ABSTRACT

Title of Document: A BALANCING ACT?
—AN EMPRICIAL EXAMINATION OF WHETHER THE DYNAMIC BALANCE POLICY HAS HELPED CHINA RECUDE CULTIVATED LAND LOSS AMID RAPID URBAN LAND EXPANSION

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For decades, the Chinese government has been concerned about its ability to meet the grain self-sufficiency goal due to the depletion of cultivated land caused by urbanization and industrialization. The Dynamic Balance Policy (DBP) was initiated in 1998 to balance China's need to protect cultivated land with the need to provide land for urban and industrial development. The DBP is a "no net loss" policy which requires local government to keep their good-quality cultivated land at the current level. If cultivated land is converted to other uses, an equal amount of other land, adjusted for the quality, must be converted to cultivation to compensate for the loss.

Empirical evidence suggests that the DBP has had no effects of reducing cultivated land loss in China. Economic incentives, such as the values of urban and cultivated land, emerge as the most influential factors for China's land use changes. Moreover, these economic incentives may have overridden the effects of the DBP, if any. Polices can be made more effective to address the windfall profits in land acquisition and conveyance, and offer economic incentives for not converting cultivated land to urban uses.

This dissertation conducts a systematic examination of the effects of the DBP of curbing the rate of cultivated land conversion. In particular, it develops a theoretical model of land conversion that combines the institutional structure of land use in China and the incentive structure of Chinese local officials whose goal is to promote local economies and budgetary balances. This model serves as the theoretical foundation for the empirical examination. The empirical implementation of the land conversion model uses the official land use data provided by the Ministry of Land and Resources of China and economic data published in various issues of provincial statistical yearbooks. This is a unique set of data which combines China's official land use data and economic data at the prefecture level and covers a period of rapid economic growth and prominent changes in land uses from 1996 to 2004.

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by
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Dedication

To my grandma and parents

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Table of Contents

List of Tables

List of Figures

1 Introduction

1.1 Overview

The loss of agricultural land to urban uses has become a stylized fact of economic growth characterized by urbanization and industrialization. No country, whether developed or developing, has been able to avoid it. Amid the loss of agricultural land to urban uses, the loss of prime farmland is a great concern due to its direct impact on the national food production and food security.

While farmland loss to urbanization is an international concern, China's problem is aggravated in five aspects. First, China's arable land resource is very limited. Between China's population explosion which is projected to reach 1.5 billion by 2030 and over 60% of its arable land experiencing water shortages, the potential of developing new cultivated land in China is not so great (State Council 2008). Despite it being the fourth largest territory in the world, only 15% of the total land area in China is arable. In 2005, with a population of 1.3 billion, China's per capita arable land was merely 0.11 hectares—half of the world's average and less than 20% of the United States' arable land per capita (FAO).

Second, in addition to limited per capita land resources, China's land use reveals apparent inefficiencies. To spur the local economy and to attract private and foreign investment, a common practice of local governments is to set aside land for industrial development. This land largely comes from cultivated land, but reportedly less than 14% of it is ever actually developed. In fact, over 1.73 million hectares of set-aside construction land still remain idle after the fervent growth of development zones between 1987 and 2003 (China Economics Weekly 2004).

Third, it is not the quantity of land lost, but rather the loss of soil productivity that concerns the Chinese government, raising fears about their ability to meet grain self-sufficiency goals. Land development in China does not typically take the physical properties of land into consideration, resulting in great losses of fertile cultivated land (Yeh and Li 1999). The loss of such land cannot be offset simply by the development of new cultivated land. The land lost is mostly wetland and irrigated land—prime for farming. However, less than 40% of the newly developed land for cultivation is equipped with irrigation and drainage facilities (State Council 2008).

Fourth, illegal and unapproved land development projects not only encroach upon a large quantity of cultivated land and cause millions of farmers lose their way of living, but also present a challenge to China's legal system. Collusion between regulators and land developers resulting in the incompliance of land use laws is prevalent in China. Maintenance of the law and order throughout the country is crucial for China's further economic prosperity (The 21st Century Economic Report 2003b; China Economics Weekly 2004; State Council 2008).

Fifth, rural land acquisition, a synonym of cultivated land conversion in the literature of land use in China, often leads to conflicts between ordinary farmers and government. Due to the ownership of land in China, rural land has to be acquired by government agencies before it can be used for non-agricultural purposes. Such conflicts have taken place in various forms and scales, ranging from peaceful protests to violent demonstrations, serving as a source of social instability in China.

1.2 Research Motivation and Questions

The continuous loss of cultivated land and its associated problems have made the protection of cultivated land one of the most pressing land policy challenges faced by the Chinese government. As China juggled the task of cultivated land preservation with the need for land for urban and industrial development, a series of measures have been adopted, of which the most fundamental one is the revision of the Land Administration Law with the provision of the Dynamic Balance Policy (DBP) in 1998. The DBP is a "no net loss" policy which requires local government to keep their good-quality, cultivated land at the current level. If cultivated land is used for purposes other than cultivation, an equal amount of other land, adjusted for quality, must to be brought into cultivation. In light of this postulation, land use composition is expected to change constantly, but the net change in cultivated land area is required to be zero, achieving a "dynamic balance".

In keeping with China's administrative approach to managing land use, the DBP imposes a quota on conversion of cultivated land to urban uses, requiring a zero net change in cultivated land areas. Achieving this quota depends upon the economic incentives for land conversion and sales. If the economic incentives overpower the administrative disincentives, the effectiveness of the policy may be jeopardized. Motivated by this general conception, this dissertation attempts to answer the following questions:

(1) What are the economic incentives for converting cultivated land to urban uses?

(2) How does the DBP affect the land use changes? And how does the DBP affects the incentive structure of land conversion?

(3) Has the DBP had its intended effects?

1.3 Research Contribution

China has received a great deal of academic attention due to its rapid economic growth and urbanization and its accompanying loss of cultivated land. Surprisingly though, there has been no evaluation of the impacts of China's cultivated land protection policies, and especially no examination of how the policies impact the area of cultivated land. After more than a decade since the promulgation of the policy, this dissertation serves as the first systematic examination of the DBP's impacts on China's land allocation between cultivation and urban.

In particular, this dissertation formulates the institutional structure of land use in China and the incentive structure of Chinese local officials in promoting local economies and fiscal balances into a land conversion model, which provides a theoretical backup for the empirical evaluation. The empirical implementation of the land conversion model adopts the official land use data provided by the Ministry of Land and Resources (MLR) of China and economic data published in various issues of provincial statistical yearbooks.

This dataset offers the unique opportunity for conducting land use analysis at the prefecture level, a level lower than the provinces in China's administrative divisions,[1]

[1] There are five *de facto* administrative divisions at the local level in China. From the top to bottom, they are province, prefecture, county, township, and village (China Statistical Yearbook 2008). Prefecture-level divisions include prefectures, autonomous prefectures, prefecture-level cities, and leagues. Prefecture-level cities are the largest number of prefecture-level divisions. They resemble municipals in

over a period of rapid economic growth and predominant changes in land use patterns from 1996 to 2004.

1.4 Dissertation Structure

The remainder of this dissertation is organized as follows. Chapter 2 explores the trends in China's cultivated land and urban land from 1996 to 2004. Chapter 3 investigates the evolution of the legal system governing the land use in China as a problem and solution process. It discusses four major problems associated with rural land acquisition and their respective government responses. Chapter 4 analyzes the incentives for cultivated land conversion that may counteract the effectiveness of the laws and the expected costs of violating the laws. Chapter 5 reviews existing studies on China's land conversion and land use policies, and sets the benchmark for the theoretical and empirical analyses in the following chapters. Chapter 6 formalizes the incentive structure of cultivated land conversion into a theoretical model, and derives the testable hypotheses for the empirical endeavor in the later chapters. Chapter 7 presents the data used in the analysis. Chapter 8 develops the empirical models and estimation methods. Chapter 9 discusses the estimation results and explores their policy implications. Chapter 10 serves as the concluding remarks.

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that they are generally composed of an urban center and surrounding rural areas much larger than the urban core. Autonomous prefectures are prefectures with one or more ethnic minorities, mostly found in Western China. Leagues are only found in Inner Mongolia. Prefectures are no longer the dominant second-level division. They have been mostly replaced by prefecture-level cities from 1983 to the 1990s. Today, they exist mostly in Western China (The Official Website of the Administrative Division of China. www.xzqh.org). As prefectures, autonomous prefectures, and leagues are a small number of prefecture-level divisions, they are all referred to as prefectures in the remainder of dissertation.

2 Land Use Trends in China, 1996 – 2004

This chapter reviews the trends in China's land use from 1996 to 2004. During this time, China achieved remarkable economic growth and experienced great changes forced by such growth, including changes in its land uses. In order to explore the transitional changes in China's land use, it is helpful to familiarize oneself with China's land classification system and terminology; therefore it will be explained in the first section of this chapter.

It is also important to define the study regions. When compared to national land use trends, areas with more concentrated population and more advanced economies may have some features distinguishing them from the national trends. This will be further explained in Section 2.2.

Following the first two preparatory sections, Sections 2.3 and 2.4 describe the land use composition and trends in China from 1996 to 2004 in detail.

2.1 Land Classification in China

There are many similar but different terms in literature to refer to land used for agricultural production, such as farmland, arable land, cropland, and cultivated land. Different countries may have different definitions for each of them, and they are sometimes used interchangeably. To avoid confusion of this kind, this dissertation adopts the terminology defined by the MLR of China.

Table 2.1 lists the official land classification in China based on the uses of land. Two types of land central to this dissertation are cultivated land and urban land. Cultivated land is defined as the land used for producing major food and feed grains, as well as vegetables (category I). Urban land is defined as the land classified as cities and towns in residential and industrial land (category V).

When comparing China's land classification with that of the United States, one can easily find that what is referred to as cropland in the United States is further divided into cultivated land and horticultural land in China.[2] The separation of cultivated land from cropland in China stems from the vaunted national grain self-sufficiency policy. To ensure grain self-sufficiency, China imputes a minimum of 1.8 billion *mu* (120 million hectares)[3] of cultivated land to be maintained at all times (China Daily 2010a). In order monitor the change in cultivated land, the Chinese accounting system keeps cultivated land separate from horticultural land.

2.2 Study Regions

In addition to land use trends in China as a whole, this chapter examines the land use trends in East China and in West and Central China separately (as defined in Figure 2.1). Shown in Figures 2.2 and 2.3, East China and some parts of Central China are where population and cultivated land concentrated. East China is also where the economic growth and urbanization the rapidest. To study land conversions from cultivated land to urban land, and to examine the economic incentives for this type of conversions, this thesis focuses on the land use changes in East China while using West and Central China as a comparison.

East China refers to the region comprised of eleven provincial administrative divisions along China's east coast. Specifically, these provincial administrative

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[2] For the land classification in the United States, please refer to ERS/USDA. http://www.ers.usda.gov/data/majorlanduses/.

[3] *Mu* is a Chinese unit for area. 1 mu = 1/15 hectare.

divisions are Beijing, Tianjin, Shanghai, Liaoning, Hebei, Shandong, Jiangsu, Zhejiang, Fujian, Guangdong, and Hainan. Based on the official land use data from the Chinese government, this region constitutes 11% of the total country's territory and is comprised of 10% of the nation's farmland, 25% of the nation's cultivated land, and 35% of the nation's construction land. This region is also the home to 37% of the Chinese population, totaling nearly 50 million people (based on the 2000 Census data of 1.3 billion of population in China).

East China has long since been the center of China's population and economic growth and is generally observed to have experienced the greatest and fastest cultivated land loss and urban expansion in the country. Because this region has a very high population density and very little unused land, much of the urban land demand must be met by converting cultivated land, especially at the fringes of urban metropolitan center (Yeh and Li 1999; Seto and Kaufmann 2003; Ho and Lin 2004a; Tan et al. 2005; Lichtenberg and Ding 2009). Between 1988 and 1996, the Pearl River Delta of the southern province Guangdong's urban area increased more than 300 percent, most of the increase was from converted agricultural land, particularly orchards, rice fields, and fish ponds (Seto and Kaufmann 2003). Similarly, in the northern economic center formed by Beijing, Tianjin and Hebei, urban land area expanded by 71% between 1990 and 2000, and about 74% of the urban land expansion was from arable land (Tan et al. 2005).

To make matters worse, East China is usually where the most fertile soil located and where the climate allows multiple cropping (Ash and Edmonds 1998; Yang and Li 2000). The impacts of cultivated land loss in this region can be profound on agricultural productivity, urban and industrial growth, and on a large number of people's lives.

Empirical findings from this region would have important implications for policy design. Therefore, this thesis focuses the discussion on this region.

2.3 Land Composition

According to the MLR land use data, the share of land of each use has not changed much between 1996 and 2004. Overall, data reveals that East China has a very different land composition from West and Central China. In West and Central China, over 80% of the land is occupied by forest, pasture, and unused land, and less than 20% is split among cultivated and horticultural land (combined less than 12% of the total), construction land composed of industrial, residential, and transportation land (around 2%), and inland water areas (nearly 4%). By contrast, a majority of the land in East China is composed of cultivated, horticultural, residential, industrial, and transportation land, and inland water areas, accounting for 55% of the total land in this region. With forestland taking up another 35% of the total, just a little over 10% of the land is unused land and pastureland.

Although there is nearly no significant change in China's land composition between 1996 and 2004, prominent changes in China's land use have occurred during this period of time, particularly in the amount of cultivated land and urban land. The trends in China's cultivated land and urban land are examined in the following two sections, respectively.

2.4 Trends in Cultivated Land

Figure 2.4 shows that China as a whole lost 7.4 million hectares or 5.7% of cultivated land between 1996 and 2004, 1.5 million hectares of which was located in the eastern and coastal provinces. The West and Central parts of China also experienced a loss of cultivated land every year during the same period.

Figure 2.5 shows that the loss of cultivated land was at an accelerated rate nationwide, especially after 2001. It also shows that cultivated land loss in West and Central China has been faster than it is in East China every year since the late 1990s. This can be explained by the "Grain for Green" (GfG) national policy which was launched in 1999 and required the conversion of subpar cultivated land to forests and pasturelands.

The GfG policy aimed to correct China's long history of land use management problems. In the planned economy of China from the late 1950s to the late 1970s, the mandate for grain self-sufficiency not only applied to the national grain supply, but also to the regional grain supply. In order to achieve the regional grain self-sufficiency, local governments had no choice but to convert forests and pastureland into land for planting grain crops (Lin and Wen 1995). Such land use practices were particularly common in the arid and semi-arid areas of northwestern China, however, most of the cultivated land developed from forests and grasslands was not suitable for cultivation. The loss of forests and grasslands caused a series of environmental problems, such as soil erosion and desertification leading to increasingly frequent and intense sand storms (Yang and Li 2000).

While the national grain self-sufficiency is still strongly advocated, the requirement for regional grain self-sufficiency has been relaxed since the rural reform launched in 1979. Several land conservation projects have been initiated to correct the environmental damages caused by converting forests and grasslands to cultivated land. The GfG policy is one of them, requiring marginal cultivated land to be reverted back to forests and grasslands. Since the main objective of the GfG program is to prevent soil erosion, the program has made the land slope the top criteria for participation. Land with 25 degrees of slope or higher in southwest China, and land with 15 degrees of slope or higher in northwest China are classified as marginal cultivated land and are eligible for program participation (Uchida, Xu, and Rozelle 2005; The Central People's Government of China 2007).

