensus regarding the forms and sources of place attachment (Lin and Lockwood, 2014), it is generally accepted that place attachment has affective, social, and physical dimensions. The questionnaire for this paper included a set of questions measuring the migrant workers' community connections, residential behavior, and levels of satisfaction (see Table 2.1). Specifically, the community connections are measured from a set of questions that inquire into the relationship with local citizens, the numbers of local helpers when they are in trouble, and the capability to speak local dialect. Residential behaviors are evaluated from actual behavior as well as subjective assessment. Actual behaviors include purchasing property in local communities and the length of time working in this area. Migrant workers were also requested to assess their current identity as either urban dwellers or "outsiders." Migrant workers were asked to state their satisfaction regarding their life in local communities. Besides, the migration type also affects their place attachment. Usually, migrations with the whole family have the most psychological investment in a place, followed by couple migration, and finally the individual migrant. Rather than constructing scale indices, all of these variables enter the model independently to address different aspects of place attachment.

2.3.4 WTP measurement

Valuing local public amenities is one of the greatest challenges facing applied economics (Levinson, 2012). Methods like the travel-cost model, hedonic pricing, contingent valuation and choice experiments have been widely developed. Measuring the benefits of air quality improvement to migrants in China, in particular, restricts the methods options. Specifically, the hedonic model is not appropriate since it is uncommon for migrants to own property in places they migrate to (around 16% according to National Bureau of Statistics). The travel cost model is also improper, because the trip cost of reaching the place cannot reflect the individual's "price" for air quality at the site. Although challenged by the potential bias in response (McFadden, 1994), the contingent valuation method (CVM) which collect people's willingness to pay directly, is the most common implementable method (Cho et al., 2008).

The implementation of stated preference for the economic assessment of air quality is conducted through an open ended question asking willingness to pay for local air quality improvement. This technique is based on hypothetical payment scenarios to capture people's desire to pay for specific aspects or the entirety of goods and services (Carson and Mitchell, 1995). The application of WTP in our study is conducted through questionnaire forms and open-ended questions for migrant workers.

In the questionnaire, the respondents were asked a self-evaluation screening question about individual's role in air pollution control. Options are listed from "very important" to "not important at all" by using the five-level Likert Scale of importance. Only those who believe that individuals have an important (or very important) role in controlling air pollution will be asked further about their WTP. This screening question can mitigate the respondent bias by removing the potential contamination for WTP from those who believe that individuals' contribution is not important. We used tax as the payment vehicle of WTP because of its legalistic claim from which we expected respondents to answer seriously. Besides, for most Chinese people, WTP is more similar to a voluntary donation, to which they tend to refuse to contribute.

How important do you think is the role of a individual in controlling air pollution?

A. *Very important* ***B.*** *Moderately important* ***C.*** *Of average*

D. *Of little importance* ***E.*** *Not important at all*

(If respondents choose A or B) *How much are you willing to be taxed per month to improve air quality, given the financial transparency:_____ yuan?*

The open-ended question is preferred over a multiple choice setting in this study due to the potential biases emerging from the adoption of predetermined bids. It is acknowledged that similar biases may occur in open-ended questions when unrealistically high or low bids appear (Cameron and Quiggin, 1994). Thus, the trained researchers offered extensive introduction on the concept of economic

assessment to survey takers. Further, a screening question was applied and the outliers were excluded from the sample as a potential distortion of the final outcome.

2.3.5 Descriptive analysis

Table 2.2 shows the descriptive summary of variables used in estimation. The average of WTP for improved air quality is 22.63 *yuan* per month(about 3.56 dollars). This value is close to peasants' WTP but about half of overall WTP found in Wang et al. (2016). Although Wang et al. (2016) also surveyed migrant workers, there is only a 2% response rate from the migrant worker population. There are two main reasons to explain the difference of WTP here compared to Wang et al. (2016): first, Wang et al. (2016) collected data in Zibo city, Shandong Province where mining and petrochemical industries are dominant and heavy smog pollution is a very serious problem. Thus, respondents have stronger willingness to protect air quality and higher WTP. Besides, the respondents are younger and more educated. For example, respondents with college degrees comprise 38.6% of their sample whereas they represent only 4.26% in our sample. Meanwhile, our respondents 50 or older are more than double than in their survey. Younger age and more environmental knowledge also contributes to higher WTP.

The air quality varies within a rather wide range from 57 to 214, which indicates moderate condition to heavy pollution according to Chinese air pollution measurement. The average of AQI (104) in survey areas indicates

"light pollution" which is unhealthy for sensitive groups. The migrant workers in the the samples have moderate relationships with local communities because the average values of the first three indexes are close to the median. Although the average length of time working for migrant workers in the current place is about 7 years, the percentage owning a property is very low(4%) and about 93% report their identities as farmers or migrant workers. Life satisfaction for migrant workers is on the average which means neither satisfactions nor dissatisfactions. Finally, there exists diverse types of migration. Specifically, 28.27% of respondents migrate individually, 34.88% migrates with couples and about 36.85% with their whole family.

In the list of controlling variables, the table shows that about 72% respondents are male and their average age is 36.71 years old. Both education and self-reported health condition are categorical variables with 5 levels. Specifically, the five levels in order for education are illiteracy, elementary school, middle school, high school, and college and beyond. Health conditions use the Likert-scale with very poor for the first level and excellent for the last level. The average education level is between middle school and high school. Most respondents report a good condition in their health and about 38.02% indicates smoking behavior in their daily life. When asked which is their priority: environmental protection or economic development to reflect their environmental attitude, about 78.95% agree that protecting the environment should be given priority, even if it causes slower economic growth and some loss of jobs. The questionnaire also contains a

set of questions about rural land rights. The results shows that the willingness to abandon their contracted land as well as residential land is very low. This addresses the tight connection between migrant workers with rural society.

To justify the representation of survey samples, we compare some demographic characteristics of the survey samples with national migrant workers population. [6] Table 2.6 in Appendix shows that migrant workers in the survey samples are mainly male, young age, less educated labors. The biggest difference occurs in the types of industrial sectors. Specifically, 78.97% of migrant workers in our survey engage in manufacturing sectors, which is over twice as much as the national level. This is reasonable because the southeast parts of Jiangsu Province has a strong manufacturing base, such as electronic and mechanical sector, high technology products, and integrated circuit and liquid crystal display. The south part is also the home of many of the world's leading multinationals in the field of electronic equipment, chemicals and textiles. Because of the high percentage of manufacturing labor forces, it is also acceptable that migrant workers in our sample have higher income and longer working time than the national migrant workers. In short, the survey samples are good representatives of national migrant workers.

[6] The national Bureau of Statistics releases annual migrant workers report based on sampling survey of 236,000 rural workers which covers all provinces since 2008

2.4 Estimation

2.4.1 Model-ZINB

The distribution of WTP is generally skewed to the right with a large proportion of zeros and has characteristics of count data. A zero-inflated model assumes that the zeros have two different origins in the data-generating process: structural zeros and sampling zeros (Hu et al., 2011). In this research, it is more appropriate to believe that there exists two types of migrant workers in terms of environmental attitude: migrant workers with no interest in protecting environmental amenities(named as "non-interest group") who always pay zero for WTP (structural zeros) and those with interest in protecting environmental amenities who could pay any positive numbers but not always (named as "interest group"). In the latter case, migrant workers may pay zero WTP (sample zeros) for some reasons such as economic capacity insufficiency, a plan of moving out etc. A Bernoulli distribution governs the binary outcome of whether a WTP is zero or positive realization and a discrete probability distribution (Poisson distribution or Negative Binomial (NB) distribution) [7] supports any other non-negative integers.

When count data is suspected to have "overdispersion" (variance is larger than the mean), the NB distribution is more appropriate than the Poisson distributions in modeling the nonnegative of WTP. Considering the presence of 27.47% zeros in WTP and greater values of variance than its mean (see Table 2.2), this paper

[7] All the normality tests rejects the null hypothesis of normal distribution.

applied a zero-inflated negative binomial (ZINB) regression model to handle both zero-inflation and overdispersion. The NB distribution looks superficially similar to the Poisson but with a longer, fatter tail. Both zero-inflated Poisson (ZIP) and the conventional NB model are applied to check the robustness later.

The ZINB model assumes that there two distinct data generation processes and these two regimes can be modeled independently. The logit model predicts excess zeros (structural zeros) and the negative binomial model models the count process. The result of a Bernoulli trial is used to determine which of the two processes is used. In this paper, structural zeros represent "no interest group." For migrant workers i, π_i indicates the probability of being "no interest group," whereas the other regime from which discrete WTPs are generated with a negative binomial model is chosen with probability of $(1 - \pi_i)$. In general:

$$WTP_i = \begin{cases} 0, & \text{with probability } \pi_i. \\ g(WTP_i|\mathbf{x}), & \text{with probability } 1 - \pi_i, \end{cases} \tag{2.5}$$

where $\mathbf{x}$ is a vector of covariates in the NB model. The probability π_i is a function of the characteristics of migrant workers i with an implicit function form: $\gamma\mathbf{z}$, where $\mathbf{z}$ is the vector of zero-inflated covariates and γ is the vector of zero-inflated

coefficients. Thus, the probability of $\{WTP_i|\mathbf{x}\}$ is

$$P(WTP_i|\mathbf{x},\mathbf{z}) = \begin{cases} \pi(\gamma\mathbf{z}) + [1-\pi(\gamma\mathbf{z})]\cdot g(0|\mathbf{x}), & \text{if } WTP_i{=}0 \\ [1-\pi(\gamma\mathbf{z})]\cdot g(WTP_i|\mathbf{x}), & \text{if } WTP_i > 0. \end{cases} \tag{2.6}$$

Generally, $\pi(\cdot)$ can be specified as either the logistic function or the standard normal cumulative distribution function (the probit function) and the logistic link function is adopted in this paper:

$$\pi(\gamma\mathbf{z}) = \frac{exp(\gamma\mathbf{z})}{1+exp(\gamma\mathbf{z})}. \tag{2.7}$$

The NB procedure models the non-negative count data:

$$g(WTP_i|\mathbf{x}) = \frac{\Gamma(WTP_i+\alpha^{-1})}{\Gamma(WTP_i+1)\Gamma(\alpha^{-1})}(\frac{1}{1+\alpha\mu_i})^{\alpha^{-1}}(\frac{\alpha\mu_i}{1+\alpha\mu_i})^{WTP_i}. \tag{2.8}$$

2.5 Results

Two types of tests are performed before looking at the estimated results. A likelihood-ratio test for $\alpha = 0$ comparing the ZINB model with the zero-inflated Poisson model is conducted and the results indicates that the ZINB is preferred to the Zero-inflated Poisson (ZIP) model becuase of the overdispersion. Next, a Vuong test is used to determine whether estimating a ZINB is appropriate over

an ordinary NB model [8] and ZINB is again preferred over ordinary NB because of the zero inflation. To confirm the results, the robustness check with different model specifications, including hurdle model, ZIP, and ordinary NB are conducted later.

2.5.1 Relevant or not

Table 2.3 shows the results from the ZINB regression with and without a set variables of place attachment. [9] Inflation models in the two scenarios are estimated by a logit model where the value 1 represents the "no interest group"(excessive zeros) and the reference group is the "interest group"(NB distribution). The WTP represents estimations from the NB distribution. Overall, place attachment increases the fit of the model but the impacts to a binary process and an NB process are different.