Participating farmers are compensated with grain, cash, and/or free seedlings. Compensation in different regions is made different based on the opportunity cost of the land. On average, the total value of three types of compensation—grain, cash, and seedlings—is worth RMB 3,150 per hectare in the middle and upper reaches of the Yellow River[4] in the first year of the program participation, and RMB 2,400 per hectare per year from the second year. Due to the higher opportunity cost of land, the total compensation package in the upper reaches of the Yangtze River[5] is valued at RMB 4,200 per hectare for the first year of the program participation, and RMB 3,450 per

[4] The Yellow River passes through 9 provincial administrative divisions. From its origin to its end, they are Qinghai, Gansu, Ningxia, Inner Mongolia, Shaanxi, Shanxi, Henan, and Shandong (The Official Website of the Administrative Division of China. www.xzqh.org). With the exception of Shandong, they are all located in western and central China as shown in the Map of China (Figure 2.1). Shandong is located in eastern China.

[5] The Yangtze River passes through 11 provincial administrative divisions. From its origin to its end, they are Qinghai, Tibet, Yunnan, Sichuan, Chongqing, Hubei, Hunan, Jiangxi, Anhui, Jiangsu, and Shanghai. With the exception of Jiangsu and Shanghai, they are all located in western and central China as shown in the Map of China (Figure 2.1).

hectare per year from the second year (Uchida, Xu, and Rozelle 2005; The Central People's Government of China 2007). Moreover, the compensation is paid for a total of 8 years if land is converted to ecological forests, 5 years if land is converted to cash forests, and 2 years if land is converted to grasslands (The Central People's Government of China 2007).

The GfG program started in 1999 as a pilot program in Sichuan, Shaanxi, and Gansu provinces. By the end of 2001, the program was expanded to 20 provinces (Uchida, Xu, and Rozelle 2005). The GfG policy was promulgated almost at the same time as when the DBP took in effect, and these two policies seem to have conflicting requirements. The conflicts are resolved as follows. The DBP targets at high-quality and good-quality cultivated land, while land lost due to the Grain for Green policy is mostly unproductive land, and thus, is not subject to the DBP requirement.

Evidence from Yang and Li (2000) proved a majority of the cultivated land loss in northwestern China was attributed to such reversions advocated by the GfG policy. The transition matrices of land use presented in Section 2.6 will shed some light on the impacts of the GfG policy on land use changes in West and Central China.

2.5 Trends in Urban Land

Between 1996 and 2004, as the area of cultivated land declines, the area of urban land—defined as the sum of cities and towns—has increased both in East China and in West and Central China (Figure 2.6). The rate of urban land expansion in East China was significantly higher than it was in West and Central China since 2000 (Figure 2.7).

Overall, there has been a decreasing trend in cultivated land and an increasing trend in urban land. Without the assistance of land transition data, we cannot determine whether the loss of cultivated land is solely due to urban land expansion. As Figures 2.5 and 2.7 together reveal that the rapid annual loss of cultivated land in West and Central China after 2000 did not lead to the same rapid annual percentage increase in urban land. As mentioned before, the loss of cultivated land in West and Central China may well have been induced by the national policy of ecological land conservation. To better understand the whereabouts of the lost cultivated land in different regions, the following sections explore the data of land transitions from one type of use to another.

2.6 Trends in Land Transitions

Using the MLR land transition data from 1996 to 2001, this section explores the transitions between cultivated land and other types of land, with a focus on transitions between cultivated land and urban land. Transition data measures land conversions in both directions, and help to pinpoint the culprits of cultivated land loss and the sources of newly added cultivated land and urban land.

2.6.1 Transition Matrix of Cultivated Land

This section uncovers the major culprits of cultivated land losses and the sources of newly added cultivated land. The top two culprits of cultivated land loss across the country are reforestation and expansion of grasslands, accounting for 25.32% and 16.50% of the cumulative loss of cultivated land from 1996 to 2001, respectively (Table 2.2A). In particular, the 1999 GfG policy of reverting marginal cultivated land to forests and pastureland created a sharp rise in the amount of cultivated land lost to forests and pastures from 1999 to 2001.

Residential, industrial, and transportation land combined is the third largest contributor of the cultivated land loss nationwide. This type of conversion of cultivated land has caught special attention from scholars and policy makers because it is typically irreversible and a large number of people's lives are affected throughout the process.

As illustrated in the lower panel of Table 2.2A, most of the new cultivated land in China is from unused land. Unused land is also a net contributor to the increase in cultivated land every year except 1996. In addition, while the reversion to forests and grasslands has taken over a lot of cultivated land, forests and grasslands are also the second and third largest contributors to the cumulative increase in cultivated land from 1996 to 2001. By contrast, residential and industrial land or transportation land is rarely converted to cultivated land.

In East China, the trends in land transitions between cultivated land and other lands are very different from the national trends as well as the trends in West and Central China. Not surprisingly, the loss of cultivated land to residential, industrial, and transportation land in this region is more prominent than in other parts of China. Residential, industrial, and transportation land combined accounted for the largest cumulative loss of cultivated land in the eastern and coastal region from 1996 to 2001 (Table 2.2B).

Furthermore, cities and towns of residential and industrial land are urban areas that can easily expand into surrounding cultivated land. In China as a whole, urban land expansion contributed less than 4% of the total loss of cultivated land between 1996 and 2001, lower than any other contributors. By contrast, in East China, the contribution of urban land expansion to cultivated land loss in the same time period was nearly 9%, higher than the percent contribution of pastureland and unused land and only slightly lower than the percent contribution of forestland and transportation land.

The next two largest contributors of cultivated land loss are water areas and horticultural land. Since some water areas and horticultural lands are for agricultural production, this implies that considerable structural changes in agriculture have occurred in this region. With higher income levels, people in East China consume increasing quantities of fruits and aquatic products and less grain cereals, thus changing food supply demands (Heilig 1997). Farmers also have shifted from growing grain crops to fruit trees in hopes of higher compensation should their land be taken by the government since the amount of land compensation is determined by the output value of their land in the past three years. Because the value of fruit trees is much higher than that of grains, orchard farmers can receive much for compensation for their land then crop farmers (Ma 2009).

Moreover, even though East China has also experienced increased losses of cultivated land to forests and pasturelands, the GfG policy is not a dominating force for the cultivated land loss in this region. The share of cultivated land loss due to reforestation and the expansion of grasslands in this region is far below the national average. The share of cultivated land turned unused is also lower than the national average, indicating higher land use efficiency in this region.

Among the sources of new cultivated land, horticultural land and unused land are two net contributors to the increase in cultivated land in East China. Unused land alone is the most important source of new cultivated land in this region. From 1996 to 2001, nearly 64,000 hectares of the net increase in cultivated land came from unused land.

To illustrate the differences in the leading causes for cultivated land loss in East China and in the rest of the country, Table 2.2C summarizes the transitions between cultivated land and other types of land in West and Central China. Similar to the average trend in China as a whole, forests and grasslands are the major culprits for cultivated land loss in West and Central China, accounting for over 50% of the total loss between 1996 and 2001. Only 8.8% of the total loss of cultivated land in this region during this period of time is due to residential and industrial development, as opposed to 34% in East China. Meanwhile, nearly 50% of the increase in cultivated land in West and Central China comes from forests and grasslands. However, forests and grasslands are not the net contributors to newly added cultivated land.

Land transition data also reveals that participating provinces of the GfG programs are concentrated in West and Central China. Some provinces in East China, Zhejiang for example, have participated in the reversion of cultivated land to forests, but very few have participated in the reversion of cultivated land to grasslands due to the geophysical conditions of the region. Although it would be desirable to explore the intentional conversion of cultivated land for ecological conservation purposes, such exploration is not central to this thesis.

2.6.2 Transition Matrix of Urban Land

Because transition data is only available for land of the first-level classified uses, while cities and towns comprising urban land are second-level classifications in residential and industrial land, there is no data on transitions between urban land and other residential and industrial land or unused land. Table 2.3A, 2.3B, and 2.3C summarize the transitions between urban land and other types of land implied by available data in whole China, East China, and West and Central China, respectively.

It can be learned from Table 2.3A and 2.3B that the decrease in urban land is trivial compared with its increase every year, except 2000. The significant decrease in urban land in 2000 was mainly because Shanghai converted 17,339 hectares of their town areas to cultivated land, constituting 99% of the total conversion of this kind in the entire country that year. This dramatic decrease in the urban area of Shanghai is likely due to a deliberate policy in 2000, because the conversion from urban land to cultivated land in Shanghai in all other years is practically zero.

It is important to note that the percent contribution of each type of land to the changes in urban land in Table 2.3 would be smaller if transitions between urban land and other residential and industrial land and unused land were counted. Nevertheless, the percentages calculated based on incomplete transition data indicate that transitions between urban land and cultivated land are the most important among all kinds in both directions. Overall, cultivated land is still the largest net source of new urban land in all three regions examined. If taking the conversion from town areas to cultivated land in Shanghai 2000 out of the equation, the total area of new urban land converted from cultivated land between 1996 and 2001 is nearly 20 times the total area of urban land converted to cultivated land in China as a whole, and 13 times in East China.

The examination of the land transition data leads to the confirmation of the general allegation that China's urban land expansion has encroached upon a large amount of cultivated land. Concerned with the ability to meet the nation's grain self-sufficiency goal, the Chinese government has taken a series of measures to protect cultivated land. However, due to the public ownership of land, government agencies in China play a role similar to private land developers yet simultaneously act as enforcement agencies of land use regulations and laws. Such conflicting roles have triggered a series of problems in land use and management. The next chapter details these problems and discusses the land use laws and institutions in China that evolve to solve these problems.

Table 2.1 Land Classification in China

I. Cultivated Land • Irrigated Rice Paddy • Rain-fed Paddy • Irrigated Cropland • Dry Land • Vegetable Land	**V. Residential and Industrial Land** • Cities • Towns • Rural Settlements • Stand-alone Industrial and Mining Sites • Saline Fields • Land for Special Uses (Military, Religious, Prisons, Cemeteries, etc.
II. Horticultural Land • Orchards • Mulberry Fields • Tea Gardens • Rubber Plantation • Other Perennial Plantation	**VI. Transportation Land** • Rail Roads • Highways • Rural Roads • Civil Airports • Harbors and Docks
III. Forest Land • Closed Forest • Bushes • Sparse Forests • Young Afforested Land • Forests Stripped of Vegetation after Cut or Fire for at Least Five Years • Breeding Nurseries	**VII. Water Areas** • Rivers • Lakes • Reservoirs • Ponds • Reed Area • Flooded Area and Tidal Flats • Irrigation Infrastructure • Flood Control Structures • Glaciers and Perennial Snowcapped Land
IV. Pastureland • Natural Grassland • Improved Grassland • Sown Grassland	**VIII. Unused Land** • Unused Grassland • Saline-alkali Land • Marshes and Swamps • Deserts • Barren Earth • Bare Rocks and Gravels • Berms • Other Unused Land

Source: Ministry of Land and Resources of China.

Table 2.2 Transitions between Cultivated Land and Other Types of Land (Hectares), 1996-2001

A. Whole China

Year	Decrease in Cultivated Land	Destination of Decrease							
		Horticulture	Forest	Pasture	Residential and Industrial		Transport	Water	Unused
						Cities and Towns			
1996	1,416,543	214,306	277,498	111,287	215,249	55,399	86,532	260,018	251,652
1997	850,732	153,647	146,066	86,053	170,141	38,261	59,263	145,001	90,561
1998	570,405	57,469	73,014	85,293	103,187	32,895	48,840	137,617	64,986
1999	841,677	71,971	181,389	106,181	116,793	28,264	64,620	160,714	140,009
2000	1,206,508	198,458	477,586	283,577	115,061	30,094	38,389	45,888	47,549
2001	893,268	83,376	308,007	281,243	120,387	37,314	34,978	42,626	22,652
Cumulative	5,779,134	779,228	1,463,560	953,634	840,818	222,226	332,621	791,863	617,409
%	100.00	13.48	25.32	16.50	14.55	3.85	5.76	13.70	10.68

Year	Increase in Cultivated Land	Source of Increase							
		Horticulture	Forest	Pasture	Residential and Industrial		Transport	Water	Unused
						Cities and Towns			
1996	683,532	62,113	221,050	141,140	8,975	538	1,491	64,192	184,571
1997	372,961	55,862	40,234	101,261	17,879	1,803	5,911	45,059	106,754
1998	309,369	45,674	55,184	58,628	19,764	4,999	5,444	25,170	99,505
1999	405,075	48,996	36,315	55,435	24,985	1,734	6,631	52,806	179,907
2000	586,051	57,188	89,788	182,569	41,107	17,908	2,650	62,294	150,454
2001	265,944	37,356	25,391	25,858	20,600	2,235	2,084	54,756	99,899
Cumulative	2,622,931	307,189	467,963	564,890	133,310	29,217	24,211	304,279	821,090
%	100.00	11.71	17.84	21.54	5.08	1.11	0.92	11.60	31.30

B. East China

Year	Decrease in Cultivated Land	Destination of Decrease							
		Horticulture	Forest	Pasture	Residential and Industrial		Transport	Water	Unused
						Cities and Towns			
1996	305,631	58,526	24,724	2,727	90,725	28,939	33,029	57,256	38,643
1997	346,043	45,309	29,444	6,279	98,848	18,229	28,154	101,584	36,425
1998	140,582	24,500	7,704	499	55,869	14,946	22,424	24,988	4,597
1999	155,479	19,524	17,880	1,297	54,138	10,744	26,203	30,470	5,969
2000	181,359	32,219	24,260	7,155	68,956	17,438	19,441	23,585	5,743
2001	190,440	25,387	36,549	8,448	78,552	23,402	12,777	21,294	7,433
Cumulative	1,319,536	205,465	140,561	26,406	447,088	113,699	142,029	259,177	98,810
%	100.00	15.57	10.65	2.00	33.88	8.62	10.76	19.64	7.49

Year	Increase in Cultivated Land	Source of Increase							
		Horticulture	Forest	Pasture	Residential and Industrial		Transport	Water	Unused
						Cities and Towns			
1996	107,415	52,777	15,768	2,430	3,871	487	621	16,064	15,884
1997	119,922	37,355	6,734	1,757	10,017	1,238	5,502	34,680	23,877
1998	80,309	24,393	6,435	1,661	9,962	4,440	2,360	14,171	21,328
1999	94,968	24,778	8,399	1,625	8,972	851	844	19,397	30,953
2000	140,514	42,044	11,496	991	26,338	17,482	952	20,406	38,287
2001	105,416	24,323	6,667	122	9,421	1,654	1,147	31,415	32,320
Cumulative	648,544	205,672	55,499	8,584	68,581	26,151	11,425	136,134	162,649
%	100.00	31.71	8.56	1.32	10.57	4.03	1.76	20.99	25.08

C. West and Central China

Year	Decrease in Cultivated Land	Destination of Decrease							
		Horticulture	Forest	Pasture	Residential and Industrial		Transport	Water	Unused
						Cities and Towns			
1996	1,110,912	155,781	252,774	108,560	124,524	26,459	53,503	202,762	213,009
1997	504,688	108,338	116,622	79,774	71,293	20,032	31,109	43,417	54,136
1998	429,823	32,968	65,309	84,794	47,318	17,949	26,416	112,629	60,388
1999	686,197	52,448	163,509	104,884	62,655	17,520	38,417	130,244	134,041
2000	1,025,149	166,240	453,327	276,422	46,105	12,656	18,947	22,303	41,806
2001	702,828	57,989	271,458	272,795	41,835	13,911	22,201	21,332	15,219
Cumulative	4,459,598	573,763	1,322,999	927,228	393,729	108,528	190,593	532,687	518,599
%	100.00	12.87	29.67	20.79	8.83	2.43	4.27	11.94	11.63

Year	Increase in Cultivated Land	Source of Increase							
		Horticulture	Forest	Pasture	Residential and Industrial		Transport	Water	Unused
						Cities and Towns			
1996	576,117	9,336	205,282	138,710	5,104	52	871	48,128	168,687
1997	253,039	18,507	33,500	99,504	7,863	565	410	10,379	82,876
1998	229,060	21,281	48,749	56,968	9,803	559	3,084	10,999	78,177
1999	310,106	24,218	27,916	53,810	16,012	883	5,787	33,409	148,954
2000	445,537	15,144	78,292	181,578	14,769	426	1,698	41,888	112,168
2001	160,528	13,033	18,724	25,736	11,178	582	937	23,342	67,579
Cumulative	1,974,388	101,517	412,464	556,306	64,729	3,066	12,786	168,145	658,440
%	100.00	5.14	20.89	28.18	3.28	0.16	0.65	8.52	33.35

Data Source: The Ministry of Land and Resources of China.

Table 2.3 Transitions between Urban Land (Cities and Towns) and Other Types of Land (Hectares), 1996-2001

A. Whole China

Year	Decrease in Urban Land	Destination of Decrease							
		Cultivated	Horticulture	Forest	Pasture	Other Residential and Industrial	Transport	Water	Unused
1996	1,542	538	23	28	147	n.a.	415	390	n.a.
1997	5,012	1,803	138	323	1,102	n.a.	707	938	n.a.
1998	7,325	4,999	134	303	23	n.a.	917	948	n.a.
1999	3,902	1,734	275	852	2	n.a.	549	492	n.a.
2000	20,968	17,908	419	514	39	n.a.	1,319	769	n.a.
2001	4,788	2,235	553	325	58	n.a.	716	900	n.a.
Cumulative	43,538	29,217	1,543	2,345	1,372	n.a.	4,624	4,436	n.a.
%	100.00	67.11	3.54	5.39	3.15	n.a.	10.62	10.19	n.a.

Year	Increase in Urban Land	Source of Increase							
		Cultivated	Horticulture	Forest	Pasture	Other Residential and Industrial	Transport	Water	Unused
1996	94,235	55,399	3,390	10,135	789	n.a.	980	23,541	n.a.
1997	53,883	38,261	2,404	4,926	448	n.a.	1,563	6,281	n.a.
1998	65,339	32,895	4,631	6,796	10,992	n.a.	1,432	8,593	n.a.
1999	41,083	28,264	2,915	3,745	1,102	n.a.	1,502	3,555	n.a.
2000	41,931	30,094	2,624	2,879	322	n.a.	1,253	4,760	n.a.
2001	54,378	37,314	4,918	2,785	851	n.a.	2,428	6,082	n.a.
Cumulative	350,850	222,226	20,882	31,266	14,505	n.a.	9,158	52,813	n.a.
%	100.00	63.34	5.95	8.91	4.13	n.a.	2.61	15.05	n.a.

B. East China

Year	Decrease in Urban Land	Destination of Decrease							
		Cultivated	Horticulture	Forest	Pasture	Other Residential and Industrial	Transport	Water	Unused
1996	834	487	9	23	13	n.a.	225	77	n.a.
1997	2,776	1,238	72	229	0	n.a.	363	875	n.a.
1998	6,264	4,440	78	247	2	n.a.	657	839	n.a.
1999	2,500	851	230	703	0	n.a.	311	406	n.a.
2000	19,186	17,482	246	346	0	n.a.	602	510	n.a.
2001	3,591	1,654	522	277	0	n.a.	559	578	n.a.
Cumulative	35,150	26,151	1,157	1,825	15	n.a.	2,716	3,285	n.a.
%	100.00	74.40	3.29	5.19	0.04	n.a.	7.73	9.35	n.a.

Year	Increase in Urban Land	Source of Increase							
		Cultivated	Horticulture	Forest	Pasture	Other Residential and Industrial	Transport	Water	Unused
1996	62,114	28,939	2,582	8,069	43	n.a.	619	21,860	n.a.
1997	25,701	18,229	1,387	1,670	7	n.a.	913	3,494	n.a.
1998	27,450	14,946	2,732	3,442	52	n.a.	765	5,513	n.a.
1999	16,699	10,744	1,609	1,885	14	n.a.	710	1,737	n.a.
2000	25,362	17,438	1,826	1,698	20	n.a.	636	3,745	n.a.
2001	35,619	23,402	3,898	1,664	31	n.a.	2,000	4,623	n.a.
Cumulative	192,944	113,699	14,035	18,429	167	n.a.	5,643	40,972	n.a.
%	100.00	58.93	7.27	9.55	0.09	n.a.	2.92	21.24	n.a.

C. West and Central China

Year	Decrease in Urban Land	Destination of Decrease							
		Cultivated	Horticulture	Forest	Pasture	Other Residential and Industrial	Transport	Water	Unused
1996	708	52	15	4	134	n.a.	190	313	n.a.
1997	2,236	565	66	95	1,102	n.a.	345	63	n.a.
1998	1,061	559	56	56	22	n.a.	261	108	n.a.
1999	1,403	883	45	149	2	n.a.	238	86	n.a.
2000	1,783	426	173	168	39	n.a.	718	259	n.a.
2001	1,197	582	32	48	58	n.a.	157	321	n.a.
Cumulative	8,388	3,066	386	520	1,357	n.a.	1,908	1,151	n.a.
%	100.00	36.56	4.60	6.20	16.18	n.a.	22.75	13.72	n.a.

Year	Increase in Urban Land	Source of Increase							
		Cultivated	Horticulture	Forest	Pasture	Other Residential and Industrial	Transport	Water	Unused
1996	32,121	26,459	808	2,065	746	n.a.	361	1,681	n.a.
1997	28,182	20,032	1,017	3,255	442	n.a.	649	2,787	n.a.
1998	37,889	17,949	1,899	3,354	10,940	n.a.	667	3,080	n.a.
1999	24,385	17,520	1,306	1,860	1,088	n.a.	792	1,818	n.a.
2000	16,569	12,656	798	1,181	302	n.a.	617	1,015	n.a.
2001	18,760	13,911	1,020	1,121	820	n.a.	428	1,460	n.a.
Cumulative	157,906	108,528	6,847	12,837	14,337	n.a.	3,516	11,841	n.a.
%	100.00	68.73	4.34	8.13	9.08	n.a.	2.23	7.50	n.a.

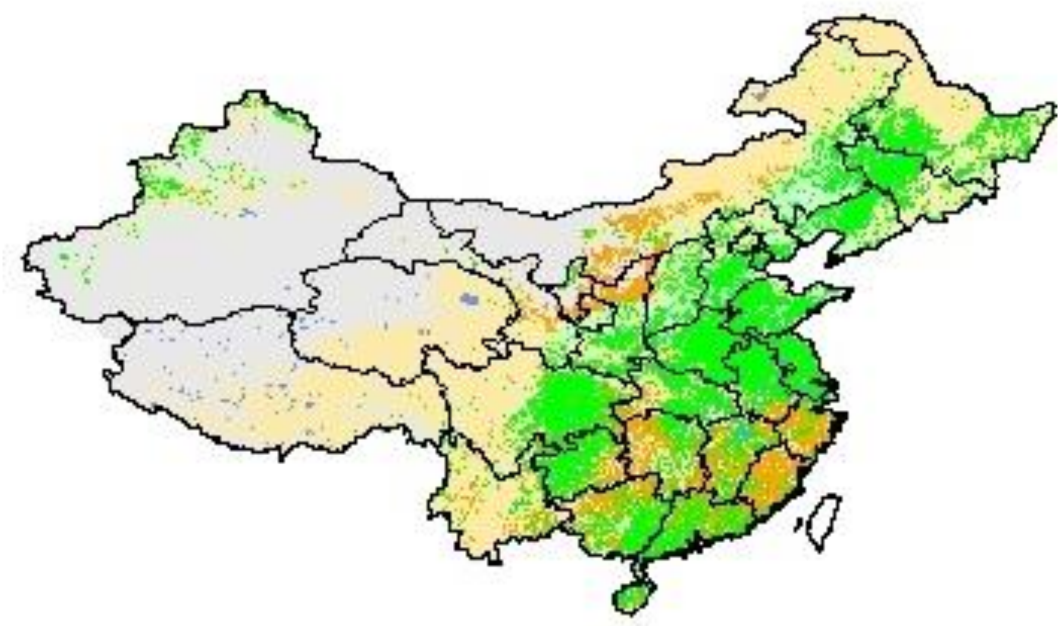
Data Source: The Ministry of Land and Resources of China.

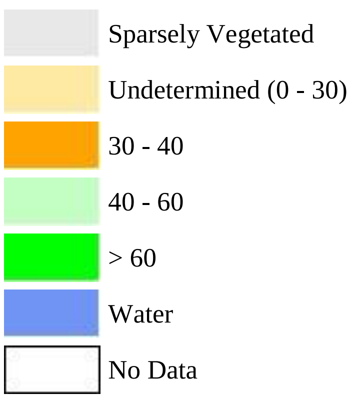
Figure 2.1 East, Central and West Divisions of China

East, Central and West Parts of China

Source: Food and Agriculture Organization of the United Nations (FAO). www.fao.org.

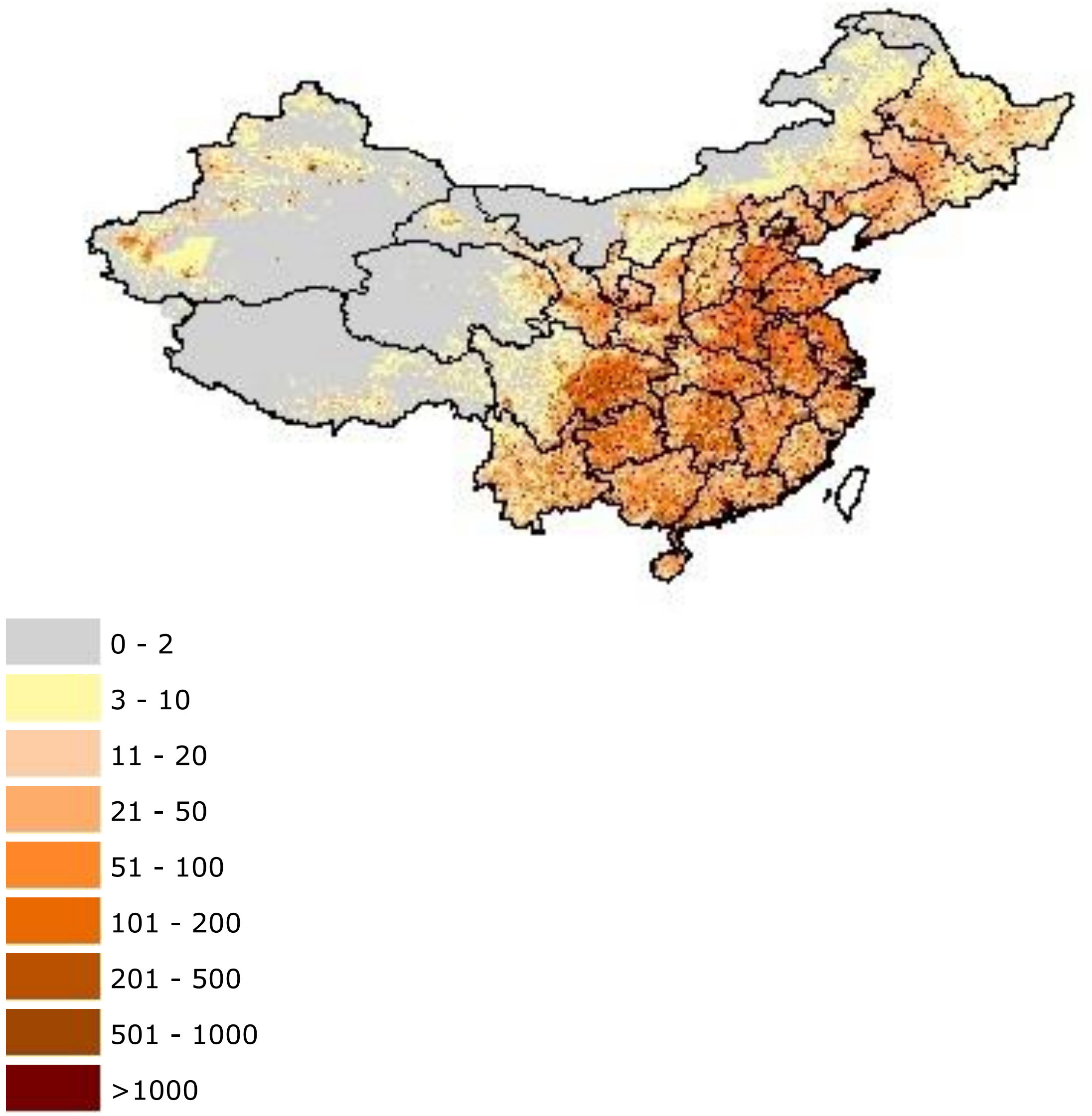
Figure 2.2 Percentage Intensity of Cultivated Land in China





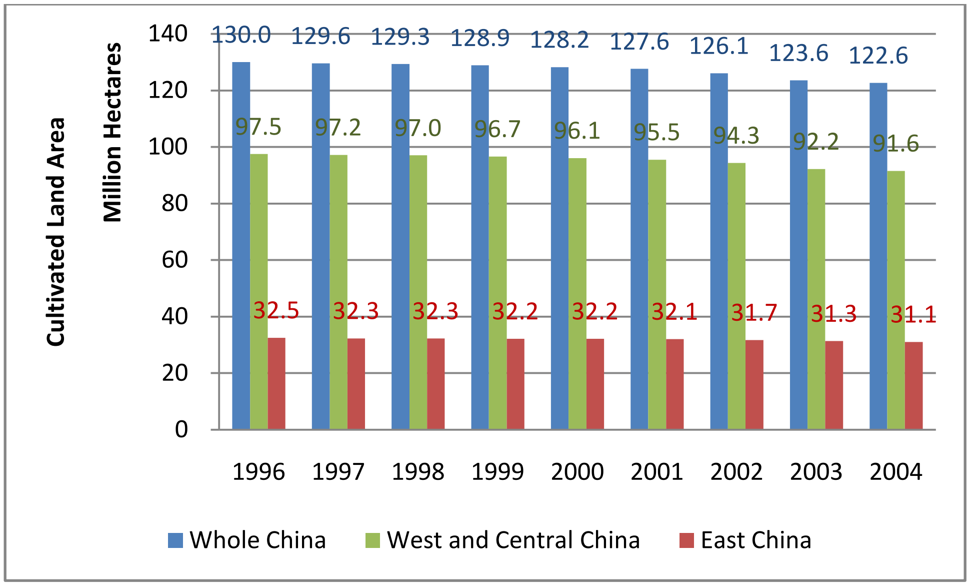
Source: Food and Agriculture Organization of the United Nations (FAO). www.fao.org.
Note: This figure from the FAO is originally titled as Permanent Crops & Arable Land (Percentage Intensity). By the FAO definition, permanent cropland and arable land together is equivalent to cultivated land.