The results show that in the inflation model, the set of place attachments affect the coefficients' magnitude but not the inferences of income as well as other demographic variables. As for the determinants of excessive zeros, Table 2.3 shows that the log odds of an excess zero would decrease by 0.636 for every additional income level. In other words, the more income migrant workers have

[8] This paper uses **zinbcv** in STATA which corrects the bias in estimation to perform Vuong test. Later, **zinb** is used for estimation because the **zinbcv** commend does not allow factor variables and time-series operators and results from both are almost identical

[9] To show the whole table into a single page, three variables of place attachments are omitted since they are not statistically significant in all cases.

the less likely that the zero would be due to membership in the no interest group. Put it plainly, the higher the income, the more likely that the migrant workers are interested in protecting environment quality. Life satisfaction and length of time working also have negative and significant impacts which means that migrant workers with higher life satisfaction and longer length of time working in current communities tend to care about local air quality. Surprisingly, owing a property increases the probability of being in the"no interest group" which is contrary with other research. This could be explained that migrant workers may take environmental amenities into account when they are considering purchasing a property in the local communities. But once they own a property, air quality is not a consideration any more and they are getting used to the local air quality.

The demographic factors show that elderly or healthier migrant workers do not express interest in protecting air quality. By contrast, migrant workers with more education attachment show more interest in air quality protection. Higher education levels mean a stronger ability to obtain environmental knowledge which changes environmental attitudes (Arcury, 1990). Migrant workers with smoking behavior are more likely to have air pollution concerns. This is consistent with the finding from self-reported health condition. Lastly, migrant workers with an environmental-friendly attitude are less like to be in the "no interest group" and the log odds is very large. This confirms the consistence of respondents' attitude.

2.5.2 Determinants of WTP

The 2nd and 4th columns of table 2.3 represent the NB distribution without and with place attachment. The table shows that place attachments not only affect coefficients' magnitude for variables such as income, environmental attitude but change the inferences for variables like education. The discussion below focuses on the NB model with place attachment.

Air quality affects migrant workers' willingness to pay for protection significantly. More polluted air quality increases their willingness to pay by 0.0019. Income turns out to have an "U-shape" relationship with their WTP. Specifically, migrant workers' WTP decreases when their incomes increase. Once the income exceed a threshold, their WTP increases as income increases. The turning point is around 2277 *yuan* per month (around 360 dollars). Suppose that migrant workers work 11 months on average, the turning point is around 4000 dollars per year, a finding comparable with those of Grossman and Krueger (1991), Dinda (2004), Panayotou (1997), Harbaugh et al. (2002) and Akbostanci et al. (2009). Place attachments overall have positive impacts on migrant workers' WTP. A higher level of life satisfaction in local communities increases WTP by 0.086 *yuan* holding others constant. Better relationship with local citizens increases migrant workers' WTP by 0.266 *yuan* and the impact is statistically significant at 1% significant level. The length of time working, the best predictor of place attachment in previous papers does not have significant impact on WTP

here.

Among all place attachments, owning a property in local communities has the greatest impact, with an increase in expected WTP of 0.468 *yuan*. Considering the positive impact of housing on binary choices, a heterogeneity impact of owing a property on migrant workers' environmental preference becomes clear. Owing a property in local communities brings down migrant workers' concerns about local air quality. This can be potentially explained by one of the core value and belief systems in Confucianism: "Property possession determines moral conscience." [10] Put in other words, owing a property makes people live and work peacefully, and thus have fewer concerns about environmental amenities.

Land rights in rural area significantly affect migrant workers' choices and behaviors. The results show that migrant workers with the intention to abandon their contracted farmland have higher WTP by 0.3764 *yuan* and the impact is even larger for residential land, which further confirms the important meaning of property, even in rural area.

[10]Citation from *Mencius* which is one of the four Chinese classic texts.

2.6 Robustness

2.6.1 Robustness checking list

The results from estimation may be very sensitive to alternative specifications and thus the hypothesis are not robust. In this part, we discuss several potential sources which may weaken our conclusions: AQI measurement, omitted variable, outliers and model specification. Meanwhile, we conduct twofold robustness checks regarding migrant workers' choice probability and WTP. We apply the same robustness check list but different policy instruments.

The air pollution indicator in this paper is the maximum value of AQI of the previous day. To rule out the potential impact from the air quality measurement, we replace the AQI indicator by the mean and median value of AQI from the previous survey day, as well as the maximum, mean and median value of AQI on the survey day. Meanwhile, the U.S. Consulate (Shanghai) which is close to the survey locations(50 and 100 miles away) has an air quality monitor to measure PM 2.5 particulates. Since PM2.5 is a key part of AQI, and the PM2.5 from survey locations show the same tendency, we applied PM2.5 from the U.S. Consulate (Shanghai) as a proxy variable for AQI. In Table 2.3, we only report the maximum AQI on the survey day and PM2.5 from U.S. Consulate as two alternative measurements for robustness check since all the AQI indexes lead to very similar results. Migrant workers' subjective assessments of air quality could highly correlates to ambient temperature (Fang et al., 1998). Meanwhile,

temperature may modify the impacts of of air pollution on heath (Koken et al., 2003) and thus affect migrant workers' WTP. Without specifying temperature, the variable of AQI would be endogenous and the estimation would yield biased and inconsistent. Thus, it is worth to check the robustness with ambient maximum temperatures on survey day.

The summary of data indicates the evidence of potential outliers of WTP. To the best of our knowledge, outliers in this study are not systematic which means that they don't belong to a different population than this paper want to study. Criterion cutoffs for outliers are computed based on a mean and a standard deviation of sample (Van Selst and Jolicoeur, 1994). In this paper, if the difference deviates by more than 3 SD from the mean of WTP, the observation then is marked as an outlier. The method of topcoding is applied for outliers which replace those extreme values with a constant. Results are reported in the fifth column of table 2.4 (Model 4). Finally, different model specifications could lead to disparate results. ZINB is superior to a conventional negative binomial when zero inflation is detected. The criteria for zero inflation, however is not consolidated. 29% zeros in dependent variable may be not sufficient evidence for excessive zeros. It is also worth comparing ZINB and zero-inflated Poisson (ZIP) since Poisson regression models are the basis for the analysis of count data (Greene1994). Lastly, zeros observations may potentially only come from one regime which infers the hurdle model or two-part model. Thus, three alternative model specifications are presented: NB model, ZIP and Hurdle model.

2.6.2 Results for robustness

Table 2.4 shows the first regime of DGPs: the binary choice using a logit model except for hurdle model to determines whether the observed WTP are zeros. There are two differences between ZINB and the hurdle model in the binary choice stage. The hurdle model applies a probit model while the ZINB uses a logit model. To be consistent in signs, we modify the reference from zeros to positive WTPs in hurdle model. NB model doesn't apply in this part because it assumes that data only comes from one regime.

Table 2.4 only presents several key or policy oriented variables and the estimations show pretty robust features in ZINB accommodating alternative air quality measurement, data sources, outliers, omitted variable and model specifications. Such robustness also exists in a large scope taking all variables into consideration. Specifically, income, place attachment (e.g., life satisfaction and length of time working) and environmental knowledge(e.g.,education and environmental attitude) all lower the probability of being excessive zeros for migrant workers. In other words, migrant workers with high income, strong place attachment and better environmental knowledge would build up interests in environmental protection. The difference of magnitude of coefficients in hurdle model with other model specifications mainly come from the estimation methods: probit model and logit model.

The robustness checks for the second regime are presented in Table 2.5. The variables include income and income squared term, four policy choices which are not necessarily identical with the variables in the first regime of DGPs. In policy choices, both housing and relationship represent place attachment which is the connection with the urban life whereas two land variables indicate the connection with rural lives. Overall, all robustness choices except ZIP and NB produce very similar results with the ZINB model. Such difference provides evidence that data issues of zero inflation and overdispersion should be paid attention to in analysis. Meanwhile, the majority of models support the "U-shape" between income and migrant workers' WTP. The turning point of annual income lies between $ 3676 and $ 4030 for migrant workers in China.

2.7 Policy analysis and aggregation

This section focuses on the post estimation and policy analysis. The main questions to be discussed here are why some migrant workers are not interested in environmental protection. Table 2.6 provides direction for policy intervention.

2.7.1 "Non-interest group"

The "excessive zeros" of WTP represent no environmental concerns from migrant workers. In other words, the migrant workers with "excessive zeros" are out of the environmental market. Interpretational difficulties can be overwhelming in

nonlinear functional forms such as logit model. Thus we calculate the marginal effects for the inflation portion of ZINB and only report the confidence intervals for variables with statistical significance. Table 2.9 in Appendix shows that income in log form decreases the predicted probability of being "excessive zero" group by 10% holding other variables constant and its 95% confidence interval is between 4.5% and 16.4%. Migrant workers with strong place attachment such as higher life satisfaction and longer length of time working are more likely to have environmental concerns. Meanwhile, education attachment and environmental attitude contribute migrant workers' interest in environmental protection significantly.

To explicitly show the relationship between income and the probability of being excessive zeros, we predict probability with income in Figure 2.2. The probability displays a clear decreasing trend when income increases. The impact of an increase of income above 7.65 has very limited impact on changing migrant workers' environmental attitude. This is because after the turning point around 7.72, most migrant workers already show interest in protecting environment and the marginal impact is decreasing.

In contrast, environmental knowledge such as high education and environmental attitude in Figure 2.3 increases migrant workers' interest significantly. This indicates that a reason that some portion migrant workers don't show interests in environmental protection could be lack of environmental

knowledge. With an environmental education program through TV or newspaper, much larger percentage of migrant workers care environmental condition.

2.7.2 Police inference on migrant workers' environmental concerns?

The WTP measures migrant workers' environmental concerns. Thus, we want to explore further the factors that affect migrant workers' WTP and proposal potential policy instruments. We provide a table in Appendix to show all the marginal effects.

Figure 2.4 shows the predicted WTP with different income levels. The graph shows that the predicted WTP roughly stays at the same level between 20 and 25 even though their income increases greatly. Thus, the impact of income on WTP is very limited for migrant workers. Figure 2.5 shows the relationships between predicted WTP and relationship and farmland as well. Specifically, migrant workers who have a better relationship with local citizens increase their WTP greatly from about 11 *yuan* to 34 *yuan* per month. If migrant workers plan to abandon their contracted farmland, their WTP increases by 10 *yuan* per month.

2.7.3 Policy instruments and Aggregation:Estimating Social Benefits Aggregation

Environmental protection programs, especially ambient air protection are always costly. This paper shows that migrant workers, an important part of the urban population, can benefit from a potential air improved program and are willing

to pay for such benefits. The current mean value of WTP is 22 *yuan* and about 72.5% migrant workers are willing to pay. Consider that our samples can represent the national migrant worker. The total migrant workers in China by the end of 2016 is 169.34 millions. The aggregate WTP for such amount of migrant workers is 2.78 billion yuan (see Table 2.6).

Education programs can increase migrant workers' environmental knowledge and thus shift about 9.8% of total migrant workers into the "interest group." The total benefits increases by about 376 million as a result. The impact from one more year in length of time working to the total benefits is only about 14 million. Any policy that increases the relationship between migrant workers and local citizen can increase their WTP by 6 yuan per month and the total benefits and the total benefit from such policy is aggregated to 736 million. For land rights, we only focus on contracted farmland. The prediction shows that migrant workers who are willing to abandon rural farmland will increase monthly payment by 7.8 *yuan* and the total aggregation is 963 million.

2.8 Conclusion

Whether or not migrant workers care about the environmental quality in urban communities where they live could make a big difference to their well-being and public policy options. The general arguments are negative which result in such situation that the environmental awareness of migrant workers are seldom emphasized in public participation and civic rights protection. This not only

reduces migrant workers' willingness to reside in urban communities and increases their mobility, but blocks off the channels through which migrant workers could contribute to environmental protection. Meanwhile, given that the central government's National Plan(2014-2020) has already aimed to give 100 million migrant workers urban *hukou* by the year 2020 and this number increases to 250 million by 2026, there is a desperate need for information about migrant workers' willingness of integration and their environmental concerns to local air quality is a good indicator of willingness of integration.