Figure 2.3 Population Density in China (People per Square Kilometer)



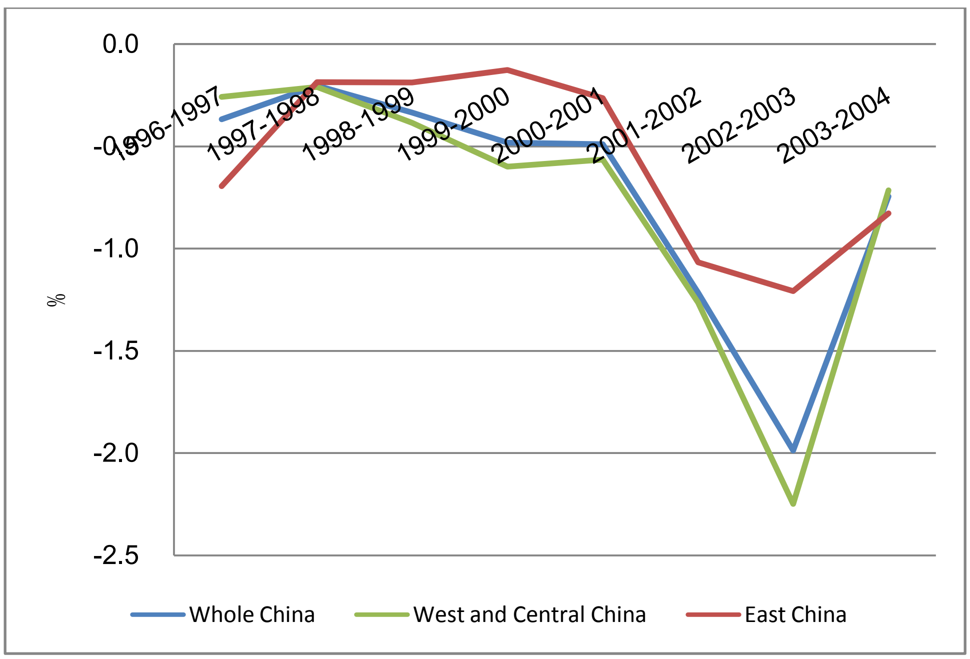
Source: Food and Agriculture Organization of the United Nations (FAO). www.fao.org.

Figure 2.4 Decline in Cultivated Land in China, 1996 – 2004



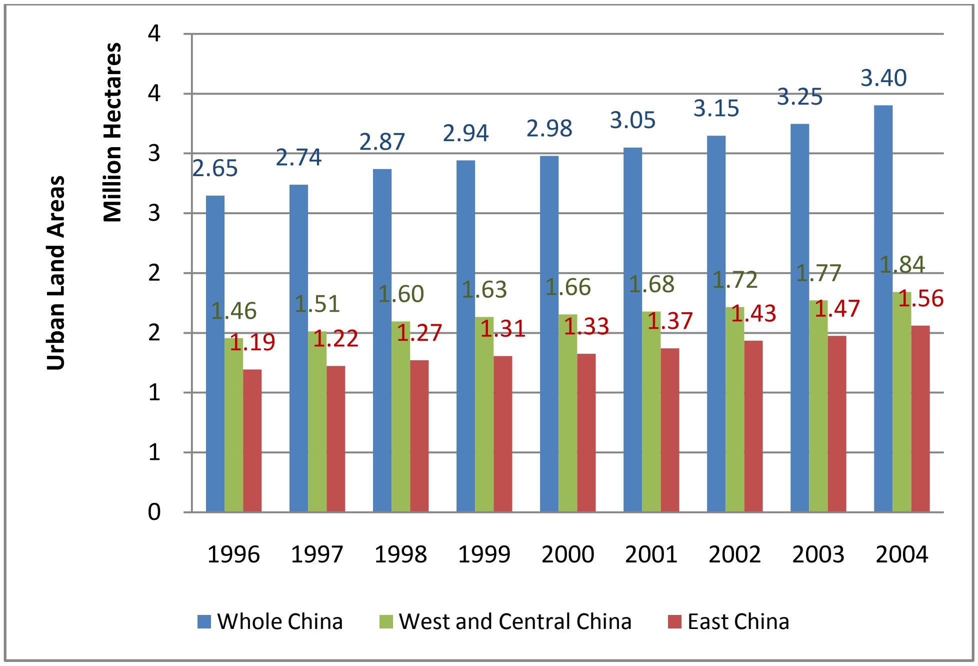
Data Source: The Ministry of Land and Resources of China.

Figure 2.5 Annual Percent Decrease in Cultivated Land, 1996 – 2004



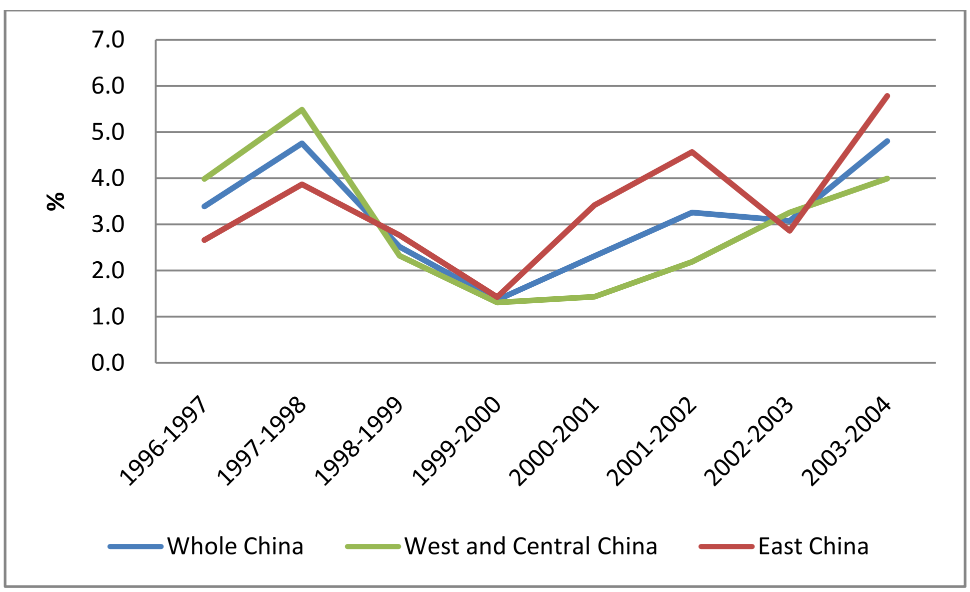
Data Source: The Ministry of Land and Resources of China.

Figure 2.6 Increase in Urban Land in China, 1996 – 2004



Data Source: The Ministry of Land and Resources of China.

Figure 2.7 Annual Percent Increase in Urban Land in China, 1996 – 2004



Data Source: The Ministry of Land and Resources of China.

3 Evolution of the Legal System Governing Land Use in China: Problems and Solutions

China's land use governing system is established to address specific problems and continues to evolve as new issues arise. China's Constitution states all land in China is public. While urban land is owned by the state, rural land is collectively owned by rural residents in a village. The first Land Administration Law (LAL) in China was created in 1986 to respond to the challenge of providing publicly-owned land to private users. It is the legal structure overseeing all land use. Since its inception in 1986, the LAL has been amended in 1988, and revised in 1998 and 2004 in order to better address problems and conflicts in land use and management, including setting regulations for rural land acquisition and conveyance. The LAL and its affiliated regulations, such as the Implementation Regulations of the Land Administration Law, the National Land Use Master Planning Guidelines for 1986 – 2000, 1996 – 2010, and 2006 – 2020,[6] and other regulations issued by the State Council or the MLR, specify the legal procedures of rural land acquisition. Table 3.1 lists the laws and regulations pertaining to this study in the chronological order.

The development of the urban land use right system and urban land market under the regulations of the LAL since 1986 has led to an increased demand for land for urban development. Such demand is typically met by converting rural land, which is a

[6] The National Land Use Master Planning Guidelines are made by the Ministry of Land and Resources of China.

government taking process, causing many of the problems outlined in the introduction chapter.

Section 3.1 is a brief discussion of the development of the urban land use rights and leasing in China, which motivates the discussion of rural land acquisition. Sections 3.2 – 3.5 investigate four major problems of rural land acquisition: food security, social unrest, illicit land acquisition practices, and the relationship between land speculation and unused construction land. These sections analyze the factors that contributed to these four conflicts, as well as government responses through new laws and regulations, such as the Dynamic Balance Policy.

3.1 Urban Land Use Right System

This section outlines the development of the urban land market in China, which motivates the discussion of rural land acquisition. In the early stage of the economic reform, China faced the paradox of supplying land to private development while still upholding the public ownership of land. Leasing land to private entities was only allowed under local rules in the Special Economic Zones (SEZ)—zones designated by China along its east coast in early 1980s to create a more conducive business environment in the economic reform.[7] Private land leasing nationwide was not legalized until 1986 with the enactment of the LAL.

In order to separate the use of land from the ownership of land, China adopted the Leasehold System created by Hong Kong in which the government sold the rights to use the land but not the land itself (Zhang and Pearlman 2004). Based on Hong Kong's

[7] The first four SEZs are Shenzhen, Zhuhai, and Shantou of Guangdong Province, and Xiamen of Fujian Province. They enjoyed more flexible and liberal economic and government measures than the rest of the country.

System the LAL of 1986 legitimized the granting of land use rights (LUR) to urban private land users and the transfer of LUR among them. The Provisional Regulations of the Grant and Transfer of the Use Rights of Urban Land (hereafter referred to as the Provisional Regulations) issued in 1990, coupled with the LAL, provided concrete procedures and national guidelines for the allocation and leasing of state-owned urban land.

According to the Provisional Regulations, the grant of the LUR by the state to public and private land users is executed in two ways. The grant of the LUR to public users is called the state allocation. It retains the characteristics of the plan system of the pre-reform China, in that the state assigns the LUR to state units and nonprofit organizations (such as public schools, military facilities, and temples) virtually free of charge and without a time limit. The grant of the LUR to urban private users is called public land leasing or conveyance. Public land leasing has significant market characteristics and, thus, is referred to as the market system, as opposed to the traditional plan system (Ho and Lin 2003; Ding and Knaap 2005).

In the public land leasing system, while land ownership remains public, private land users can purchase the use rights of urban land for a fixed time period—40 years for commercial uses, 50 years for industrial and educational uses, and 70 years for residential uses (State Council 1986, 1988, 1998, and 2004). In addition to the transaction fee which applies to both public and private land users, private land users also pay a substantial amount for the LUR. The payment for the LUR, also known as the conveyance fee, is determined by negotiation, bidding (*zhaobiao*), auction (*paimai*), or listing (*guapai*). Factors influencing the conveyance fee include location, land grade, intended use type, floor-area ratio, infrastructure cost, demolition cost, land acquisition cost, and urban land use taxes, similar to the factors in western land markets.

Negotiation was the preferred method for determining land users and conveyance fees for a long time until the passage of the Regulations on Bidding, Auction and Listing in Land Conveyance in 2003, which required that public land leasing be done only through bidding, auction, and listing (Lin and Ho 2005; Cai, Henderson, and Zhang 2009). The land market in the early stage of China's economic reform was very informal. Due to the lack of transparency and auditing system in China in general, it was no surprise that governments granted land use rights to their favored developers at a negotiated price.

Bidding, auction, and listing are more competitive and transparent methods than negotiation for deciding on the land users and conveyance fees and are designed to develop a competitive land market in China. The basic difference is that bidding is a one-time game while auction and listing are repeated games. More specifically, in bidding, local land bureaus invite public bids and select the bid best suitable for their community and development needs.

Auctions resemble English auctions in that bids are organized in an ascending order, and the highest bidder with a bid higher than the reservation price wins the auction. Land conveyances through English auctions are quite transparent and often videotaped with the press present (Cai, Henderson, and Zhang 2009).

By comparison, listing is an unusual kind of auction that involves two stages (Cai, Henderson, and Zhang 2009). In the first stage, bidding is open for ten working days. Bids are posted on the trading board of the land bureau and on the internet immediately after they are submitted (this is why it is called listing (*guapai*) in Chinese terms).

During these 10 working days, bidders can withdraw or resubmit their bids based on the posted bids. At the end of the first stage, if there is only one bidder left, this bidder gets the property at his/her bid price, as long as it is not lower than the reservation price. If there are more than one standing bidders, the auction enters the second stage which is a standard ascending English auction among the remaining bidders.

Apart from negotiation, auction and listing are the two prevailing methods for determining land users and conveyance fees in China at large, while only Beijing and Shanghai offer bidding (Cai, Henderson, and Zhang 2009). Cai, Henderson, and Zhang (2009) have also found if negotiation is not an option, local land bureaus tend to choose listing because it gives local officials more control over the preferred auction winners than English auctions and, thus, provide a platform for corruption.

The dual-track system of granting LUR, i.e., the coexistence of the traditional plan system with a new market system, forms the urban primary land market. In the urban primary land market, the state, represented by governments at the county level and above,[8] is the sole supplier of land for urban development. The increasing demand for land for urban development has been mainly met through rural land conversion, which is a government taking process in China. The next four sections investigate four major problems arising from rural land acquisition and government responses to them.

[8] County-level divisions are the third local administrative division. They include urban districts, counties, county-level cities, autonomous counties, *qi* (a name inherited from Mongolia), autonomous *qi*, forestry areas, and special districts at the county level in Guizhou province. Counties are the most common county-level divisions. County-level cities are similar to prefecture-level cities, covering both urban and rural areas. Urban districts are the urban areas of prefecture-level cities, consisting of built-up areas only. They do not exist in prefectures. All other county-level divisions are small in numbers, and they are all referred to as counties in this dissertation.

3.2 Concerns over Food Security and Policies of Cultivated Land Protection

Presented in Chapter 2, trends in China's cultivated land and urban land, as well as the transitions between them, indicate that urban land expansion in China has encroached upon a large amount of cultivated land. The continuous loss of cultivated land in the last two decades coupled with continuous population growth has given rise to the Chinese government's concerns about its ability to meet their goal of maintaining grain self-sufficiency. Such concerns were heightened when Lester R. Brown, a Washington DC based environmentalist, asserted in 1995 that China would soon need to rely on massive grain imports which could cause unprecedented rises in the world's food prices. Since then, China has identified cultivated land loss as the central threat to the nation's food security and made cultivated land protection a pressing issue.