This research shows that about 72.5% migrant workers have environmental concerns towards local air quality protection and are willing to take the high environmental responsibility. Meanwhile, migrant workers who do not show interest in environmental protection typically have information constraints and education programs which aim to provide more environmental knowledge increases the percentage up to 82.3%. Place attachment, such as length of time working in local communities and life satisfaction also induces them to pay more attention to local environmental amenities. Rural land factors are identified as "pulling" factors which weak their willingness to reside in urban area. However, this doesn't mean the government encourages migrant workers to give up their land property rights and cut the connection with rural society. In fact, more and more migrant workers are not willing to abandon their land rights because (1) rural land property serves as a social security net for senior migrant workers and (2)with the continued process of urbanization, land owners near cities can expect

the central government to buy their land for a handsome sum sometime in the future.

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Tables

Table 2.1: Summary statistics of place attachment

Item	Explanation	Category	Mean	Min	Max
Relationship	Relationship with local citizens	Categorical	3.48	1	5
Local helpers	Helpers from local communities	Dummy	2.76	1	5
Local dialect	Ability to understand local dialects	Categorical	1.18	1	3
Housing	Owning a property	Dummy	0.04	0	1
Working length	Years of working in this place	Numerical	6.98	0	30
Self-identity	Self-identified as local citizen	Dummy	0.07	0	1
Life satisfaction	Life satisfaction	Categorical	3.50	1	5
Family migration	Migration with whole family	Dummy	0.37	0	1
Couple migration	Migration with couple	Dummy	0.35	0	1
Observations	1621				

Table 2.2: Summary statistics for all variables

Variables	Mean	Std. err.	Min	Max
Dependent variable				
WTP	22.63	37.68	0.00	500.00
Independent variable				
AQI	104.16	33.63	57.00	214.00
Income(Log)	8.23	0.39	5.99	10.60
Place attachment				
Relationship	3.48	0.61	1.00	5.00
Local helpers	2.76	1.05	1.00	5.00
Local dialect	1.61	0.64	1.00	3.00
Housing	0.04	0.20	0.00	1.00
Working length	6.99	5.63	0.00	30.00
Self-identity	0.07	0.25	0.00	1.00
Life satisfaction	3.50	0.66	1.00	5.00
Family migration	0.37	0.48	0.00	1.00
Couple migration	0.35	0.48	0.00	1.00
Controlling variables				
Gender	0.72	0.45	0.00	1.00
Age	36.71	10.81	18.00	60.00
Educ	2.95	0.84	1.00	5.00
Health	4.38	0.59	1.00	5.00
Smoke	0.38	0.49	0.00	1.00
Environmental attitude	0.79	0.41	0.00	1.00
Abandon contracted farmland	0.06	0.24	0.00	1.00
Abandon residential land	0.02	0.13	0.00	1.00
Observations	1620			

Table 2.3: Estimation of ZINB model

VARIABLES	Without place attachment		With place attachment	
	WTP	Inflation	WTP	Inflation
AQI	0.002*	-0.000	0.002**	-0.000
	(0.001)	(0.002)	(0.001)	(0.002)
Income	-4.626**	-0.570***	-3.941**	-0.636***
	(1.993)	(0.190)	(1.856)	(0.188)
Income squared	0.304**		0.255**	
	(0.121)		(0.112)	
Life satisfaction			0.086*	-0.226**
			(0.050)	(0.100)
Relationship			0.266***	-0.096
			(0.055)	(0.118)
Housing			0.468**	1.130***
			(0.182)	(0.288)
Local dialect			0.050	0.188*
			(0.053)	(0.106)
Working length			-0.003	-0.037***
			(0.007)	(0.014)
Self-identity			0.038	0.444*
			(0.121)	(0.241)
Gender	0.019	0.213	0.097	0.220
	(0.088)	(0.159)	(0.086)	(0.162)
Age	-0.028	0.017**	-0.026	0.023***
	(0.023)	(0.006)	(0.023)	(0.007)
Age squared	0.000		0.000	
	(0.000)		(0.000)	
Educ	0.118**	-0.191**	0.077	-0.258***
	(0.049)	(0.088)	(0.049)	(0.087)
Health	0.106*	0.226*	0.092*	0.220*
	(0.058)	(0.121)	(0.055)	(0.119)
Smoke	-0.058	-0.342**	-0.057	-0.324**
	(0.078)	(0.148)	(0.075)	(0.151)
Envi. attitude	0.186**	-1.440***	0.143*	-1.422***
	(0.089)	(0.139)	(0.085)	(0.140)
Abandon contracted farmland	0.486***		0.376***	
	(0.117)		(0.098)	
Abandon residential land	0.811***		0.759***	
	(0.211)		(0.234)	
location = 1	0.321***	-0.047	0.259***	-0.067
	(0.096)	(0.156)	(0.092)	(0.159)
location = 3	-0.170**	-0.152	-0.191**	-0.282*
	(0.081)	(0.153)	(0.077)	(0.157)
Constant	20.312**	3.704**	16.741**	5.452***
	(8.213)	(1.711)	(7.698)	(1.697)
Observations	1,620	1,620	1,620	1,620

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 2.4: Robustness check: choice probability

Variables		Original	Model 1	Model 2	Model 3	Model 4	Model 5-1	Model 5-2
Income								
	Income	-0.636***	-0.648***	-0.635***	-0.654***	-0.632***	-0.353***	-0.616***
		(0.188)	(0.189)	(0.189)	(0.189)	(0.185)	(0.099)	(0.176)
Policy choices								
	Life satisfaction	-0.226**	-0.224**	-0.223**	-0.208**	-0.223**	-0.129**	-0.223**
		(0.100)	(0.100)	(0.099)	(0.101)	(0.098)	(0.054)	(0.093)
	Working length	-0.037***	-0.037***	-0.036***	-0.038**	-0.037***	-0.020***	-0.035***
		(0.014)	(0.014)	(0.013)	(0.013)	(0.013)	(0.007)	(0.013)
	Education	-0.258***	-0.260***	-0.250***	-0.263***	-0.255***	-0.141***	-0.248***
		(0.087)	(0.087)	(0.087)	(0.087)	(0.086)	(0.046)	(0.081)
	Environmental attitude	-1.422***	-1.419***	-1.409***	-1.410***	-1.412***	-0.823***	-1.368***
		(0.140)	(0.141)	(0.141)	(0.141)	(0.139)	(0.082)	(0.134)
AQI		-0.000			-0.001	-0.000	0.000	-0.000
		(0.002)			(0.002)	(0.002)	(0.001)	(0.002)
AQI-0			0.002					
			(0.002)					
PM2.5				0.005**				
				(0.002)				
Temp					0.041**			
					(0.018)			
Outliers						√		
Different models								
	Hurdle model						√	
	ZIP							√
Observation		1620	1620	1620	1620	1620	1620	1620

Standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1

Table 2.5: Robustness check: WTP

Variables		Original	Model 1	Model 2	Model 3	Model 4	Model5-1	Model 5-2	Model 5-3
Income									
	Income	-3.941**	-4.027**	-3.933**	-3.940**	-2.969**	-3.889***	-1.962	-1.002
		(1.856)	(1.829)	(1.813)	(1.856)	(1.353)	(1.236)	(1.265)	(1.900)
	Income squared	0.255**	0.260**	0.254**	0.255**	0.194**	0.253***	0.134*	0.087
		(0.112)	(0.110)	(0.109)	(0.112)	(0.081)	(0.074)	(0.074)	(0.115)
Policy choices									
	Housing	0.468**	0.458**	0.471**	0.472***	0.333**	0.267*	0.529**	-0.022
		(0.182)	(0.183)	(0.183)	(0.182)	(0.156)	(0.158)	(0.211)	(0.218)
	Relationship	0.266***	0.271***	0.276***	0.266***	0.234***	0.250***	0.255***	0.270***
		(0.055)	(0.055)	(0.055)	(0.055)	(0.052)	(0.047)	(0.068)	(0.068)
	Contracted farmland	0.376***	0.374***	0.378***	0.377***	0.393***	0.543***	0.393***	0.314*
		(0.098)	(0.099)	(0.099)	(0.098)	(0.090)	(0.116)	(0.105)	(0.166)
	Residential land	0.759***	0.789***	0.799***	0.758***	0.731***	0.705***	0.669***	0.393
		(0.234)	(0.240)	(0.238)	(0.234)	(0.217)	(0.260)	(0.248)	(0.310)
AQI		0.002**			0.002**	0.002**	0.001	0.001	0.002*
		(0.001)			(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
AQI-0			0.000						
			(0.001)						
PM2.5				0.001					
				(0.001)					
Temp					0.001				
					(0.008)				
Outliers						√			
Different models									
	Hurdle model						√		
	ZIP							√	
	NB								√
Observation	1621	1621	1621	1621	1621	1621	1621	1621	1621

Standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1

Table 2.6: Policy analysis and benefit aggregation

	No policy	Choice process		WTP	
		Education program	working lengh	Relationship	Land rights
Percentage of interest group	0.725	0.823	0.729	0.725	0.725
		(+0.098)	(+0.004)	-	-
WTP (yuan per month)	22.629	22.629	22.629	28.628	30.471
		-	-	(+5.998)	(+7.841)
Total migrant workers(2016,million)	169.340	169.340	169.340	169.340	169.340
Total benefits(yuan,million)	2,779.502	3,155.622	2,793.648	3,516.199	3,742.563
		(+376.120)	(+14.156)	(+736.687)	(+963.061)
Total benefits(dollar,million)	440.492	500.099	442.733	557.242	593.116
		(+59.607)	(+2.242)	(+116.751)	(+152.625)

Note: Numbers in parentheses are the difference with the no policy scenario. Percentage of interest group is ratio of non-zeros WTP over total observations. The exchange rate is using 6.31.

Figures

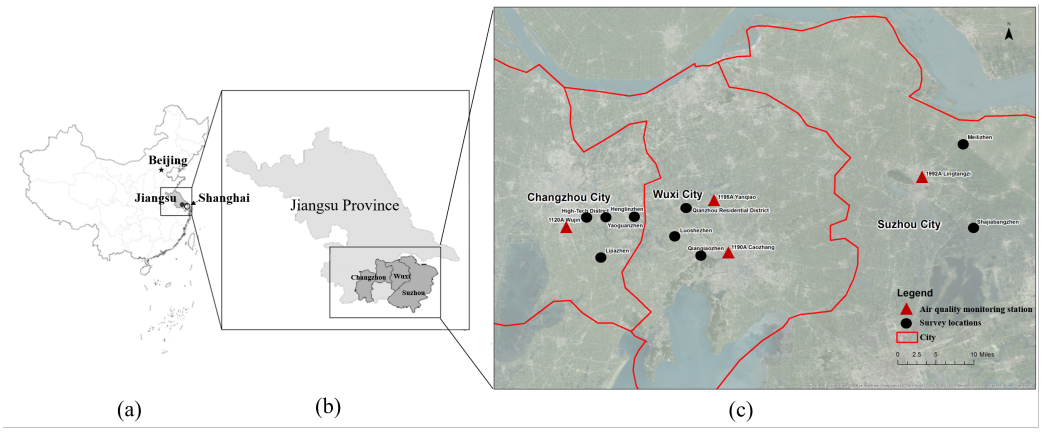


Figure 2.1: Sketch map of survey area (a)China; (b)Jiangsu Province; (c)survey locations

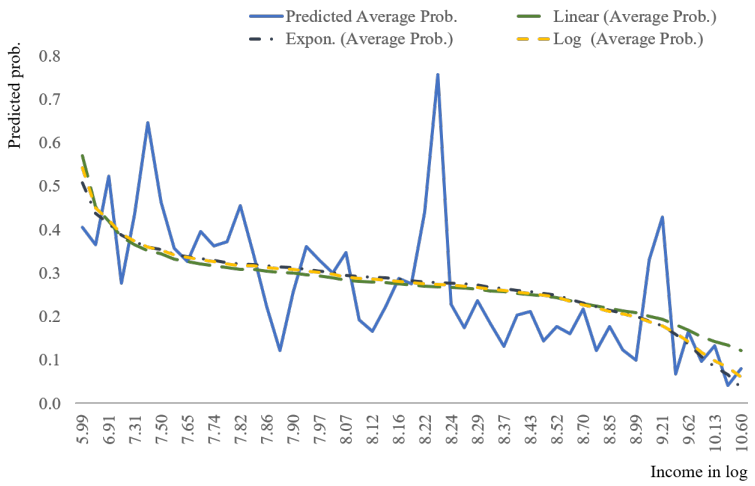
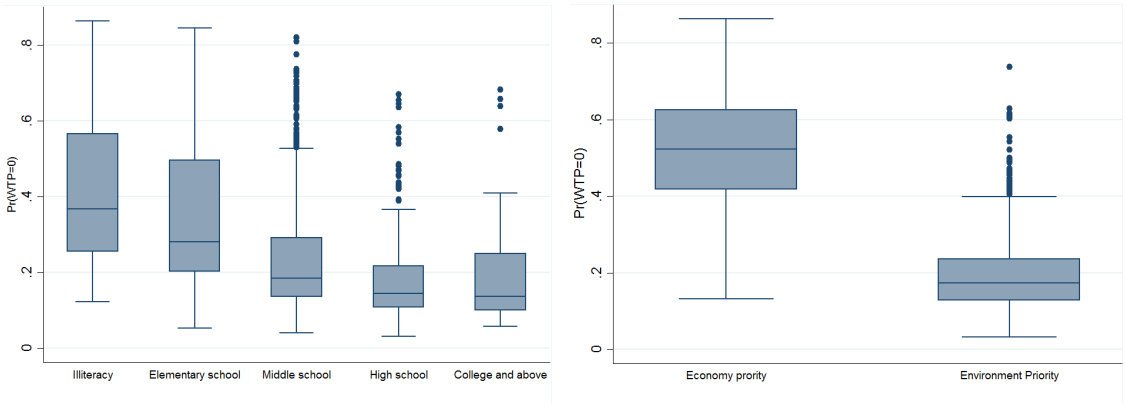


Figure 2.2: Predicted probability and environmental attitude



(a) Education and probability (b) Environmental attitude and probability

Figure 2.3: The trend of probability with education

Appendix

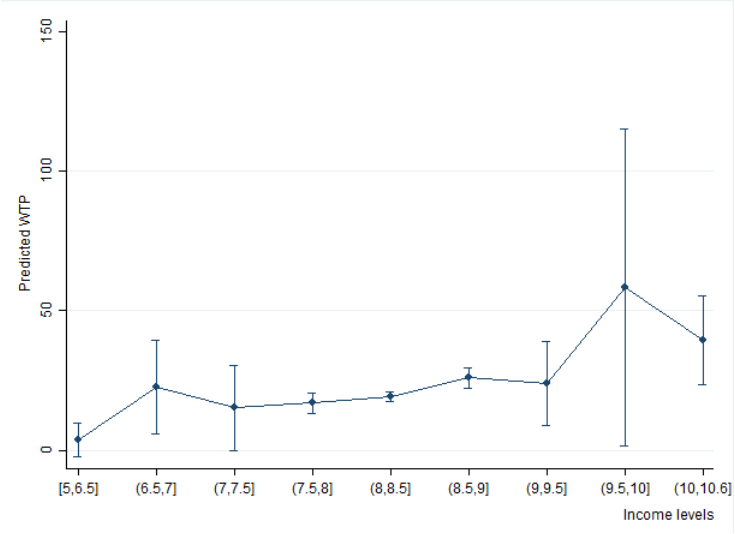
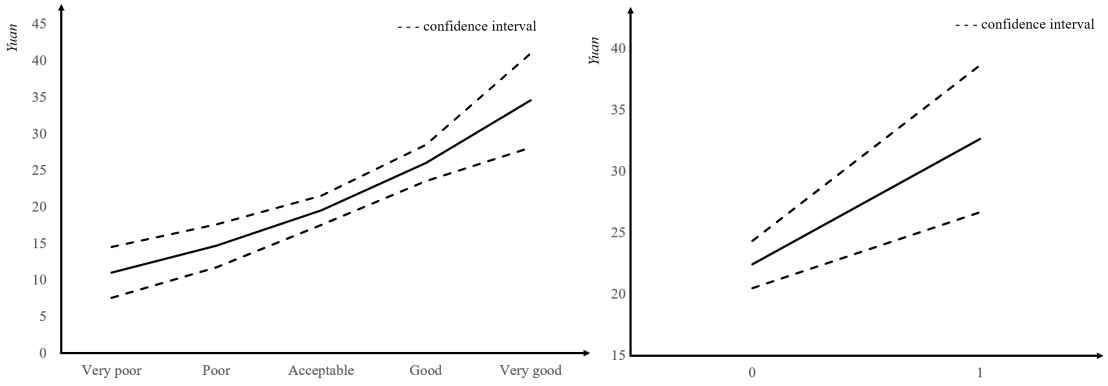


Figure 2.4: Predicted WTP and income levels



(a) Relationship with local citizens (b) Abandon contracted farmland

Figure 2.5: Prediction of WTP with farmland and social integration

Table 2.7: Sample size calculation

Index	Wujin(2015)	Huishan(2015)	Changshu(2015)
Population(permanent)	1,436,200	706,600	1,510,100
Population(registered)	930,345	493,500	1,068,200
Non-local migrant workers	505,855	213,100	441,900
Labor in Agricultural sector(%)	28%	28%	28%
Rural labor force	260,497	138,180	299,096
Labor working in local areas(%)	83%	83%	83%
Local migrant workers	216,212	114,689	248,250
Total migrant workers population	722,067	327,789	690,150
Margin of error (ME)	3.50%	3.50%	3.50%
Confidence level	95%	95%	95%
Recommended sample size	784	783	784
Target sample size	800	800	800
Actual sample size	807	801	748

Data sources: the Department Statistical Bureau in each cities. The percentage of labor in Agricultural sector and the percentage of labor working in the local areas come from the report in National Bureau of Statistics[11].

Table 2.8: Comparison the survey sample with the national migrant workers(2016)

Variables	Explanation	Survey sample	National level	Difference
Gender	Male	71.79%	65.50%	6.29%
	Female	28.21%	34.50%	-6.29%
Age	16-20	4.82%	3.30%	1.52%
	21-30	31.03%	28.60%	2.43%
	31-40	21.72%	22.00%	-0.28%
	41-50	28.34%	27.00%	1.34%
	51+	14.09%	19.20%	-5.11%
Education	Illiteracy	4.57%	1.00%	3.57%
	Elementary school	20.56%	13.20%	7.26%
	Middle school	54.94%	59.40%	-4.46%
	High school	15.68%	17.00%	-1.32%
	College and above	4.26%	9.40%	-5.14%
Job type	Manufacturing	78.97%	30.50%	48.47%
	Construction	6.78%	19.70%	-12.92%
	Wholesale and retail	1.53%	12.30%	-10.77%
	Transportation	2.94%	6.40%	-3.46%
	Accommodation and Restaurants	1.49%	5.90%	-4.41%
	Other service industry	8.29%	11.10%	-2.81%
Income	Overall		3275	795
	East	4070	3454	616
Working situaiton	Work day per week	6.49	6.20	0.29
	Work hour per day	9.6	8.5	1.1

Sources: National Bureau of Statistics.

Table 2.9: The marginal effects for the predicted probability of being non-interest group

	dy/dx	Delta-method Std. Err.	z	P>|z|	[95% Conf.	Interval]
AQI	0.000	0.000	-0.040	0.966		
Income	-0.105	0.030	-3.440	0.001	-0.164	-0.045
Place attachment						
Life satisfaction	-0.037	0.016	-2.290	0.022	-0.069	-0.005
Relationship	-0.016	0.019	-0.810	0.416		
Local helpers	-0.003	0.011	-0.280	0.777		
Housing	0.186	0.046	4.000	0.000	0.095	0.277
Local dialect	0.031	0.017	1.780	0.075		
Working length	-0.006	0.002	-2.810	0.005	-0.010	-0.002
Self-identity	0.073	0.039	1.850	0.064		
Family migration	-0.033	0.028	-1.200	0.232		
Couple migration	-0.043	0.029	-1.490	0.136		
Demographic factors						
Gender	0.036	0.027	1.350	0.176		
Age	0.004	0.001	3.230	0.001	0.001	0.006
Educ	-0.042	0.014	-3.010	0.003	-0.070	-0.015
Health	0.036	0.019	1.860	0.063		
Smoke	-0.053	0.025	-2.140	0.032	-0.102	-0.005
Envi. attitude	-0.234	0.020	-11.790	0.000	-0.273	-0.195
Location. 1	-0.012	0.027	-0.420	0.672		
Location. 3	-0.046	0.026	-1.790	0.073		

Note: dy/dx for factor levels is the discrete change from the base level.

Table 2.10: The marginal effects for the WTP

	dy/dx	Delta-method Std. Err.	z	P>|z|	[95% Conf.	Interval]
AQI	0.039	0.019	2.040	0.042	0.001	0.077
Income	-79.017	38.905	-2.030	0.042	-155.270	-2.764
Income squared	5.310	2.355	2.250	0.024	0.694	9.926
Place attachment						
Life satisfaction	2.883	1.106	2.610	0.009	0.716	5.051
Relationship	5.998	1.281	4.680	0.000	3.488	8.509
Local helpers	0.799	0.701	1.140	0.254		
Housing	4.274	3.856	1.110	0.268		
Local dialect	0.125	1.165	0.110	0.915		
Working length	0.121	0.155	0.780	0.437		
Self-identity	-1.359	2.693	-0.500	0.614		
Family migration	0.890	1.857	0.480	0.632		
Couple migration	2.052	1.730	1.190	0.235		
Demographic factors						
Gender	0.952	1.912	0.500	0.618		
Age	-0.651	0.472	-1.380	0.168		
Age squared	0.003	0.006	0.480	0.634		
Educ	2.863	1.053	2.720	0.007	0.798	4.927
Health	0.846	1.245	0.680	0.497		
Smoke	0.381	1.673	0.230	0.820		
Envi. attitude	9.879	1.862	5.310	0.000	6.230	13.528
Abandon contracted land	7.841	2.020	3.880	0.000	3.883	11.800
Abandon residential land	15.816	4.885	3.240	0.001	6.242	25.390
Location. 1	6.401	2.340	2.740	0.006	1.814	10.988
Location. 3	-2.386	1.608	-1.480	0.138		

Note: dy/dx for factor levels is the discrete change from the base level.

Chapter 3

Social Isolation, Gender Differences, and Rural Migrants' Cigarette Smoking [1]

[1] Liu, Z., Florkowski, W., and Chen, H. Submitted to *Health & Place*, 06/25/19.