The Dynamic Balance Policy (DBP) was initiated in 1998 to balance China's need to protect cultivated land with their need to reserve land for urban and industrial development. "Dynamic Balance" was a term first introduced in the Basic Farmland Protection Regulation in 1994. This Regulation defined basic farmland as cultivated land planted with food grains, cotton, oilseeds and vegetables, cultivated land with good irrigation, drainage, and erosion control systems, or with development potentials for these facilities, experimental fields for agricultural research and development, and other cultivated land determined by the State Council. It required county and township governments to designate basic farmland protection zones which contain two grades of cultivated land—high-quality with high productivity and good-quality with moderate productivity. By law, high-quality cultivated land can never be converted to nonagricultural use. Good-quality cultivated land can be converted to nonagricultural use upon approval and after the planned period which usually takes between five to ten years (Ding 2003; Lichtenberg and Ding 2008). If good-quality cultivated land is converted to nonagricultural uses, an equal amount of same quality land must be reclaimed to compensate the loss. Thus, the amount of good-quality cultivated land will always be balanced.

Though the concept was first introduced in 1994, the DBP was not written into law until the revision of the LAL in 1998 and, thus, it was not emphasized and enforced until 1998. The DBP, provisioned in the 1998 LAL, required each province to designate at least 80% of its cultivated land as the basic farmland, as specified in the 1994 Basic Farmland Protection Regulation, and maintain such levels. Although the DBP is stipulated to be implemented at the provincial level, in practice the exchange of new cultivated land for the converted cultivated land has been confined within counties and county-level cities by the Ministry of Land and Resources (Lichtenberg and Ding 2008).

Besides the dynamic balance requirement, the 1998 LAL tightened the approval procedures for rural land acquisition and reinforced the supervision of the central government in an effort to protect diminishing cultivated land. All construction projects that intend to use cultivated land must get project approval through provincial-level governments and land use approval through the central government. In addition, conversions of the following three types of land were required to have the approval directly from the central government: basic farmland, cultivated land not classified as basic farmland but exceeding 35 hectares, and any other types of land plots exceeding 70 hectares.

Although the 1998 LAL was written to take effect on January 1, 1999, local governments were allowed some time to create their own acts for implementation accommodating for local land use management, or revise their Land Administration Regulations based on the new LAL. Table 3.2 lists the effective dates of the implementing acts of the 1998 LAL of each provincial-level administrative division.[9] For provinces that do not have an implementing act for the national LAL, the effective dates of their revised Provincial Land Administration Regulations are listed.

The various effective dates of the 1998 LAL at the local level imply that the DBP was phased in gradually throughout the country. As shown in Table 3.2, 27 out of the 31 provincial-level divisions started implementing the new LAL within two years since January 1, 1999, and another three provinces started in 2001 and 2002. Only Qinghai province did not start until October 1, 2006.

The provincial implementing acts of the 1998 LAL and the Provincial Land Administration Regulations, revised after the 1998 LAL, commonly require cities and counties to maintain their basic farmland at a fixed level. If a land acquisition agent fails to reclaim the appropriate amount and type of land, they must pay a cultivated land reclamation fee which is determined by the provincial government. Governments at county level or above (usually the city and county governments) are required to use the cultivated land reclamation fees they collect to develop new land for cultivation so that the total amount of cultivated land in their administrative regions remain the same. If the city or county government is not able to reclaim land in their administrative regions due to the scarcity of arable land, they must request approval from a higher level

[9] The provincial-level administrative divisions in mainland China include twenty-one provinces, five autonomous regions, and four municipalities governed directly by the State Council.

government to reclaim land in another city or county. The quantity and quality of the reclaimed land must meet the standard set by the provincial land bureau and agricultural bureau.

Various studies conducted after Brown's have determined his prediction is unlikely to come to fruition for three main reasons. First, part of the cultivated land loss in China can be explained by the structural adjustment within the agricultural sector (Lichtenberg and Ding 2008). As indicated by the MLR data, a considerable amount of cultivated land is converted to orchards, grazing grassland, and fish ponds which should not be counted as a loss in agricultural productivity (see Chapter 2). Second, technology advancement and agricultural industrialization has improved the productivity of land and other inputs in agricultural production (Deng et al. 2006; Lichtenberg and Ding 2008). Third, because the average income has risen, Chinese people are consuming more fruits, aquatic products, oils, eggs, dairy products, meat, and poultry, and less staple cereals (Heilig 1997).

Nevertheless, a combination of factors, namely meager arable land resources, a large population base, ongoing urbanization, and the national policy calling for 95% of grain self-sufficiency, contribute to China's unwavering determination to maintain certain levels of cultivated land. The Chinese population is projected to reach 1.36 billion by 2010 and 1.45 billion by 2020. Simultaneously, the urbanization rate is projected to reach 58% by 2020. Therefore, tensions between population growth and land scarcity will not ease in the future. Since concerns linger, cultivated land preservation remains a top priority in the National Land Use Master Planning Guidelines for 2006 – 2020, disseminated on October 23, 2008. The Guidelines stipulate that to ensure grain self-sufficiency, the nation's cultivated land be maintained at 121 million hectares by 2010 and 120 million hectares by 2020 (State Council 2008).

3.3 Social Unrest and Policies of Rural Land Rights and Compensation

The loss of cultivated land concerns the Chinese government not only because of food security, but also because of social stability. Conflicts from compulsory land acquisition and unsatisfactory compensation have sparked protests and sometimes violent clashes. According to official statistics from the complaint reception bureau of the National People's Congress Standing Committee, 2,938 letters complaining of government compulsory land acquisitions and unsatisfactory compensation were received in 2003 and 5,407 such complaint letters were received in 2004 (Asia Pulse, October 27, 2005). Besides writing complaint letters, some farmers have sued, held demonstrations, or squatted on the disputed land. BBC News described this situation as "a wave of protests sweeping the mainland." The government admitted there were 74,000 "mass incidents" related to land issues in 2004, up from just 10,000 a decade ago (Sunday Morning Post 2005). Overall, about 65% of the mass incidents in rural areas nationwide are triggered by land disputes (China Daily 2010b).

In some dramatic cases, disputes over land acquisition and compensation can take deadly forms and lead to violent riots and the death of ordinary villagers. Many of such deadly incidents are not disclosed in public and it is difficult to estimate the total injuries and deaths of farmers caused by land disputes. In one reported incident, ten to twenty villagers in the southern province, Guangdong, were killed by security force gunfire as part of a conflict over land acquisition (Washington Post 2005). In a more recent incident, four farmers were arrested in Guangdong when taking their grievances about land seizures to government officials. A peaceful protest calling for their release turned violent and at least one villager was severely injured (Washington Post 2009).

Grassroots protests and turmoil triggered by rural land acquisition pose a danger to the social stability of China. As its economy growing into one of the largest in the world, China is gravely concerned with its social stability and its image in the world.

This section explores the following five main causes for the tension between government and farmers in land acquisition: (1) compulsory land acquisition, (2) inadequate land compensation, (3) unfair distribution of land compensation, (4) wide variations in the land compensation determined by arbitrary compensation schemes, and (5) the misuse of land compensation retained by village collectives.

3.3.1 Compulsory Land Acquisition

Prior to the passage of the first Property Rights Law in 2007, farmers' ownership rights over the land they cultivated are deemed as contractual rights, and thus very week in nature. The periodical reallocation of land within the village and the government compulsory acquisition of land for development purposes are just two examples of how weak the rights farmers had over their land (Ho 2001; Ding 2003; Zhang and Pearlman 2004; Lin and Ho 2005; Clarke, Murrell, and Whiting 2008).

The contractual system of China's rural land use right was introduced in the rural reform incepted in 1979. First, rural land in China was, and still is, collectively owned by rural residents in a village. Chinese farmers in a village used to produce as a group and split the profit. Once China realized private land would yield higher productivity, they started the rural land reform in 1979 (Zhang and Pearlman 2004). Similar to the urban land reform, the rural land reform tried to privatize the land use right while keeping the collective nature of its ownership.

An important regulation in the rural land reform was the Household Responsibility System (HRS), implemented in the early 1980s. In the HRS, village collectives were in charge of the land allocation among rural households based on the demographic characteristics of the households, such as the number of household members and the number of adult male labors. Then, land was leased to individual households for farming. Originally, farmers were required to pay a land contract fee but that requirement was lifted in 2001. To encourage farmers to maintain soil quality and improve land productivity, the HRS required the lease not to be less than 15 years, and it was renewable and tradable among villagers as long as the land was used for agricultural production. In practice, however, land was reallocated among villagers by village leaders fairly frequently and very few transfers of rural land use rights had occurred (Ho 2001; Ding 2003; Zhang and Pearlman 2004; Lin and Ho 2005; Clarke, Murrell, and Whiting 2008).

To improve tenure security and to further promote incentives for farmers to maintain the land quality and productivity, the revision of the LAL in 1998 extended the lease of rural land to 30 years. And in 2002, the Rural Land Contracting Law (RLCL) was passed to emphasize the legal protection of contracting farmers. The 1998 LAL and the RLCL made major progress in prohibiting the arbitrary adjustment in the land allocation in a village. They required that any adjustment in the land allocation in a village be made with the consent of at least two-thirds of the village member's assembly. In addition, each adjustment must be approved by the township government or above.

The LAL and RLCL allow farmers to transfer their land use rights for agricultural uses, but prohibit them from selling their land use rights to private developers for urban construction purposes, or using their land use rights as collaterals. If certain land lots are designated for development, the transaction of land from farmers to developers must go through local governments, involving village collectives, township, county, and higher governments. This transaction is referred to as government land acquisition. Government land acquisition transfers the rural land ownership from village collectives to the state. Once rural land becomes state-owned, government is responsible for providing basic infrastructures, such as roads, electricity, and pipe water. Then its use right can be placed on the urban primary land market for public land allocation or leasing (Tan et al. 2009).

Despite all of the legal efforts to protect farmers' land rights, in practice, arbitrary readjustment of land allocation within a village and compulsory land acquisition without farmers' participation in the decision-making process still have their frequent occurrence (Li and Xu 2004; Su and Shen 2008; Ma 2009). Moreover, research has found knowledge of farmers about their rights underscored by the LAL and the RLCL is rather limited. There is also no easy process by which farmers could bring violations to light or challenge the actions of village collectives and land acquisition agencies (Development Research Center of the State Council of China and World Bank 2005).

In their field research, Li and Xu (2004) found farmers were not consulted at all during the decision-making process of land acquisition. Decisions were made one-sidedly by governments at various levels involved in the acquisition, including village leaders. Farmers were simply notified when their land would be acquired, for what purpose, and how much compensation they would receive. And many times, such notices to farmers were orally delivered by village leaders without any official documents. Among 17 villages surveyed by Li and Xu (2004), only two had official government notices posted in the offices of the village committees.

In most cases, farmers have no choice but to comply, surrender their land, and accept the compensation offered. Some farmers take actions to dispute the government acquisition of their land, however, evidence shows such disputes will not delay the land acquisition projects, regardless of how the dissension is resolved ultimately (Tan et al. 2009).

As noted by Ding and Knaap 2005, Ding 2007, and Tan et al. 2009, communist China is not the only country where the government is able to seize land. Eminent domain in western countries allows governments to acquire private land as long as the acquisition serves public interests. While different countries may execute different levels of eminent domain powers, China's land acquisition is the easiest, least time-consuming, and least costly because collectively-owned rural land is essentially already public.

3.3.2 Inadequate Land Compensation

Conflicts between farmers and governments in land acquisition are not necessarily caused by the compulsory nature of the acquisition process. When individual farmers have no choice but to give up their land, they are most concerned about the level of compensation. The LAL requires that government and/or potential land users of the acquired land compensate farmers affected by land acquisition. However, the amount of compensation is set artificially low by law.

Unlike in the western market system where land owners are compensated according to the market value of their land, the driving principle behind the land compensation in China is to not leave farmers worse-off than before. According to this principle, the amounts of the land compensation and resettlement subsidies are based on the output value of the acquired cultivated land in the past three years, but not the current value of the land in the urban land market or the discounted future value of the land (Zou 2009).

The 1988 LAL specified three components of the compensation package: compensation for the land, resettlement subsidies for the displaced farmers, and compensation for the loss of unharvested crops and land attachments. The 1988 LAL required that the land compensation be between three and six times, and resettlement subsidies be two to three times, the land's average annual output value over the past three years. Additionally, the 1988 LAL required that resettlement subsidies not exceed ten times, and the total of land compensation and resettlement subsidies not exceed twenty times, the average annual output value of the land in the past three years.

The 1998 LAL reinforced the 1988 LAL requirement for compensation in rural land acquisition and raised corresponding multipliers for land compensation to six to ten times the land's average annual output value over the past three years with a maximum of fifteen times the value, and resettlement subsidies to four to six times the same value with a maximum of thirty times the value.

The formulas specified by the LAL result in far lower compensation than what farmers would get if they were allowed to sell their land to private developers freely, especially when taking into account the potential benefits from urbanization (Ding 2007). Statistics from the Unirule Institute of Economics (UIE 2007), a non-governmental think tank in Beijing, shed some light on the difference between the land compensation and resettlement subsidies paid to the farmers and the value of their land on the urban land market. In practice, land compensation ranges from RMB 75,000 to 120,000 per hectares for public transportation projects, and from RMB 300,000 to 450,000 per hectare for industrial and commercial development projects. By contrast, the price of public land leasing in the urban areas is normally 7 to 10 times the compensation paid to the farmers. In the Yangtze River Delta, for example, the price of public land leasing ranges from RMB 2,100,000 to 5,250,000 per hectare. Examples of the land compensation and conveyance fees given by Ding and Lichtenberg (2011) indicate conveyance fees can be 10 to 20 times the compensation paid to farmers in some specific land acquisition projects.

Perhaps, what worries the farmers the most is their long-term livelihood after losing their land. Given Chinese farmers on average own 0.07 hectares of land per person, based on the above compensation scheme, they will each receive RMB 5,000 – 9,000 (about US$640 – 1,154)[10] in land acquisition due to public transportation projects, and RMB 20,000 – 30,000 (about US$2,564 – 3,846) in land acquisition due to industrial and commercial development projects (UIE 2007). Such small lump-sum compensation does not provide farmers with the equivalent lifetime security that land does. Without

[10] Calculated as 1US$ = 7.8 RMB.

skills for investment, lump-sum compensation will be exhausted several years after the land acquisition. Besides, without cultivating products themselves, farmers will have to spend more money on food, resulting in a higher living cost than before.

Because monetary compensation alone cannot provide a new, sustainable lifestyle for landless farmers, non-monetary compensation, such as job training and job opportunities in the village and township owned enterprises, is included in many land compensation packages. Due to the socialist nature of many policies in China's early years of economic reform, the 1988 LAL made it mandatory for local governments to assign jobs to farmers in land acquisition. With the marketization of the economy in every respect, including the job market, governments were no longer required to arrange employment for farmers involved in land acquisition. The 1998 LAL only suggested local governments develop local job opportunities for urbanized farmers. As allowed by law, a portion of the land compensation and resettlement subsidies could be used to develop village and township enterprises and/or to subsidize the businesses on the acquired land to hire local farmers—but in either case, a job was not guaranteed.