Abstract

The last chapter focuses on the health condition of migrant workers. China is the world's largest producer and consumer of tobacco. Despite the progress made in reducing tobacco use in the overall population, marginalized populations, especially migrant workers, are experiencing disproportionate disparities in exposure to tobacco and tobacco-related health. Social isolation from migration may introduce psychosocial stress, which further induces risky health behaviors such as smoking, and the mechanisms may vary across gender. This paper applies survey data from the southeast Jiangsu Province of China collected in 2016. The data show that the overall pooled prevalence of smoking among rural-to-urban migrants is 38.21% (51.70% in male and 4.06% in female). The contributions to migrants' smoking prevalence mainly come from social isolation, such as migration stability, ties with family and fellow migrants and life satisfaction in migrant cities. Patterns of cigarette consumption among migrants are further explored from aspects such as expenditure, cigarette quality and willingness to quit. Additionally, we find that migrant smokers, especially male migrant smokers, are more sensitive to income and price than female smokers.

Keywords: Migrants, smoke, social isolation, gender difference, tobacco control

JEL Codes: H12, J16, J61, L66

3.1 Introduction

The epidemic of tobacco consumption is one of the leading risk factors for global premature mortality and disability and has claimed more than five million lives each year since 1990 (WHO, 2012). Despite the progress made in reducing tobacco use in the overall population, marginalized populations are experiencing disproportionate disparities in exposure to tobacco and tobacco-related health (Fagan et al., 2004, 2007; Fernander et al., 2007; Shin et al., 2013). Certain underprivileged groups are enduring a significantly higher prevalence of smoking and higher risk in tobacco-related morbidity than other subgroups of the population. The reason for minority groups high rates of tobacco has been linked to their experience of high-level psychosocial stress due to various adverse situations (Dressler et al., 2005). To cope with significant levels of psychosocial stress, marginalized populations are more likely to smoke, which generally produces a temporarily calming effect. While many studies explore the sources of psychosocial stress for minority groups such as discrimination in race or gender, poor living conditions and health and work-force inequalities (Cui et al., 2012; Fagan et al., 2007; Liu et al., 2015; Shin et al., 2013), little knowledge exists on marginalized population's social bonding and isolation from local communities and their impact on tobacco smoking behavior.

Social isolation, which is the converse of social integration, can be broadly defined as disengagement from social ties or bonding, community participation,

and institutional or emotional connections (Pantell et al., 2013; Seeman, 1996). Individuals experience social isolation when they fail to maintain a social relationship, subjectively or passively, including intimate relationships with family and close friends and more formal relationships with other individuals and groups in society. Earlier studies presented strong evidence that social isolation leads to both mental and physical risks (Eng et al., 2002; Seeman, 1996; Zhang et al., 2007). Studies on the relationship between social isolation and health, however, mainly focus on the causal effect of the social relationship on mortality and cardiovascular diseases. The association of social ties with risky health behaviors has received much less attention. Additionally, while the majority of studies use samples from the whole population as research subjects or subgroups distinguished by age or gender, marginalized populations and their social isolation is poorly understood. Thus, this paper fills a gap in the literature on one of the largest marginalized subgroups of China's population, migrant workers, and explores how social isolation affects their smoking behavior.

The massive labor migration in China started in the middle of the 1980s, and the total number of migrant workers reached 288 million in 2018 (National Bureau of Statistics, 2019). In the current study, migration is defined as a temporary or semi-permanent move of a farm household from rural areas to urban areas or from less to more developed provinces in search of jobs and earning opportunities. About 60% of rural laborers left their place of birth/registered permanent residence, and 44% of 172 million out-migrants moved across province borders

and experienced different cultures and living environment in the new region. Further, the hukou system, the national household registration system, restricts residents' access to public services to their place of birth and thus limits migrant workers' access to the urban social benefit system, including education, housing subsidies, pension plans, and other social services. Thus, both institutional and non-institutional factors define marginalized migrant workers in terms of residency and socioeconomic status and place migrants under considerable health risks and psychological problems (Schultz, 2014). Perceived psychosocial stress is likely to induce migrant workers to choose risky behavior with adverse health outcomes, such as smoking. As the world's largest producer and consumer of tobacco, China has about 350 million smokers and accounts for about 38% of total global tobacco consumption (Eriksen et al., 2013; Reitsma, 2017). In 2010, about 28.1% of adults in China were regular smokers. A considerable gender difference exists as 52.9% of men smoked tobacco, but only 2.4% of women smoked (Li et al., 2011). The prevalence of smoking in China causes about one million deaths from smoking-related diseases annually, and the annual mortality rate is expected to reach three million by 2050 (Yang et al., 2015). Rural-to-urban migrants, a new and rapidly expanding subgroup of the Chinese population, constitutes about 1/3 of all tobacco smokers. The overall smoking prevalence and gender shares of smokers among migrant workers are higher than the population at large. Zheng et al. (2018) showed that 34.1% (55% male and 4% female) of migrants smoked in 2013. Although studies show that duration of stay in urban areas away from villages, occupation, and household registration status were highly

correlated with migrants' smoking behavior (Cui et al., 2012; Shin et al., 2013; Zheng et al., 2018), prevalence of tobacco use among rural-to-urban migrants and its impact factors are not completely clear. Therefore, understanding how social isolation contributes to excess smoking prevalence in rural-to-urban migrants, as well as gender differences, can provide valuable information for tobacco control interventions.

This chapter focuses on a marginalized population segment in China, migrant workers, and explores the causal effect of social isolation on migrants' smoking behavior as well as gender differences in tobacco smoking. The study applies survey data from the southeast Jiangsu Province of China collected in 2016. The data show that the overall pooled prevalence of smoking among rural-to-urban migrants is 38.21% (95% CI: 36.16, 40.25). In the stratified analysis, specific pooled prevalence estimates are 51.70% for male (95% CI: 49.22, 54.18) and 4.06% for female (95% CI: 2.50, 5.62). The results show that rural male migrants have a significantly higher proportion of smokers than women confirming earlier reports (Liu et al., 2016; Zheng et al., 2018), but the rate of smokers among women is about twice that of the population at large. Additionally, male migrants smoke lower quality cigarettes than female migrants. The modeling approach involves the explicit use of variables to measure social isolation. Estimations show that migrants' smoking choices are correlated with age, education, income, and working stress. However, the contributions to migrants' smoking prevalence mainly come from social isolation, such as migration stability, ties with family

and fellow migrants, and life satisfaction in migrant cities. The stratified analysis indicates that the smoking behavior of male migrants is mainly affected by social isolation, while the smoking prevalence of female migrants is mainly affected by individual characteristics. Patterns of cigarette consumption among migrants are further explored and include such aspects as expenditure on cigarettes, cigarette quality and the consideration of the decision to quit smoking. Additionally, to identify a path leading to the reduction of the rates of smoking among the migrant workers, the current study finds that migrant smokers, especially male migrant smokers, are more sensitive to income and price changes than other groups of smokers.

While social isolation has been linked to worse health outcomes or risky health behavior across all ages, the current study focuses on migrant workers. The health risks posed by social isolation may be particularly severe for migrant workers, especially as they are likely to face stressful life transitions. Thus, this study offers potential contributions to the literature regarding two aspects of cigarette smoking that have not been thoroughly examined. First, this study systematically examines rural-to-urban migrants' social ties and connections in both rural and urban areas in connection of reported cigarette smoking. Second, the study illuminates factors influencing the disproportionate rates of tobacco use among migrant workers, a marginalized segment of the population.

The remainder of the paper is organized as follows. In Section 3.2, the literature survey concentrates on social isolation and forms of social isolation among migrant workers. Section 3.3 provides details about the collection of the survey data among migrant workers and ways to measure the migrant worker social isolation. Section 3.4 shows the estimation results of the specified empirical relationships pertaining to the cigarette smoking, expenditures, cigarette quality and possible decision to quit smoking altogether. Section 3.5 concludes this paper with some suggestions regarding the path towards the reduction of cigarette smoking among rural migrants.

3.2 Conceptualizing social isolation

Studies on the effects of social isolation (or similarly social ties, social network or social environment) on health emerged in the 1970s (Berkman and Syme, 1979; Cassel, 1976). While the negative impact of social isolation on physical and mental health has been extensively studied, measurements of social isolation, impact mechanisms, and conclusions vary widely both across and within disciplines (Cornwell and Waite, 2009). Thus, it is worth to review the literature to identify ways to measure social isolation of migrant workers.

3.2.1 Social isolation: measurement and impact

Social isolation, which is the converse of social integration, can be broadly defined as disengagement from social ties or bonding with other individuals and groups in

the society, community participation, and institutional or emotional connections (Finch et al., 2010; Pantell et al., 2013; Seeman, 1996). When individuals in a society have a small social network, infrequent participation in social activities, or perceived lack of social support, they are experiencing social isolation. Social integration is not only a network with other individuals or entities but also a form of social capital, similar to human capital, that has economic and productive meaning (Coleman, 1994).

The key interest of studies on social isolation is to explore the causal effect of social isolation on health outcomes. Links between social integration and patterns of physiological functioning have been hypothesized to represent the pathways through which social isolation impacts risk for poor health outcomes (Seeman, 1996). Studies from an epidemiologic standpoint have provided strong evidence that social interaction does "get under the skin" to affect critical physiological parameters, including neuroendocrine, immune, and cardiovascular functioning (Seeman, 1996). The scope of research on social isolation, however, is mainly limited to some specific subgroups of the population, such as older persons and international immigrants (Cassel, 1976; Cornwell and Waite, 2009), or to more developed regions and countries, such as the United States (Eng et al., 2002). Social isolation of other subgroups of populations and regions, especially marginalized populations from developing countries, has not been well studied.

Understanding the causal effect of social isolation on health outcomes requires not only determining the mechanisms of social isolation but also how it is measured. Berkman and Syme (1979) innovatively measured social isolation by using a summary index reflecting ties with a spouse, close friends and relatives, and participation in church and other types of groups. Later, research on the measurement of social isolation follows the Berkman-Syme social network index and combined marital status, ties with close friends/relatives (by phone), group memberships, and church involvement (assessment of the individual's ties with others). Seeman (1996) offers a thorough literature survey on social isolation measurement. One limitation in those studies is that they typically focused on only two or three aspects of social isolation because of data limitations (House, 2001). However, individuals' social connections represent a dynamic and complex social system and different aspects of social relationships may have different impacts on health behaviors and outcomes. A multidimensional approach that better captures the multifaceted nature of social network relationships could gain a more comprehensive and sophisticated understanding of social isolation's impact. Such an approach would encompass simultaneous measurement and analysis of the structural and qualitative features of individuals' social networks.

3.2.2 Forms of social isolation among migrant workers

Migrant workers in China face many challenges to integrate into local communities in urban areas, which constitutes a source of psychosocial stress and depression.

Poor living conditions, instability of living and employment conditions, high mobility, social discrimination, and lack of social support hinder migrants from social assimilation and social integration (Liu et al., 2016; Mou et al., 2013). The hukou system constitutes an institutional barrier that keeps migrant workers from benefiting from urban social services, such as education, medical care, and pension benefits. Such barriers in living and working environments do not encourage social assimilation, and many migrants in urban areas tend to isolate their social relationships (Finch et al., 2010). Social isolation, in turn, makes them more vulnerable to risky health behaviors, such as smoking.

However, studies on the causal effect of social isolation on smoking behavior in the migration population have been few worldwide. There are many studies which pay attention to migrants' social isolation, but these studies typically focus on one or two aspects of social behavior, and their conclusions on the impact of social isolation vary widely across studies. For example, (Elder et al., 2000) discussed satisfaction with social support using data from Hispanic migrant adolescents. Chen et al. (2004) studied migration years, number of cities in which the migrants had worked, job and life satisfaction, and living with relatives using data from Beijing. Yang et al. (2009) measured migrants' isolation using three Chinese cities. Liu et al. (2015) also mentioned the impact of the number of cities workers migrated through on their smoking behavior.