The weak language and lack of requirements of the 1998 LAL has left millions of farmers without land and without jobs. The survey of 58 villages conducted by the Rural Research Center of the Ministry of Agriculture between 1999 and 2000 found that approximately 34% of the urbanized farmers were jobless, and many of them had difficulty adapting to their new life after their villages were urbanized (Ma 2009). Statistics also show after 30 years of economic reform and opening up, more than 50 million farmers have lost their land and nearly half of them have no jobs or social insurance (China Daily 2010b).

It is important to realize even if farmers are guaranteed a job by their compensation packages, they may still face a serious risk of losing the job. The Rural Survey Team of Zhejiang Province found in their 2003 survey most companies were reluctant to hire farmers who lacked qualifications required by profit-seeking firms. A case study of the employment and social security situation of farmers after land acquisition in Beijing's Fengtai District found farmers were more likely to be laid off due to their inadequate education and skills than their urban counterparts when the business was not doing well (Tang and Zhang 2004).

Facing limited job opportunities in their new "urbanized" villages, many farmers, especially the younger ones, choose to leave their villages and search for jobs in big and mega cities such as Beijing, Shanghai, and Guangzhou. Rural migrant workers in China earn a lower salary than their urban counterparts and are generally discriminated and denied many public services, such as public schools for their children, job training, and urban social security programs (Guo 2001; Henderson 2009).

To address these problems, the State Council issued the Resolution to Deepen Reform and Tighten Land Management in October 2004 (hereafter referred to as the 2004 Resolution). It is important to note the 2004 Resolution was disseminated after the LAL had been revised in August 2004. The 2004 LAL did not make particular changes in the compensation requirement specified in its 1998 version, whereas the 2004 Resolution further stressed the requirement for proper compensation and resettlement for farmers in land acquisition, and called for special provisions to ensure long-term solvency. The 2004 Resolution required local governments to develop a job market for farmers and assist them in finding employment after the land acquisition. This requirement was an improvement upon the compensation scheme specified in the LAL, since both the 1998 and 2004 versions of the LAL only suggested, but not required, local governments to facilitate farmers' job searches after land acquisition. The 2004 Resolution made the provision of job training and job opportunities to farmers affected by land acquisition a mandatory requirement. In addition, it required the provision of social security to farmers affected by land acquisition. Despite these requirements, the 2004 Resolution did not spell out the details on how to develop a job market for landless farmers or how to finance their social security. It asked the labor department and the social security department to search for solutions (Zou 2009).

In response, the Ministry of Labor and the Ministry of Social Security proposed the Ideas for Vocational Training and Social Security Provision for Farmers Affected by Land Acquisition in 2006 (hereafter referred to as the 2006 Ideas). The 2006 Ideas asserted farmers whose land had been incorporated into urban areas should be granted the urban resident's status, and consequently have the right to enjoy the urban social security system. For farmers who had lost the land but still resided in rural areas, local governments were required to provide necessary social security programs, such as minimum living standard assurance (*dibao*), health insurance, unemployment insurance, and pensions. Such provisions should be funded by land compensation and resettlement subsidies, but if this funding fell short, additional money should be taken from local revenues collected from state-owned land use fees. The 2006 Ideas also called for vocational training for landless farmers financed by local revenues.

Both the 2004 Resolution and the 2006 Ideas required establishing the social security system for farmers. Such requirement became a legal sanction and was integrated in the

Property Rights Law of China in 2007. The 2007 Property Rights Law required that long-term life security for farmers be included in land compensation packages, in addition to the compensation required by the LAL.

Despite the increased effort to protect and improve the well-being of farmers involved in land acquisitions, none of these national laws and regulations has outlined how to establish such a social security system. In fact, the implementation at local levels may oppose the intention of the law, altogether. Scholars are concerned that with the new requirement to provide farmers with life-long security after land acquisition, there will be more delayed payments of land compensation fees to farmers because local governments will now be inclined to retain a larger portion of the land compensation and resettlement subsidies to distribute over a longer period of time (Zou 2009). Without a transparent auditing system, farmers will be displeased by public officials managing their money.

In addition, many of the rural social security programs are not based on voluntary participation. Instead, farmers are required to enroll in such programs in order to receive the compensation they deserve. Some farmers simply prefer to receive the full compensation in the current value over making monthly payments to their retirement funds, for example, and waiting to receive their pensions after certain age (Cao, Feng and Tao 2008).

3.3.3 Unfair Distribution of Land Compensation

Besides the inappropriate compensation formulas, the hierarchical distribution of the compensation is another cause for the low compensation. Land compensation starts at the highest level of involved government and trickles down, through the other levels of involved governments, to eventually reach the deserving farmers. Since individual farmers are at the bottom of this hierarchical order, the share left to them is often unacceptably low, even if the original amount provided by the land acquisition agencies satisfies the LAL requirements (Ding and Knaap 2005).

In his dissertation on China's land conversion process, Ma (2009) conducted a field study in a representative county in China, the Dragon County (a fictitious name). By interviewing local officials and farmers, Ma (2009) obtained first-hand information on the problems associated with cultivated land conversion, such as unsatisfactory land compensation as well as illegal land conversion and development projects. One example in Ma (2009) illustrates how compensation could be expropriated during the delivery from the upper level government to individual farmers. In a county-level public road project, compensation was determined by the county government and then delivered to farmers via township and village governments. Each level of the government would take slice of the pie before passing the remaining fee onto the next government or, eventually, the farmer. A local official interviewed by Ma (2009) said:

> When the Coastal Road was under construction, the county government paid 18,000 *RMB*/*mu* (*as compensation for land*) to the affected villages. It was a uniform standard set by the county government, but some townships took a share of it. For example, one township gave only 15,000 *RMB*/*mu* to its villages. Some township governments delayed paying the villages, and some even used up all the compensation themselves for proclaimed financial difficulty.

Implied in Ma's (2009) interview, the insufficiency of land compensation also appears in the form of delayed compensation as village collectives often do not pay farmers in full, upfront. Instead, the money is doled out in monthly or yearly installments; in some cases, farmers never receive the full compensation they deserve. The general lack of transparency and public participation in China makes farmers very vulnerable to this type of financial arrangement (Shen 2007). In some cases, the intended users of the acquired land are responsible for providing the land compensation, but they do not have the cash available. Instead, as negotiated through local governments and village heads, the new land users opt for giving farmers the initial public offerings of their new enterprises occupying the converted land. For farmers with very little knowledge of financial market and financial instruments, this form of compensation means nothing and many of them refuse the offer. When farmers have no choice but to accept such an arrangement, they live off the dividends of the stocks which often are not sufficient for living (Sina News 2009).

3.3.4 Wide Variations in Land Compensation

In addition to insufficient amount and unfair distribution of land compensation, a third source of farmers' dissatisfaction with land compensation is its wide variations within the same locality. Compensation levels can vary from project to project and, even in some cases, from household to household within the same project. Although the LAL specifies a national standard for land compensation, the amount of compensation, in practice, often depends on the location and potential developers (Ding 2007). All things being equal, compensation for private projects, such as commercial housing and office buildings, is typically much higher than for public infrastructure projects, such as highways and airports, as revealed by the UIE (2007) statistics. Likewise, compensation in villages closer to cities is usually higher than in the remote villages. The perception of such inequities cause tension and distrust between villagers and the government.

3.3.5 Misuse of Land Compensation by Village Collectives

Other than the dissatisfaction of farmers with the amount, distribution, and fairness of land compensation, conflicts between farmers and government can also arise from how village collectives spend the retained portion of the compensation. Village collectives are the economic units in rural areas and own the rural land collectively with individual farmers. Therefore, both village collectives and farmers are entitled to the compensation.

According to the LAL, compensation for unharvested crops and land attachments must be given to farmers, upfront, while land compensation and resettlement subsidies can be retained partially or fully by village collectives. The LAL requires that any retained compensation be used for financing projects serving public interests, such as building irrigation infrastructures, and resettling and training unemployed farmers. Such fund should not be kept as personal wealth. However, the retained portion of compensation is often misused and becomes a source of corruption due to the lack of appropriate accounting and auditing systems (Ding and Knaap 2005).

3.4 Legal Procedures of Rural Land Acquisition and Illegal Practice

This section first reviews the legal procedures of rural land acquisition specified by the 1986 LAL and reformed by the 1998 LAL, and then explores the unapproved and illegal land conversion in detail.

The 1986 LAL (amended in 1988) granted local governments at the county level and above the authority to acquire rural land. Local governments were required to establish specific procedures for implementing the national law and each level of government was required to obey the regulations set by the government of one level higher. The 1986 LAL required that local governments create an overall land use plan based on the National Land Use Master Planning Guidelines created by the MLR, and decisions on rural land acquisition and urban land development conform to this overall land use plan. Any proposed rural land acquisition is required to be approved by local government at a higher level than the government that intends to acquire land, and the amount of land authorized for conversion is required to be within the annual quota set in the local overall land use plan.

With the promulgation of the first LAL in 1986, newly founded land management bureaus at different levels of government were required to make an overall land use plan in their localities. The goals of making an overall land use plan were to coordinate the land use among different economic sectors, therefore, increase land use efficiency and preserve cultivated land. In 1993, the State Council published the National Land Use Master Planning Guidelines (hereafter referred to as the National Guidelines) 1986 –

2000. By the end of 1996, most of the provincial-level governments completed writing the overall land use plans for their provinces. However, the National Guidelines 1986 – 2000 did not establish procedures for the creation and implementation of the master plan at local levels, nor did it clarify which agencies should be involved. As a result, neither the National Guidelines nor the local overall land use plans were ever followed (Cai 2004).

The 1988 LAL failed to induce disciplined land use and proved unsuccessful with respect to farmland protection and urban land use efficiency (Valletta 2005). The inefficacy of the 1988 LAL coupled with the accelerated cultivated land loss urged China to revise the law. In 1997, the State Council issued a Notice on Further Enforcing Land Management and Protecting Cultivated Land, also known as the No. 11 Document. The No. 11 Document called for investigations into all construction since 1991 to determine how much cultivated land was converted to new construction, and how well the land had been used. The No. 11 Document's findings directly led to the substantial revision of the LAL in 1998, specifically in regard to cultivated land preservation (Tang 2008).

Learning from the failures of the 1988 version, the 1998 LAL included principles and procedures for local governments to create and implement overall land use plans. All land quotas in these local master plans are required to conform to the quotas in the National Guidelines and they still must follow a hierarchical system in which local governments are required to submit their overall land use plans to a higher level government for approval. Local land use plans must stay within the overall land use plan quotas of the government above them and the amount of cultivated land cannot dip below the quota of the higher government.

The 1998 LAL also introduced the zoning concept which required the overall land use plans at the county and township levels to designate zones for each land use purpose. Local governments are required to utilize existing construction land for redevelopment, limit unnecessary conversion of cultivated land, and control the total amount of construction land within the quota. The 1998 LAL stressed the importance of land use master plans and set the basis for the assembly of the National Guidelines 1996 – 2010.

The legal procedures of rural land acquisition specified by the LAL are arguably difficult to enforce in practice. For example, the revision of the LAL in 1998 requires the acquisition of basic farmland, other farmland exceeding 35 hectares, and any land exceeding 70 hectares to be approved by the central government agencies. However, the central government approval procedures are reportedly lengthy and rigid, and cause local officials to bypass them by all means (China Economics Weekly 2004; Ma 2009). A common trick they play is dividing large land use projects into several small ones for easier and faster approval since the acquisition of farmland of 35 hectares or fewer can be approved by provincial governments (Xinhua News Agency 2006; Ma 2009).

Moreover, the planning tools based on the LAL and the National Guidelines have not proved to be very realistic. Examining the land use laws and policies in China, one can easily conclude the quota system is government's main vehicle for constraining accelerated cultivated land conversion. Specifically, central and local level land use master plans must specified a minimum amount of cultivated land and a maximum amount of construction land in their corresponding regions in each planning horizon. The annual conversion of cultivated land to urban construction uses is required to be within the quotas defined in the local land use master plans as well as in the National

Guidelines. The DBP, in nature, is also a stipulated quota. Since quotas are usually made 10 to 15 years ahead of time, it is unrealistic to expect them to remain relevant and achievable for long periods of time due to the changes in economic environments, especially for a fast growing country such as China. For example, more than 20 provinces reached the 2010 quota for minimum amount of cultivated land allowed by 2002 (Cai 2004).

Unapproved and illegal land transactions were prevalent in China's land development. Reported by the Ministry of Land and Resources (MLR), 70% of the 6,866 so-called high-tech and industrial development zones across the country were built on illegally acquired land and abandoned altogether by 2004 (China Daily 2004). Between 1999 and 2008, nearly1.4 million unapproved and illegal land use cases have been uncovered by MLR land inspections, involving more than 569,972 hectares of land, of which 259,148 hectares are cultivated land (MLR 2000 – 2009).

Ironically, one of the motivations for illegal land development has been the correction measures in land use management. As land developers and local officials anticipate changes in laws would make land acquisition and conveyance more difficult, they would engage in land transactions more actively right before the new law or regulation. For example, the number of illegal land use cases surged about six months before the effective date of the Regulations on Bidding, Auction and Listing in Land Conveyance. Once the Regulations became effective on July 1, 2003, the conveyance of land for profit-seeking construction projects had to be carried out through bidding, auction, and listing, instead of negotiation (The 21st Century Economic Report 2003b).

The prevalence of unplanned, unapproved, and illegal land use activities is indicative of the difficulties the central government has in overseeing local land activities. Besides passing laws and decrees, the central government generally lacks a functioning supervision system for local compliance. The most common supervision instrument is periodic inspections which are effective in the short-term, but do not induce constant, long-term compliance of the law (China Economics Weekly 2004).

In the most recent land inspection campaign carried out between September 15, 2007 and January 15, 2008 (a.k.a. the 100-day land inspection campaign), the MLR identified three common violations of land use laws. First, farmland is provided to non-agricultural land users through rental contracts instead of going through the acquisition approval procedure and, therefore, avoiding conveyance fees. Most rental contracts are signed by townships, villages, and individual farmers. Among 32,000 illegal land use cases uncovered during the 100-day campaign, 19,000 cases are in this form of violation, involving 25,000 hectares of land. The second type of common violation is industrial land expansion that does not conform to the national master planning guidelines. Although only 420 such cases out of 32,000, they take over 58,000 hectares of land. A third type of common violation is to begin the land acquisition and resettlement process long before the proposed project is approved. This violation was found in nearly 12,000 cases, involving 151,000 hectares of land (MLR 2008).[11]

[11] It is not clear over what time period these illegal land use cases have occurred.

3.5 Land Speculation and Idle Construction Land

Many aforementioned illegal and unapproved land development projects are motivated by speculative land conversion and development. Because of the nature of speculation, the land acquisition procedures specified by the LAL are not likely to be followed. This section investigates a particular type of land use inefficiency in China—idle construction land— caused by such speculative behaviors.

Land conversion and sales for speculation purposes normally take place before development funds are fully established, which leaves a tremendous amount of land idle or underdeveloped. Because it is quick and easy for land speculators to acquire land in the rural areas, much of this idle land was cultivated land before it became idle (Cai 2003, Ho and Lin 2004a; Su 2005). Speculative land conversion and conveyance reached three climaxes between 1987 and 2003, commonly referred to as three "Land Enclosure Movements." The salient feature of Land Enclosure Movements is that land is acquired by local governments for anticipated development opportunities, but not for immediate use.

The first Land Enclosure Movement started in 1987, just after the first Land Administration Law was enacted in 1986. The law gave legal sanction to the granting and subsequent transfer of long-term leases of publicly owned land. Some developers sensed the profitability of land transactions brought by the new law and started enclosing land.

Since development zones were exempt from many political and economic regulations and could be managed with preferential land use policies, they grew rapidly during 1992 and 1993, serving as the peak of the first Land Enclosure Movement. Many local governments set aside large parcels of previously cultivated land as industrial development zones or parks to attract capital investment from foreign investors. According to the Ministry of Construction's statistics, there were over 6,000 development zones at and above the county level by March 1993, spanning 1.5 million hectares—bigger than the total urban areas in Chinese cities and towns at the time (1.34 million hectares) (China Economics Weekly 2004).

Unfortunately, many of these development zones remained idle because the anticipated investment was never realized. By 1996, 116,000 hectares of land in designated economic development zones remained undeveloped, over half of which was previously farmland that could not be converted back (Cai 2003, Ho and Lin 2004a; Su 2005). In some cases, the size of the idle industrial land exceeds the size of adjacent villages (The United State Embassy 2007).

The second Land Enclosure Movement was spurred by the real estate boom in the early 2000s. Employment in Chinese cities previously came bundled with housing, but in 1998, employer allocated housing was terminated. As a result, residential housing became a profitable commodity on the market and residential development became a large user of land.

The boom of the real estate market presents developers with another profitable opportunity besides selling housing units. Because industrial development land is exempt from many taxes and fees, some developers use their connections with local officials to obtain land classified as industrial development land at reduced rates. They then wait for opportunities to create more profitable housing projects or sell the land use right to real-estate developers. While developers wait for such opportunities, the land remains idle (Cai 2009).

The third Land Enclosure Movement started in 2002, sparked by another wave of building development zones. The MLR found 70% of the 6,866 so-called high-tech and industrial development zones across the country had not been developed in 2004 (China Daily 2004). After three Land Enclosure Movements, over 1.73 million hectares of designated construction land became idle (China Economics Weekly 2004). More than 13 million hectares of land in the planned development zones were ordered to be returned to agricultural use, accounting for almost 65% of the total land planned for these development zones (Lin 2007).

Government attempts to eliminate idle construction land dates back to April 26, 1999, when the MLR issued the Methods of Dealing with Idle Construction Land (hereafter referred to as the Methods). The Methods require local governments to impose fees on construction land left idle for one year; such fees are to not exceed 20% of the conveyance fee. If land sits idle for more than two years, the government reserves the right to reclaim the land back and return it to its original use (The State Council 1999). According to Cai (2009), the supremacy of this regulation is under the LAL and the Constitution which presents big problems for implementation at local levels. If the land allocation or conveyance contract, which is protected by the LAL and the Constitution, does not specify the deadline for any deferred development of the land, local governments are not empowered to take the land back from developers. In many cases, since developers have used their connections with local officials to obtain the land, the same connections will prevent their land from being revoked. In practice, this regulation is strictly enforced at local levels when inspections are carried out by central government agencies, but as soon as the central government loosens the supervision strength, the regulation is completely ignored. Thus far, the two-year limit of idle development land has not been firmly enforced nationwide (Cai 2009).

As mentioned earlier, unapproved and illegal land transactions were prevalent in the three Land Enclosure Movements. Local officials have been widely blamed for colluding with land developers and taking advantage of the loopholes in laws. Once caught, they are severely punished via fines, confiscation and/or demolition of the buildings on the illegally developed land, returning land to its original uses, administrative penalties, and/or criminal charges.

According to the MLR news release on their 100-day land inspection campaign, 3,857 local officials were turned in to the central government investigation agencies and 2,864 of them received administrative penalties. An additional 2,797 officials were sent to criminal courts, 535 of them receiving criminal charges. The central government agencies collected a total of US$500 million worth of fines and confiscated and/or demolished over 26 million square meters of illegally built buildings (Ministry of Land and Resources 2008).

While land grabbing officials face administrative penalties, land developers normally pay fines and incur the cost of demolishing the buildings and returning land to its original use. For example, in 2003, a chemistry equipment manufacturing company acquired some basic farmland illegally in Shanghai. The punishment, finalized in 2007, included a fine of nearly $40,000 per hectare, removal of the already-completed construction on the land, and returning the land to cultivation (Shanghai Baoshan Planning and Land Management Bureau 2008).

With the threat of such harsh punishments, why would local officials risk jeopardizing their political careers and collude with land developers engaging in illegal land uses? The next chapter analyzes the motivation of local government for cultivated land conversion which will explain the incentives for illegal land behaviors.

Table 3.1 Development of China's Land Use Laws and Policies, 1978–2008

<table>
<tr><th>Date/Period</th><th>Event</th><th>Descriptions and/or Comments</th></tr>
<tr><td>1978</td><td>Adoption of the Household Responsibility System</td><td>-Abandoned village collective production team
-Leased the rural land for agricultural production to farming households for a 15-year term</td></tr>
<tr><td>1986</td><td>Land Administration Law</td><td rowspan="2">-The first Land Administration Law in China legalizing the grant and transfer of the use rights of publicly owned land
-Set forth a hierarchical approval procedure for converting collectively owned rural land to state-owned urban land
-Required government agencies acquiring rural land to arrange employment for landless farmers
-Required local governments to make overall land use plans conforming to the National Land Use Master Planning Guidelines</td></tr>
<tr><td>1988</td><td>Amendment to Land Administration Law</td></tr>
<tr><td>May 19, 1990</td><td>Provisional Regulations on the Grant and Transfer of Use Rights of Urban Land</td><td>-Provided more concrete procedures for the leasing of urban land</td></tr>
<tr><td>1993</td><td>National Land Use Master Planning Guidelines, 1986 – 2000</td><td>-By the end of 1996, most of the provincial-level governments finished making the overall land use plans for their provinces.</td></tr>
<tr><td>1994</td><td>Basic Farmland Protection Regulation</td><td>-Defined the basic farmland and required counties and townships to designate basic farmland protection zones
-Coined the concept of the Dynamic Balance, requiring the amount of good-quality cultivated land to be kept at a fixed level in the dynamic process of land conversions</td></tr>
<tr><td>Exact Time Unknown</td><td>National Land Use Master Planning Guidelines, 1996-2010</td><td></td></tr>
<tr><td>1997</td><td>Notice on Further Enforcing Land Management and Protecting Cultivated Land (a.k.a. No. 11 Document)</td><td>-Served as the launch of the national inspection of the sources of new construction land to gain knowledge of the legality of land conversions and conveyances and land use efficiency
-Directly led to the revision of the Land Administration Law in 1998 with regard to cultivated land preservation</td></tr>
</table>

Table 3.1 (Continued)

Date/Period	Event	Descriptions and/or Comments
1998	Revision of the Land Administration Law	-Extended the rural land use lease from 15 years to 30 years - Removed the hierarchical approval procedures for converting cultivated land to urban uses and transferred the approval authority back to the central government -Raised the amount of land compensation and resettlement subsidies in rural land acquisition -Abandoned the requirement for arranged employment and puts landless farmers on the competitive job market -Made the Dynamic Balance Policy introduced in the 1994 Basic Farmland Protection Regulation a lawful requirement
April 26, 1999	Methods of Dealing with Idle Construction Land	-Required local governments to impose idle construction land fees not to exceed 20% of the conveyance fee if the land was not used one year after the conveyance, and to reclaim the land and return it to its original use if it remained idle for more than two years
2002	Rural Land Contracting Law	-Gave emphasis to the legal protection of the 30-year rural land contracts -Stated the rural land use leases were tradable among agricultural users, but not between agricultural and urban users. Rural land use leases were not allowed to be used as collateral for loans. -Stated the rural land use lease would be renewable as long as it continued to be used for agricultural production -Required that any adjustment in the land allocation in a village be made with the consent of at least two-thirds of the village member's assembly, and with the approval by the township government or above
July 1, 2003	Regulations on Bidding, Auction and Listing in Land Conveyance	-Required the conveyance of land for profit-seeking construction projects be carried out through bidding, auction, and listing, instead of negotiation

Table 3.1 (Continued)

Date/Period	Event	Descriptions and/or Comments
August 2004	Revision of the Land Administration Law	-Reiterated the requirement of compensation in rural land acquisition, but did not change the compensation formula specified in the 1998 version
October 2004	Resolution to Deepen Reform and Tighten Land Management	-Gave greater emphasis to the requirement of proper compensation and resettlement of farmers in land acquisition, especially in the long-term sense -Required local governments to facilitate the job search of farmers and to include urbanized farmers in the urban social security system
2006	Ideas for Vocational Training and Social Security Provision for Farmers Affected by Land Acquisition	-A follow-up of the 2004 Resolution to Deepen Reform and Tighten Land Management -Suggested a few methods of building social security for farmers
October 1, 2007	Property Rights Law	-Strengthened the urban land tenure security by guaranteeing automatic renewal of the urban land use rights upon expiration -Although not automatic, rural land use leases could be renewed under certain laws -Recognized farmers' land use rights as property rights, as opposed to contractual rights as defined by previous laws -Highlighted and reinforced the legal restrictions on readjustments of land allocation by village collectives -Called for a land registration system -Did not make any changes in the formula for the compensation in land acquisition -Still silent on whether farmers is allowed to trade their land use rights freely or use them as collateral for loans
October 23, 2008	National Land Use Master Planning Guidelines, 2006-2020	

Table 3.2 Effective Dates of the Implementing Acts* of the 1998 Land Administration Law of Each Municipality and Province in the Chorological Order

Provincial-Level Division	**Date (MM/DD/YYYY)**
Chongqing Municipality[3]	01/01/1999
Shandong Province[2]	*08/22/1999*
Gansu Province[3]	09/02/1999
Xinjiang Autonomous Region[2]	09/15/1999
Hebei Province[2]	09/24/1999
Hainan Province[1]	*09/24/1999*
Yunnan Province[1]	09/24/1999
Shanxi Province[1]	09/26/1999
Hubei Province[1]	09/27/1999
Xizang (Tibet) Autonomous Region[2]	11/25/1999
Shaanxi Province[2]	11/30/1999
Henan Province[3]	12/01/1999
Sichuan Province[1]	12/10/1999
Fujian Province[1]	*01/01/2000*
Heilongjiang Province[3]	01/01/2000
Guangdong Province[2]	*01/08/2000*
Hunan Province[2]	03/31/2000
Jiangxi Province[1]	04/28/2000
Zhejiang Province[1]	*06/29/2000*
Neimenggu (Inner Mongolia) Autonomous Region[2]	10/15/2000
Jiangsu Province[1]	*10/17/2000*
Tianjin Municipality[1]	*11/01/2000*
Anhui Province[2]	12/01/2000
Shanghai Municipality[2]	*01/01/2001*
Guizhou Province[3]	01/01/2001
Ningxia Autonomous Region[3]	01/01/2001
Guangxi Autonomous Region[2]	09/01/2001
Liaoning Province[2]	*04/01/2002*
Jilin Province[1]	09/01/2002
Qinghai Province[1]	10/01/2006
Beijing Municipality[2]	*Last Update: 01/01/1993*

Sources: 1. Real Estate Law Service Net, http://www.law110.com
2. Law Library, http://www.law-lib.com
3. China Agricultural Information Net, http://www.agri.gov.cn

Note: *Some provinces call their implementing acts of the 1998 *LAL* the *Provincial Land Administration Regulations.*

** Municipalities and provinces in the east and along the east coast are italicized.

4 Counter-Incentives for Cultivated Land Protection Policies

As analyzed in the previous chapter, the hierarchical approval system specified in the 1988 LAL failed in practice, because local governments who are responsible for managing the land use and enforcing the law have stand to profit more from skirting the law. Even after the 1998 LAL tried to correct this problem by putting the central government in charge of approving cultivated land conversion, local governments still managed to circumvent the law and engage in unapproved or illegal land development.

This chapter analyzes the economic incentives driving local governments' questionable actions surrounding land acquisition and conveyance, and their expected costs of getting caught out of compliance. The economic incentives for land conversion are believed to stem from the cadre evaluation system of China. When the job performance of government officials is evaluated, local fiscal management and economic growth are the most important factors. Performance evaluations based on these two criteria determine officials' opportunities for advancement as well as their remuneration (Huang 1990; Rozelle 1994; Whiting, 2001; He and Wu 2005; Clarke, Murrell, and Whiting 2008; Lichtenberg and Ding 2008). Personal goals and career ambitions of higher office may incline local officials disregard regulations on cultivated land conversion in order to bolster their own district's economic growth and success (Clarke, Murrell, and Whiting 2008; Lichtenberg and Ding 2008).

These incentives are analyzed in Section 4.1 on how arbitrage in land transactions has raised local revenues and eased local budget pressure, and in Section 4.2 on how competition among local economies has led to the encroachment onto cultivated land. Section 4.3 evaluates whether new laws and regulations have been designed to downplay these known incentives, and whether existing punishments and penalties for noncompliance of laws are a deterrent to questionable land projects. Section 4.4 explores the challenges of the implementation of national regulations at local levels due to the strong incentives for land conversion.

4.1 Decentralization of the Fiscal System and Local Budgetary Pressure

The decentralization of China's fiscal system in 1993 reduced intergovernmental transfers from the central to local governments by shifting responsibilities for the provision of public infrastructure from the central government to local governments. Consequently, many local governments have faced increasing budget deficits (Eckaus 2003; Ding 2005b; Cao, Feng, and Tao 2008; Clarke, Murrell, and Whiting 2008).

Land acquisition and conveyance is an effective way for local governments to raise revenues. Due to the land ownership and legal system as previously discussed, government land acquisition in China is relatively easy, inexpensive, and not as time consuming when compared with western countries (Tan et al. 2009). As discussed in Chapter 3, the land compensation fees and resettlement fees are very low due to the prevailing compensation formula. Further, the cost for governments to provide basic public infrastructures on the acquired land, such as roads, electricity, and tap water, is minimal, accounting for only 20-50% of the total acquisition cost (Tan et al. 2009).

While the cost of land acquisition is low, the conveyance fee paid by private land users is very high. In practice, the conveyance fee is determined by calculating the present value of the land rent for the next 50 to 70 years, depending on the intended land use and leasing period (Wang 2005). The UIE (2007) statistics in Chapter 3 reveal the unit land conveyance fee is normally 7 to 10 times the unit land compensation. For the total of 14.7 million hectares of land seized by government in the past two decades, the government has gained 2 trillion RMB (about US$294 billion) from the differential between the total conveyance fee and the land compensation paid to farmers (China Daily 2010). Without a doubt, the local government's ability to buy low and sell high makes land acquisition and conveyance a very profitable government business with no investment risk (Ding 2007; Tan et al. 2009).