Generally, studies on migrants' social isolation focus on only the structural features (or quantitative aspect) of social isolation which are easily measured from surveys. Variables like migration years, number of cities in which migrants had worked, connections with relatives, solitude, and satisfaction with social support are the main aspects of social isolation or ties in those studies. The qualitative features or the integration of quality and quantity features have received little attention. In contrast, Ji et al. (2016) adopted a comprehensive index: a status of social integration, which contains six questions to measure the subjective degree of social integration, including the degree of life satisfaction and the degree of perceived acceptance by locals. However, the content and meaning of the index are not very clear. Meanwhile, that study fails to consider migration types, migrants' interaction with fellow migrants and community participation.

The measurement of social isolation in the current study integrates both structural and qualitative features of social isolation from three aspects. They are the perceived social support (e.g., help from local residents and connections with fellow migrants), social ties with local residents (e.g., ability to communicate in local dialect, relationship with local residents), and perceived difference and discrimination (e.g., perceived cultural difference, distance, perceived exclusion, and discrimination in work).

3.3 Data and method

3.3.1 Survey organization and implementation

The data used in this paper were collected in a survey of the southeast Jiangsu Province of China in 2016. Jiangsu Province, especially in the southeast, is one of the most developed regions in China and accounts for about 6% of China's total GDP in 2015. Because of the increased development in labor-intensive industries, the southern regions have attracted about 8 million migrant workers from around the country. The study applied the stratified sampling method and selected Wuxi, Changzhou, and Suzhou from among the region's cities. Three districts or county-level cities were randomly selected. They are Wujin district from Changzhou city, Huishan district from Wuxi city, and Changshu city from Suzhou city. The sample sizes in each district or city were calculated based on the population of migrant workers in each location, confidence level, and suitable margin of error. Table 3.7 in the Appendix shows the details of how the sample size was calculated. Both graduate and undergraduate students from Nanjing Agricultural University were recruited and trained as enumerators to collect the data through personal interviews with migrant workers.

The developed questionnaire included questions probing for information on socio-demographic characteristics of the respondent and household such as marital status, age, gender, education, occupation, employment status, and migration type. A separate set of questions inquired about the social relationship with

acquaintances and local residents in urban areas, where the migrant has been employed. The collected information regarding cigarette-smoking behavior including the decision to choose smoking, expenditure on cigarettes, and the consideration of the decision to quit was collected during face-to-face interviews.

3.3.2 Data description and preliminary analysis

A total of 2,188 respondents provided a complete set of answers and that sample is used in the current study. In the sample, 38.21% of respondents were classified as current smokers. In the stratified analysis, the specific pooled prevalence of smoking is 51.70% for male and 4.06% for female migrant workers. Among migrant workers, smokers consumed 0.922 cigarette packs per day on average (there are 20 cigarettes in a pack) and the monthly expenditure on smoking was around 301 yuan (around $ 44) (Table 3.1). The prevalence of smoking and shares of smokers by gender in this study coincide with a recent study from Zheng et al. (2018) who used the data from the nation-wide sample of 7,200 migrants and reported 34.1% of smokers in the whole sample, 55% of males smoked cigarettes, and 4% females were current smokers. Meanwhile, the proportion of migrant smokers who considered quitting smoking was 59.7%.

The average age of the migrant is 37 (Table 3.1), almost three years younger than the national average of 40.2 years in migrant population (National Bureau of Statistics 2019). The majority of respondents, 71.4%, are male and the ratio of non-labor household members to total family members is about 0.32.

The average monthly income in the sample used by the current study is 3,821 Renminbi (around $ 555), which slightly exceeds the average monthly income of the total migrant population (3,721 Renminbi) (National Bureau of Statistics 2019) . Nearly a third (32%) of respondents indicated drinking alcohol. The self-evaluated health status is almost three on a five-step scale, suggesting "health was neither good nor bad".

In terms of migration characteristics, migrant workers have worked and lived in the city where they were surveyed for around 7 years and 22.3% of migrants believe that it was hard to find a job in the cities. For migrants with a job, 61.4% of migrants signed a labor contract with employers to protect their labor rights. Meanwhile, 54% of migrants reported that they have worked overtime and the percentage of migrants who experienced wage arrears was 14.4%. Thus, migrants' labor rights were impinged to some extent. The adverse work experience reflected in the overtime and overdue pay could introduce stressful conditions into migrants' daily life.

A. Gender heterogeneity in smoking

Cigarette smoking is a habit that strongly varies between genders. Although among the migrant workers in the sample nearly 52% smoke, only about 4% of women admitted to cigarette smoking. Gender differences in smoking have been observed in other countries and it appears are very much linked to culture. In

Europe or North America, smoking rates are relatively similar in both genders and seem to vary by age. However, in other countries, for example Turkey, where smoking by women is often disapproved by society, the rate of smokers also widely vary with men being the likely smokers.

Smoking prevalence by gender was statistically tested in the current study (Table 3.2). Not surprisingly, the test confirmed the different rates among men and women. However, the tests did not confirm the gender differences in monthly expenditure on cigarettes and the number of cigarette packs consumed per day. Although the statistical tests did not detect differences, the review of the average expenditure shows that a male smoker spent about 46 Renminbi (15%) per month more than a female smoker. Additionally, a male smoker used about 0.92 pack versus 0.82 pack smoked by a female migrant worker. The slight differences in expenditure and the portion of the cigarette pack smoked daily suggest that women, if they smoke, do so with somewhat lower frequency.

Female migrants appear to consume more expensive brands of cigarettes (20 *yuan*/packet) than male migrant workers (Table 3.2). The difference in price per pack purchased by gender is statistically significant given the mean price of 12.4 Renmibi for men and 16.79 Renmibi for women. The difference between genders was also confirmed in the case of reported consideration of quitting smoking. Although three out of five men considered quitting (out of 752 smokers), only one in three women considered quitting. However, there were only 18 female migrant

workers who provided response to that question and caution needs to be exercised in drawing any conclusions with regard to quitting.

B. Registry heterogeneity in smoking

Another type of heterogeneity in smoking behavior may exist among migrants and local laborers. The two groups differ in household registry status reflecting the difference in socioeconomic status, including access to a package of benefits available for urban residents. Table 3.3 shows average monthly cigarette expenditure, packs smoked per day, price per pack and the consideration of quitting cigarette smoking. A statistical test did not confirm any differences between the two groups although the means for each group and each item vary. Specifically, the share of smokers among both migrants and local laborers is 34% vs. 38%, but the number of the responding local workers was considerably smaller than that of migrant workers. The first group spent around 302 Renminbi on cigarette consumption each month, while the local workers spent almost 321 Renmibi. Additionally, the migrants smoked a couple of cigarettes more per day than local laborers. Migrant workers smoked 0.92 cigarette pack each day, while the local workers smoked 0.88 pack. The price per pack bought by the migrants was about 10% lower (12.53 Renmibi) than that paid by the local workers, about 14 Renminbi. It could be the desire to save more that led to purchase of less expensive and likely lower quality cigarettes., which could exacerbate the health risks associated with smoking. The percentage of smokers who considered smoking

cessation among migrants was higher (almost 60%) than the local laborers (51%). The difference demonstrates that public health campaign aiming at giving up cigarette smoking addressed to migrant workers may be respond to the inner realization of harm caused by such behavior.

C. Measurement of social isolation

The current study considers the measurement of structural and qualitative features of social isolation. Instead of using the Berkman-Syme social network index which involves measures not suitable for migrant workers in China, this paper measures social isolation in a explicit way. The complexity of factors associated with social isolation led to the inclusion of six measures. Two factors are accurately measured and include the distance between home village and migrant cities and the number of cities in which the migrants had worked. Four other measures capture the migrant worker perceptions and are measured with the help of a multistep scale. They are the self-evaluation of identity, contact frequency with fellow migrants in the migrant city, relationships with local residents, and life satisfaction in migrant cities.

The average distance in kilometers from the home village to a migrant city in the sample was 663 km (Table 3.1), which means that rural migrants may experience a significant difference in lifestyle and local culture during their stay in an urban area. The cultural differences also include possible difficulties in

communicating in a local dialect. The average number of cities in which the migrants had worked was 2.5. Only 6.6% of migrants believed they were citizens rather than migrants in the city where they worked. Regarding the perceived social support, migrants visited fellow migrants in the same migrant cities frequently as suggested by the average score of 2.4 on a three-step scale (Table 3.1). In the survey, rural migrants reported having good relationships with local residents and their overall life satisfaction was relatively high.

3.3.3 Estimation approach

The focus on the migrant worker smoking choice narrows the observed outcome to a binary effect, where smoking is recorded as 1, 0 otherwise. In seeking factors most indicative of the smoking behavior, one can identify a host of factors grouped in three categories: individual characteristics, work stress measures, and social isolation constructs. The migrants' smoking choices (*smoke*) is represented as a logit model,

$$Prob(smoke_i = 1) = \frac{1}{1 + e^{-(\beta_0 + IC_i\beta_{1i} + WS_i\beta_{2i} + SI_i\beta_{3i}) + \varepsilon_i}}, \tag{3.1}$$

where *smoke* is a binary variable assuming the value of one to indicate a smoker, *IC* are the migrant worker characteristics, *WS* are the working stress measures, and SI is a vector of social isolation variables. The βs are parameters to be estimated, with the subscript denoting the observations. A stochastic term for observation i is ε_i. Among available estimation techniques used in empirical

studies, the logit technique has been frequently applied because of less restrictive assumptions compared with the probit technique.

3.4 Results

3.4.1 Cigarette smoking prevalence

The decision to smoke by migrant workers was estimated for four specifications. The sequential estimation starts by using the whole sample without controlling for social isolation measures, then estimates smoking prevalence for the whole sample with social isolation variables, and estimates two separate equations for male and female migrants separately. Table 3.4 shows the logit estimation results given four different specifications.

The comparison of the two models indicates that when adding social isolation measures the coefficients of all control variables including individual characteristics and working stress variables on the migrant choice to smoke cigarettes are almost unchanged, suggesting a robust specification. An increase in the pseudo-R-square in the model that includes social isolation measures demonstrates that the model fit increases. Additionally, the likelihood-ratio test (LR chi2(8) = 48.86 and Prob>chi2 = 0.000) also supports the addition of extra variables of measuring social isolation to substantially improve model explanatory power. The calculated marginal effects for the two models also show little change and, thus, the

discussion is limited to the model that includes social isolation measures.

The decision to smoke cigarettes by a migrant worker increases by nearly 60% if a person was a male as compared to female workers. The effect of age is initially negative as younger migrants avoid smoking and the probability that a migrant smokes decreases by 1.5% for every additional year, but for older workers the probability increases although the exact percentage is negligible. The turning point of age is estimated around 37 years old, which is a relatively young age. The effect of education is as in many earlier studies of smokers, namely those with college degree had an almost 21% lower probability of smoking. However, there are relatively few college educated migrant rural workers. Not surprisingly, a worker who assesses his or her health as bad had an almost 19% lower probability of smoking cigarettes. Smoking and drinking behaviors were found to complement each other in earlier studies (Bilgic et al.) and a similar result was obtained in the current study. A migrant worker who admitted to drink alcohol was almost 14% more likely to smoke cigarettes.

Two measures of work stress had the opposite effect on the decision to smoke. Overtime work lowered the probability of smoking by 5.3% as the migrant worker might have simple run out of time to smoke. However, having wages owed by the employer increased the probability of smoking by 7.1% (Table 3.4). Among the measures related to social isolation, six had a statistically significant effect on the decision to smoke cigarettes and their directional effects were as expected.

An increasing physical distance from the home village led to an increase in choosing to smoke although the measurable effect was negligible (Table 3.4). The larger number of cities a migrant reported to have worked in, the higher the probability of smoking; each additional city was associated with an 1.6% higher smoking probability. Poor life satisfaction was also associated with a 5.6% lower probability of cigarette smoking. Perhaps, such migrant workers were focused on earnings and the amount of possible savings and refrained from smoking, which implied an additional expenditure. If a migrant worker perceived his relationships with local residents as being good, he had a 6.4% higher probability of smoking. The positive impact can be explained by the important function of cigarette smoking as a social connection builder in Chinese culture (Pan 2004). It is a custom in China to offer a cigarette to others to signal respect and hospitality and this custom may also apply to the social connection between migrants and local residents.

Two measures representing a decrease in social isolation actually decreased the probability of choosing to smoke. More frequent contacts with fellow migrants from the home area lowered the probability of smoking by 3.8% (Table 3.4). Such contacts offer an opportunity to socialize in a group that shares the same culture and dialect, and to exchange news from the home region. An even larger decrease in the probability of smoking, 16.7%, was associated with viewing one self as being a "citizen," that is an urban resident rather than an outsider (in Chinese: *wai di ren*) with, presumably, access to the package of benefits like other local

urban residents.

To explore the gender difference in smoking behavior, two models with a different gender are further specified. The results show that the "U-shaped" relationship between age and smoking choice exists only among female migrants and the turning point of age in smoking is 33 years old. Income significantly contributes to both male and female smoking choice and the impacts are more important among female migrants. For both male and female migrants, alcohol consumption is positively related to smoking choice and the magnitude of the effect for female migrants is much higher than the effect for male migrants. The physical stress from working (overtime working) only affects male smoking choices probability because the majority of laborers in physically demanding work are men. The psychological stress from wage arrears induces smoking for both men and women in migrant population. However, social isolation has a greater impact on male migrants than for female migrants. Specifically, both the distance between home villages and migrant cities and the numbers of migrant cities contribute smoking behavior only for male migrants, not for female migrants. However, for both male and female migrants, self-identification as a local citizen has a significantly negative impact on their smoking choices. Additionally, male migrants have the same impact for other aspects of social isolation with the whole population, such as the contact with fellow migrants, the satisfaction of life and the relationship with local residents.

3.4.2 The pattern of cigarette consumption

The pattern of cigarette consumption by rural migrants is associated with the amount an individual spends on cigarette purchases and the price paid for cigarettes. The former indicates the intensity of the habit, while the former is a proxy of the quality of smoked cigarettes. The quality or more expensive cigarettes imply a different content of substances known to cause harmful effects, including lung cancer. Lastly, the pattern of cigarette consumption involves the desire to quit smoking. Thus, this section focuses only on migrant workers, who are smokers and reports estimation results of three relevant equation quantifying the effects of earned income, socio-demographic characteristics, and other personal factors on the cigarette consumption patterns of migrant smokers.

A. Expenditure on cigarettes

Table 3.5 shows the regression of expenditure on a set of explanatory variables of individual and household characteristics. The number of cigarette packs per day has a positive impact on the expenditure on the cigarette. Income has a significant positive impact on monthly expenditure on cigarettes. Since the equation applies a log-linear form, the coefficient associated with income implies that if a migrant monthly income increases by 1000 yuan, the expenditure on cigarette purchases will increase by 11.3%. Migrants who reported consuming alcohol are likely to spend less in smoking. Earlier studies found that smoking

and alcohol drinking complimented each other (Bilgic et al., 2010).

B. Cigarette price

The cigarette price can reflect the quality of the cigarettes that migrants consume. Estimation results (Table 3.5) show that income is associated with higher price of smoked cigarettes. Common expectations are that as the budget constraint eases due to increasing income, a consumer may purchase higher quality products and in the case of cigarette smoking migrant workers there are job demands that limit opportunities to smoke and quality cigarettes compensate for such restriction. The only other factor positively influencing the price of smoked cigarettes is the self-reported good health. Migrants reporting being in good health tend to prefer higher quality cigarettes.

Three other variables lower the price per pack of cigarettes (Table 3.5). The household raise ratio lowers the cigarette prices suggesting the migrant worker with a larger number of non-working household members choses less expensive cigarettes. Furthermore, those who are married also select less pricey cigarettes. It appears that those migrant chose behavior consistent with spending less, presumably because they need income to support the non-employed members and spouse. Meanwhile, alcohol consumption also has a negative impact on the price of purchased cigarettes suggesting lower quality of the smoked cigarettes. The results again seems to suggest that migrant workers who both smoke and drink

are conscious spenders and choose to purchase low quality cigarettes. Since the low quality cigarettes tend to contain more harmful substances, smoking such cigarettes may cause more damage in the long run.

C.Decision to quit cigarette smoking

The third aspect of the pattern of cigarette consumption by migrant workers smoking is a willingness to quit smoking. Table 3.5 shows both the estimation results of the decision to quit smoking and the calculated probability changes in the decision to quit in response to a unit change in the explanatory variable. The former are discussed in detail because they provide quantified measures which have practical implications for exploring path to encourage migrant workers to stop smoking cigarettes. Overall, the applied set of explanatory variables that includes commonly used personal characteristics has a low predictive power to explain quitting behavior. However, there exists a gender difference in quitting cigarette smoking. Specifically, male migrants are almost 23% more likely to quit smoking than female migrant workers. Although male migrants have a higher smoking prevalence than female migrants, female migrants who smoke seem to be more addicted. Also worrisome is the result suggesting that migrant workers who viewed themselves as being in good health condition, were about 14% less likely to quit smoking than those who thought their health was neither good nor bad. Since the health effects of smoking typically occur after decades of cigarette smoking, the arguments built around the disease prevention may have limited

effect on quitting. We then estimate the model by considering gender difference. Given that the sample size for the female smoker is small, the model predicts their behavior only to a limited extent.

3.4.3 Elasticity of demand for cigarettes

The limited insights gained about factors behind the decision to quit cigarette smoking led to an investigation into whether the cigarettes are a normal good. If cigarettes are a normal good and the argument about the detrimental health effects may not be sufficiently convincing to encourage quitting, then economic arguments may yield appropriate results. Namely, if cigarettes are a normal good, increasing their price through adding excise taxes may encourage some to quit and, more importantly, prevent rural migrants who do not smoke yet, never to start smoking. After all, migrant workers are highly motivated by earnings and opportunity to save. Therefore, the income elasticity of demand is obtained by running a regression using a log-log functional form of the following equation,

$$ln(Q_i) = \alpha_0 + \alpha_1 ln(Y_i) + \alpha_2 ln(P_i) + X\alpha + \epsilon_i, \tag{3.2}$$

where the lnQ_i is the number of cigarette packs smoked daily expressed in logs, lnY_i is the log of monthly income, lnP_i is the log of cigarette price and X is the vector of control variables. All αs are parameters to be estimated and ϵ is the error term.

Table 3.6 shows the estimation results with and without control variables, while including binary variables indicating registry difference and gender. Overall, the income elasticity of cigarette demand is 0.16. The positive income elasticity of demand indicates that cigarettes are a normal good for smokers in China as well as for different category of smokers: migrants vs local laborers, and male migrant smokers and female migrant smokers. However, migrants' income elasticity of cigarette demand is smaller than the overall smokers and smokers with local residency. Meanwhile, male migrant smokers' income elasticity is smaller than female migrant smokers. The small values of income elasticity imply that demands for cigarettes are not sensitive to income changes. For all groups, income plays a negligible role in cigarette smoking reflecting its addictive nature (Yu and Abler, 2010).

We are also interested in how the demand for cigarette changes given changes in price. The result in table 3.6 shows that the price elasticity of cigarettes is between -0.422 and -0.381, which is less than one. The coefficient indicates that tobacco demand is price inelastic. In other words, when price increases, tobacco consumption decreases by a lesser percentage compared to the price increase. The cigarette price elasticity in our paper is consistent with other scholars' finding which shows that price elasticity is between -0.7 to -0.35, either using Chinese data or using other developing counties data (Chen and Fan, 2016). Furthermore, migrants' price elasticities are larger than local laborers' and male migrants' price elasticities are larger than female migrants. These findings indicate that migrant

smokers, especially male migrant smokers are more sensitive to price change than other smokers.

3.5 Discussions and Conclusions

Despite the progress made in reducing tobacco use in the overall population in the world, certain underprivileged groups are experiencing disproportionate disparities in exposure to tobacco and tobacco-related health. In China, the migrant's population reached 288 million in 2018, occupying 20.7% of the total population, but constitutes about 1/3 of all tobacco smokers. Understanding what contributes to excess smoking prevalence in rural-to-urban migrants can not only provide valuable information for tobacco control interventions in China but also improve the welfare level of migrant workers who are experiencing disadvantaged social status and vulnerability to health risk behavior.

This paper hypothesizes that migrants smoking behavior is a maladaptive coping mechanism for psychosocial stress, which may be introduced from social isolation. To test the hypothesis, we apply survey data from the southeast Jiangsu Province of China collected in 2016 and measure social isolation from both the structural and qualitative features of individuals' social networks. The data show that the overall pooled prevalence of smoking among rural-to-urban migrants is 38.21% (51.70% in male and 4.06% in female). Further examinations show that migrants' smoking choices are correlated with age, education, income and working stress. However, the contributions to migrants' smoking prevalence

mainly come from social isolation, such as migration stability, ties with family and fellow migrants and life satisfaction in migrant cities. The analysis indicates that the smoking behavior of male migrants is mainly affected by social isolation, while the smoking prevalence of female migrants are mainly affected by individual characteristics. Patterns of cigarette consumption among migrants are further explored from aspects such as expenditure, cigarette quality and willingness to quit. Additionally, we find that migrant smokers, especially male migrant smokers, are more sensitive to income and price than other smokers.

Findings from this research address the importance of social integration in controlling tobacco for marginalized populations. Enhancement of migrants' integration will reduce smoking prevalence among the migrant population, which helps China close the gap in tobacco control as set by WHO FCTC requirements. Meanwhile, social integration also induces migrants to settle down in migrant cities. Given that migration from rural areas to urban areas in China is mainly temporally and unstable, the central government aims to let 100 million migrant workers get city hukou by 2020, according to China's urbanization plan (2014-2020). To achieve the goal of retaining migrants in urban areas, the government should improve migrants' social integration and sense of belonging, instead of simply changing their residency (or *hukou*).

Results of this study also confirm the role of socio-demographic factors linked to smoking and expenditures on cigarettes, especially the negative influence of

education on smoking. Since most migrants have completed their formal education, public information programs with a focused message are a path to reaching smokers and encouraging smoking cessation. Since health care is a government-funded service, both municipal and central governments should be interested in funding efforts targeting rural migrants using the gender-specific profiles developed in this study.

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Tables

Table 3.1: Summary statistics for smoking behavior

	Definition	Count	Mean	St. Dev	Minimum	Maximum
Smoking behavior						
Smoke	1= smoke	2175	0.382	0.486	0	1
Expenditure	Monthly expenditure	800	301.806	170.525	30	750
Pack	Packets per day	827	0.922	0.506	0	4
Quitting smoking	1=considered quitting	777	0.597	0.491	0	1
Individual characteristics						
Age	Years	2183	37.178	11.199	16	76
Educ	Categories	2186	2.930	0.850	1	5
Gender	1= male	2187	0.714	0.452	0	1
Health Cond.	Categories	2187	2.938	0.288	1	3
Income (1,000)	Monthly income	2181	3.815	1.181	0	6
Drink	1=yes	2174	0.320	0.466	0	1
Raise	non-labor/family member	2183	0.320	0.224	0	1
Job (or migration) stress						
Overtime work	1= overtime working	2140	0.547	0.498	0	1
Wage arrear	1= wage arrears	2137	0.144	0.351	0	1
Social isolation						
Distance	Kilometers	2184	663.562	518.544	3	2282
Identity	1= citizen	2172	0.066	0.249	0	1
# of migrant city	Migrant cities' numbers	2171	2.484	2.403	0	30
Contact with fellow migrants	Categories	2182	2.426	0.738	1	3
Life satisfaction	Categories	2181	2.475	0.621	1	3
Relationship with residents	Categories	2181	2.426	0.552	1	3
Observations			2187			

Table 3.2: Gender differences in smoking cigarettes

Variable name	Male migrants		Female migrants		Difference
	Obs.	Mean	Obs.	Mean	(p-value)
Smoking prevalence	1559	0.517 (0.500)	616	0.041 (0.197)	0.000
For smokers					
Expenditure	755	302.948 (170.226)	23	256.957 (184.229)	0.203
Packs per day	801	0.924 (0.502)	23	0.821 (0.612)	0.336
Price	775	12.408 (7.633)	23	16.791 (20.079)	0.012
Willing to quit	752	0.601 (0.490)	18	0.333 (0.485)	0.022

Table 3.3: Household registry status and difference in smoking cigarettes

Variable name	Migrant workers		Local laborers		Difference
	Obs.	Mean	Obs.	Mean	(p-value)
Smoking prevalence	2175	0.382 (0.486)	167	0.341 (0.475)	0.296
For smokers					
Expenditure	798	301.623 (170.695)	56	320.714 (193.897)	0.423
Packs per day	824	0.921 (0.505)	57	0.883 (0.526)	0.583
Price	798	12.535 (8.261)	56	13.948 (10.916)	0.227
Willing to quit	770	0.595 (0.491)	49	0.510 (0.505)	0.244

Table 3.4: Estimation of the smoking decision

VARIABLES	without SI	with SI	male migrants	female migrants
Individual characteristics				
Gender	0.604***	0.591***		
	(0.038)	(0.038)		
Income (1,000)	0.026**	0.027**	0.023*	0.010**
	(0.011)	(0.011)	(0.013)	(0.004)
Age	-0.013*	-0.015**	-0.011	-0.004
	(0.007)	(0.007)	(0.008)	(0.003)
Age squared	0.000**	0.000**	0.000	0.000
	(0.000)	(0.000)	(0.000)	(0.000)
Elementary school	-0.055	-0.062	-0.003	-0.023
	(0.069)	(0.068)	(0.076)	(0.018)

Middle school	-0.062	-0.068	-0.019	-0.017
	(0.066)	(0.065)	(0.071)	(0.020)
High school	-0.066	-0.074	-0.015	-0.028
	(0.071)	(0.070)	(0.077)	(0.021)
College and above	-0.220***	-0.208***	-0.201**	
	(0.075)	(0.076)	(0.097)	-
Health cond. is bad	-0.196***	-0.185***	-0.322***	-
	(0.072)	(0.071)	(0.120)	-
Health cond. is good	0.033	0.043	0.025	-
	(0.057)	(0.058)	(0.079)	-
Drinks alcohol	0.132***	0.136***	0.136***	0.040**
	(0.024)	(0.025)	(0.028)	(0.017)
Working stress				
Overtime work	-0.040*	-0.053**	-0.072***	0.000
	(0.022)	(0.023)	(0.028)	(0.007)
Wage arrear	0.079**	0.071**	0.068*	0.013
	(0.032)	(0.032)	(0.038)	(0.008)
Social Isolation				
Distance	-	0.000*	0.000*	0.000
	-	(0.000)	(0.000)	(0.000)
# of migrant city	-	0.016***	0.018***	0.001
	-	(0.005)	(0.006)	(0.001)
Fellow migrants	-	-0.038**	-0.046**	-0.002

	-	(0.015)	(0.019)	(0.005)
Identity	-	-0.167***	-0.193***	-0.045**
	-	(0.052)	(0.064)	(0.020)
Life satisfaction poor	-	0.050	0.025	0.019
	-	(0.054)	(0.057)	(0.026)
Life satisfaction good	-	-0.056**	-0.060**	-0.008
	-	(0.024)	(0.029)	(0.007)
Relationship with residents poor	-	0.010	-0.019	-0.002
	-	(0.066)	(0.081)	(0.009)
Relationship with residents good	-	0.064***	0.074***	0.004
	-	(0.023)	(0.028)	(0.006)
Pseudo R2	0.208	0.226	0.048	0.358
Observations	2,063	2,063	1,476	530

Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1

Table 3.5: Estimation on smoking expenditure, price of a cigarette pack and willingness to quit smoking

VARIABLES	Expenditure	Price	Quitting
Pack per day	0.514***		
	(0.045)		
Income (1,000)	0.113***	1.075***	0.005
	(0.020)	(0.275)	(0.018)
Gender	0.087	-1.768	0.227*
	(0.145)	(2.085)	(0.116)
Age	-0.001	-0.037	0.004
	(0.013)	(0.165)	(0.012)
Age squared	-0.000	-0.000	-0.000
	(0.000)	(0.002)	(0.000)
I_marriage	-0.021	-1.937*	0.067
	(0.069)	(0.992)	(0.068)
I_raise	-0.069	-2.366**	-0.082
	(0.084)	(1.111)	(0.082)
Educ = 2	0.007	0.003	-0.151
	(0.107)	(1.602)	(0.097)
Educ = 3	-0.001	0.114	-0.118
	(0.104)	(1.552)	(0.091)
Educ = 4	0.024	0.843	-0.087
	(0.111)	(1.690)	(0.098)

Educ = 5	0.171	2.949	-0.083
	(0.159)	(2.508)	(0.142)
Health Cond. = 1	-0.124	-1.967	-0.131
	(0.302)	(2.815)	(0.253)
Health Cond. = 3	0.088	1.910**	-0.142*
	(0.074)	(0.958)	(0.084)
Drinking habit	-0.079**	-1.097**	-0.055
	(0.038)	(0.517)	(0.036)
Expenditure			0.000
			(0.000)
Constant	4.567***	12.634***	
	(0.285)	(4.069)	
Observations	781	781	788
R-squared	0.241	0.098	

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Table 3.6: Estimation on demand elasticity of cigarettes

Variable name	All smokers	All smokers	Registry status		Gender	
			Migrants	Local laborers	Male migrants	Female migrants
Income (log)	0.164***	0.158***	0.143***	0.331	0.145***	0.592
	(0.041)	(0.047)	(0.048)	(0.264)	(0.047)	(0.653)
Price (log)	-0.422***	-0.373***	-0.381***	-0.267**	-0.380***	-0.284
	(0.029)	(0.030)	(0.032)	(0.119)	(0.033)	(0.222)
Gender	-	0.213*	0.185	0.701	-	-
		(0.125)	(0.128)	(0.432)		
Constant	-0.568*	-1.284***	-1.025**	-3.195*	-0.867**	-1.510
	(0.328)	(0.400)	(0.420)	(1.712)	(0.398)	(7.441)
Control variables	No	Yes	Yes	Yes	Yes	Yes
Obs.	849	837	781	56	761	20
R-squared	0.203	0.241	0.249	0.353	0.252	0.560

Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1

Appendix

Table 3.7: Sample size calculation

Index	Wujin(2015)	Huishan(2015)	Changshu(2015)
Population(permanent)	1,436,200	706,600	1,510,100
Population(registered)	930,345	493,500	1,068,200
Non-local migrant workers	505,855	213,100	441,900
Labor in Agricultural sector(%)	28%	28%	28%
Rural labor force	260,497	138,180	299,096
Labor working in local areas(%)	83%	83%	83%
Local migrant workers	216,212	114,689	248,250
Total migrant workers population	722,067	327,789	690,150
Margin of error (ME)	3.50%	3.50%	3.50%
Confidence level	95%	95%	95%
Recommended sample size	784	783	784
Target sample size	800	800	800
Actual sample size	807	801	748

Data sources: the Department Statistical Bureau in each cities. The percentage of labor in Agricultural sector and the percentage of labor working in the local areas come from the report in National Bureau of Statistics[2].

Table 3.8: Comparison the survey sample with the national migrant workers(2016)

Variables	Explanation	Survey sample	National level	Difference
Gender	Male	71.79%	65.50%	6.29%
	Female	28.21%	34.50%	-6.29%
Age	16-20	4.82%	3.30%	1.52%
	21-30	31.03%	28.60%	2.43%
	31-40	21.72%	22.00%	-0.28%
	41-50	28.34%	27.00%	1.34%
	51+	14.09%	19.20%	-5.11%
Education	Illiteracy	4.57%	1.00%	3.57%
	Elementary school	20.56%	13.20%	7.26%
	Middle school	54.94%	59.40%	-4.46%
	High school	15.68%	17.00%	-1.32%
	College and above	4.26%	9.40%	-5.14%
Job type	Manufacturing	78.97%	30.50%	48.47%
	Construction	6.78%	19.70%	-12.92%
	Wholesale and retail	1.53%	12.30%	-10.77%
	Transportation	2.94%	6.40%	-3.46%
	Accommodation and Restaurants	1.49%	5.90%	-4.41%
	Other service industry	8.29%	11.10%	-2.81%
Income	Overall		3275	795
	East	4070	3454	616
Working situaiton	Work day per week	6.49	6.20	0.29
	Work hour per day	9.6	8.5	1.1

Sources: National Bureau of Statistics.

Conclusion

This dissertation addresses migration issues from three aspects using primary data from China. The first chapter focuses on the non-separability between the land market and labor market, and explores whether the imperfection of land markets hinder rural labor migration. The second chapter sheds light on migrant workers' environmental concerns and discusses how place attachment affects migrants' environmental attitude. The last chapter focuses on a marginalized population segment in China, migrant workers, and explores the impact of social isolation on migrants' smoking behavior as well as gender differences in tobacco smoking.

The dissertation finds that farm households who obtained land certificates were subsequently 7.7% more likely to have a migrant household member. We also show that the development of the land rental market can increase migration. This paper adds new empirical evidence for non-separability between land markets and labor markets when market failures exist, and enriches the literature on the channel through which the development of property rights affects economic development. For migrant workers who live in urban areas, our

research shows that about 72.5% migrant workers have environmental concerns about local air quality protection and are willing to pay taxes to improve their living environment. Meanwhile, migrant workers who do not show interest in environmental protection typically have information constraints and education programs which aim to provide more environmental knowledge might increase the percentage with positive WTP up to 82.3%. Place attachment, such as working length in local communities and life satisfaction also induces them to pay more attention to local environmental amenities.

The dissertation also discuss migrants' health condition and behavior in the last part. The research points out that migrants' smoking behavior is a coping mechanism for psychosocial stress, which may be introduced from social isolation. To test the hypothesis, we apply survey data from the southeast Jiangsu Province of China collected in 2016 and measure social isolation from both the structural and qualitative features of individuals' social networks. The data show that the overall pooled prevalence of smoking among rural-to-urban migrants is 38.21% (51.70% in male and 4.06% in female). Further examinations show that migrants' smoking choices are correlated with age, education, income and working stress. However, the contributions to migrants' smoking prevalence mainly come from social isolation, such as migration stability, ties with family and fellow migrants and life satisfaction in migrant cities. The analysis indicates that the smoking behavior of male migrants is mainly affected by social isolation, while the smoking prevalence of female migrants are mainly affected by individual

characteristics. Patterns of cigarette consumption among migrants are further explored from aspects such as expenditure, cigarette quality and willingness to quit. Additionally, we find that migrant smokers, especially male migrant smokers, are more sensitive to income and price than other smokers.