In addition to being fast and risk-free, another advantage of revenues generated from land conversions and conveyances is they are recorded as off-budget, and thus, can be easily used to offset local budgetary deficits. Further, land revenues include not only the one-time conveyance fee and the cultivated land occupation tax, but also various types of land taxes and fees, like urban land use taxes, land management fees, land value increment taxes, and taxes on newly added construction land. The stream of revenues provided by these monthly and yearly taxes and fees add a further incentive for local governments to allocate land to urban uses.

It is difficult to estimate how much of a local government's total revenue is comprised of land revenues. It has been argued the legal status of some of the land revenues is obscure and the occasional reports of their amounts are murky (Eckaus 2003). Limited statistics suggest land conveyance fees accounted for 35% of total local government revenue nationwide from 2001 to 2003, and in 2004, this share reached 47% (Ping 2006). In Shenzhen and Xiamen,[12] profits generated from rural land acquisition accounted for 70% of the municipal revenues (Lin and Ho 2005). Cai, Henderson, and Zhang (2009) documented that revenues from land sales in Chengdu, Chongqing, and Suzhou[13] made up 2.6 to 5% of local GDP in 2004 and 2005. Based on the official statistics published in the Land and Resources Statistical Yearbooks of China, Ding and Lichtenberg (2011) found in China as a whole, land-related revenues grew from less than 10% of the total budgetary revenue (i.e., taxes) in 1999 to 55% in 2003 and 2004.

4.2 Pressure for Local Economic Growth

Local government officials are evaluated and promoted based upon their competency of maintaining local fiscal balance and the performance of the economy in their locality. The decentralization of China's political system has led to rigorous economic performance competitions among localities (Skinner, Kuhn, and Joseph 2001; Cao, Feng, and Tao 2008). Performance measures of local economies include local Gross Domestic Product (GDP), employment rate, and the amount of private and foreign direct investment (FDI). During the reform era in China, industrial development funded by private and FDI proved more successful in generating GDP and employment opportunities than agricultural sectors or state-owned enterprises (Clarke, Murrell, and Whiting 2008). As a result, more cultivated land is converted to industrial and urban uses. Likewise, to attract investment from private and foreign sources, many local

[12] Shenzhen and Xiamen are two of the first four Special Economic Zones designated by China in the early 1980s (See Footnote 7).
[13] Chengdu is the capital city of the southwestern province Sichuan. Chongqing is the fourth provincial municipality, parallel to Beijing, Tianjin, and Shanghai. Suzhou is a prefecture-level city in Jiangsu Province, situated in Yangtze River Delta.

governments set aside large parcels of previously cultivated land and declare them industrial development zones (Cao, Feng, and Tao 2008; Lichtenberg and Ding 2008).

Furthermore, government policies encouraging real estate development have resulted in more cultivated land loss. The demand for housing in expanding urban areas is growing rapidly. Urban development sprawls beyond the city core, expanding into rural areas since acquiring cultivated land is far cheaper than acquiring existing urban land (Ding 2005a). In Beijing, for instance, the cost of converting cultivated land accounts for 30 to 40% of the total development cost. By comparison, the cost of acquiring existing urban land can be 60% of the total development cost (Ding and Knaap 2005).

In summary, the pressures and benefits faced by local officials to raise local revenues and to promote local economies have motivated fervent engagement in land acquisitions, even if it means unlawful conducts. The next section investigates whether government policies aiming to control land use have addressed the local governments' self-serving motivations for land conversion and conveyance.

4.3 Lack of Disincentives for Land Conversion and Weak Punishment for Noncompliance of Laws

Chapter 3 points out regulations and policies regarding cultivated land protection in China are all based on a quota system. No landmark measures have been taken to reduce or eradicate the fundamental incentives driving cultivated land conversion, i.e., address the substantial differences between the conveyance fee and the acquisition cost. The 1998 LAL raised the land compensation fees and resettlement subsidies, but the increase in land acquisition cost is negligible and does not significantly shrink the profit margin. Also, the 1998 LAL does not require land compensation to be formulated in accordance with the market value of the land, nor contain any specific regulations on calculating the conveyance fees in the urban primary land market, both, if defined, would aid in closing the gap between the cost and profit.

Conveyance fees can still be substantially higher than acquisition costs even after accounting for costs accrued in replacing the lost cultivated land with new land under the new LAL, because local officials have a series of low-cost approaches to meeting the "dynamic balance" requirement. By interviewing local people in Qingzhou City of Shandong Province in 2001, Lin and Ho (2005) found local officials could select barren land in remote areas and designate it as basic farmland, but classify fertile land adjacent to urban areas as uncultivable land. Similarly, Zhang, Huang, and Ni (2001) found local governments in the east coastal areas redefined fishing ponds as cultivated land in order to meet the quota for cultivated land in their jurisdiction. Such gimmicks are much cheaper than acquiescing to the central government's suggestions of transferring the top soil of fertile land to barren land, creating new farmland through ocean fill, developing irrigation systems on dry land, and/or improving land quality through agricultural research and development.

Additionally, China's system of discovering and punishing unapproved and illegal land transactions does not help effectively close the profit margin in land transactions either. Although the administrative penalties on local officials conducting unapproved and illegal land transactions for profits-reaping purposes are harsh, and often include expelling of the political power and criminal charges, the chance of such local officials being caught is fairly small (Xinhua News Agency 2006, 2007). The central government currently relies on periodic land inspections to discover illegal land behaviors. In some cases, those once-illegal land projects could have obtained the required approvals several years after the development, and thus sporadic land inspections would not be able to discover this type of illegal projects. In other cases, the land grabbing officials could hide or destroy any records of their murky behaviors right before the upcoming land inspection. As previously mentioned, there is also no easy process for farmers to bring violations to light. Hence, local land grabbing officials face a relatively low risk of being caught and jeopardizing their careers (Ma 2009).

4.4 Challenges of Implementing National Policies at Local Levels

The inefficacy of China's current legal system in curbing cultivated land conversion is also a result of weak implementation of national policies at local levels. The decentralization in the Chinese political system allows local governments to play an active and direct role in the development process. Local governments are responsible for the implementation and enforcement of the laws and policies issued by the central government. Local governments are encouraged to make accommodations for their specific, local circumstances when it comes to enforcing and implementing national policies. This allowed local discretion provides tremendous opportunities for local officials to interpret central government policies in favor of their own development goals. A case study of the articulation and implementation of the farmland protection policies at the local level in Huzhou City of Zhejiang Province by Skinner, Kuhn and Joseph (2001) sheds some light on the ineffectiveness of the DBP at the local level.

Huzhou is one of the prefectural-level cities in the Yangtze River Delta and a perfect example of how local governments negotiate around DBP requirements. Amid the rural industrialization through developing township and village enterprises (primarily based on food processing and garment manufacturing) in Zhejiang Province, Huzhou has lost more than 9% of its cultivated land since 1978. Between 1992 and 1997, per capita cultivated land decreased by 8.9%, from 0.056 to 0.051 hectares. The DBP's mandate in Huzhou is based on the Provincial Implementing Act issued by the Zhejiang Land Management Bureau. The Huzhou prefecture government and its lower-level county and township governments are required to maintain cultivated land in their respective administrative regions equal to that of the level in 1996, both quantity and quality. However, local governments have been able to seek significant flexibility in meeting this requirement.

In Huzhou, two initiatives are fundamental to agricultural land protection: land reclamation and land use reorganization. Reclaimed agricultural land typically comes from inferior land not suitable for cultivation, such as barren land, ponds, beds of small rivers, obsolete irrigation channels, and land situated with illegal residential houses. Land reclamation fees are collected if provincial quantity and quality standards are not met. However, many township governments and enterprises simply consider the land reclamation fees as a fixed cost and a necessary expense for their industrial and residential development priorities.

The local governments' ability to interpret and implement the DBP in favor of their local development interests is further revealed through the reorganization of land use. As available sources for land reclamation decline, local officials in Huzhou seek to relocate and merge dispersed rural settlements to make land available for industrial development, even though it is often good farmland.

Some townships in Huzhou can also take advantage of the development land that has been set-aside. Their local land regulations state that all land, including agricultural land, falling within the development land area is considered construction land if the land use plans were developed prior to the formalization of the provincial agricultural land protection regulations in 1999. This practice facilitates the encroachment of industrial and residential activities onto agricultural land without violating the LAL.

Thus far, the analysis of the incentives for local governments involved in cultivated land conversion to not comply with the central government requirements has been based on anecdotal evidence. This thesis attempts formulate this incentive structure into a theoretical land conversion model. Based on the theoretical analysis, this thesis will examine empirically the strength of the economic incentives in land acquisition and the effectiveness of the Dynamic Balance Policy under such influences. Given this attempt, it is necessary to review existing literature on the driving forces of China's cultivated land conversion, setting the benchmark for the theoretical and empirical analyses of this thesis.

5 Literature Review

While urbanization and industrialization is commonly believed to have fostered the rapid loss of cultivated land in China, there has been a lack of economic and econometric analyses of this relationship. Geographers, urban planners, as well as policy researchers have contributed voluminous studies on China's land use changes, in particular from agricultural to urban uses, in its economic reform era. Nevertheless, most of them are limited to an anecdotal account of the changes in China's land use, and/or a descriptive rationale for the driving forces of the observed changes. Many of the previously discussed studies fall into this category, for example, Heilig (1997), Yeh and Li (1999), Lin and Ho (2003), Ho and Lin (2004a), Tan et al. (2005), and Long et al. (2007).

A handful of studies distinguish themselves from others by examining the driving forces for China's land use changes, using economic modeling and regression-based econometric techniques. They are Seto and Kaufmann (2003), Liu, Zhan and Deng (2005), Deng et al. (2008), and Lichtenberg and Ding (2009). This chapter reviews these works and discusses their similarities and differences in the approach to addressing similar issues adopted by this thesis.

First of all, Liu, Zhan and Deng (2005) is the only study that has examined the effects of the cultivated land protection policies in China. They argued that various laws, regulations and policies regarding land use and management had been issued during their study period of 1990 – 2000. To examine the policy impacts, they included two year dummies indicating the issuance of new policies in their model urban land expansion. The 1992 year dummy was included to test the effectiveness of the Implementing Act of the Land Administration Law issued in 1991 and the Urgent Notice of Prohibiting

Misused and Unapproved Farmland Acquisition issued in 1992. The 1995 year dummy was included to test the effectiveness of the Basic Farmland Protection Regulation issued in 1994, which was the groundwork policy of the Dynamic Balance Policy as discussed in Chapter 3.

It is not difficult to see that the definition of the policy indicators in Liu, Zhan and Deng (2005) is flawed. By including the year dummies for 1992 and 1995, Liu, Zhan and Deng (2005) assumed the policies were effective only in the year they were issued or in the following year. It is not clear if they have meant to assign the value 1 to the policy dummies for the year in which the policy was issued and also for the years after the policy issuances. In addition, Liu, Zhan and Deng (2005) applied the same year dummy for different provinces, which may not have reflected when the policy change had actually occurred in that province. As far as this thesis has found, local governments of different levels in China are typically allowed some "grace period" for the implementation of national policies. Local governments can take the grace period to make the implementing acts suitable for their localities. Provincial implementing acts of the 1998 LAL issued in various years after 1998 are an example of such practice (see Table 3.2). The policy indicator of this thesis will be carefully crafted based on this fact.

One thing that all of the studies reviewed in this chapter have in common is that they all use panel data of land use and socioeconomic variables, which allows them to examine the demographic and economic driving forces for land use changes, controlling for unobserved heterogeneity across sections. While they have all compiled socioeconomic data from published statistical yearbooks, they obtained their land use data from two different sources. Specifically, Seto and Kaufmann (2003), Liu, Zhan and Deng (2005), and Deng et al. (2008) used technologies in the geographic information systems (GIS) to estimate the changes in land use, whereas Lichtenberg and Ding (2009) adopted the official land use data collected by the Ministry of Land and Resources of China.

Given the amount of time and effort required for interpreting the remote-sensing images and validating the interpretation in the fields, those studies using GIS data for land use changes all have small panels with very few years and/or cross-sectional units, limiting the statistical power in their econometric analyses. Specifically, the dataset of Seto and Kauffman (2003) contains only 11 counties in the Pearl River Delta for two years, and the dataset of Liu, Zhan and Deng (2005) consists of 13 cities for three years. Deng et al. (2008) is a diligent effort to compile the data for all 2,348 counties in China. Their dataset includes over 2000 cross-sectional units, but the time component has only three years. Because the land area in the base year is used as an exogenous variable in the model, their study is for the land use changes between two years only.

Data used by these studies not only casts doubt on the statistical power of their econometric analysis due to its small sample size, it also fails to transmit the dynamics of land use changes. Due to the time and effort required, all of the aforementioned studies based on the GIS data only managed to assemble the data for two or three data points with five to eight years apart, and then calculated the land use changes between the two end dates of the study period. Such data omits any important land use changes in years between the beginning and ending years. Seto and Kauffman (2003) attempted to overcome this shortcoming of the GIS data and formed a time series of eight years between 1988 and 1996. They used the Bayesian maximum likelihood method to identify the years in which urban land use changes had occurred based on the probability density function of each class of land and the land use maps of 1988 and 1996. With this information, they were able to obtain the annual changes in land areas by use. However, such data derived based on assumptions and probability density functions should be used with caution, as they may not be warranted by the reality check.

By comparison, Lichtenberg and Ding (2009) and this thesis both adopt the official land use data, which is a continuous series of eight years from 1996 to 2004. First-differencing the data to study the changes in land areas still leaves the sample with seven time units. The sample of Lichtenberg and Ding (2009) contains 99 prefecture-level cities in East China, making a total of 792 observations in the data, large enough to yield precise estimators. Similarly, this thesis has compiled data for all prefectures in China, along with four provincial-level municipalities, making a total of 2,640 observations in the whole China sample, and 808 observations in the East China sample.

With panel data, Seto and Kaufmann (2003) adopted the random coefficient estimation to account for heterogeneity and unobserved variables among counties. Their estimation results showed that the annual rate of land conversion from agricultural land to urban uses is positively correlated with the ratio of the agricultural land value to urban land value. This finding seems to be counterintuitive in that common wisdom and empirical evidence found by Lichtenberg and Ding (2009) claim that areas with higher agricultural land value should have experienced a slower rate of converting agricultural land to urban uses. Seto and Kaufmann (2003) explained that relatively more productive and valuable agricultural land was converted to urban uses, because where land was productive was also where population concentrated and increased population put an upward pressure on urbanization. However, they also found that the annual rate of land conversion from agricultural land to urban uses is negatively correlated with the agricultural labor productivity, contradicting their finding of the positive correlation between agricultural land conversion and the agricultural land value. Seto and Kaufmann (2003) did not make any effort to reconcile this conflict.

Seto and Kaufmann (2003) recognized the potential endogeneity in the relationship between land use changes and the productivity of land or labor, and tried to infer the direction of the causality using the Granger causality test. The Granger causality test is a test used in time-series analysis. It determines whether one time series is useful in forecasting another. The sample of Seto and Kaufmann (2003) has too few time-series observations for this kind of test. Based on an unsuitable test, Seto and Kaufmann (2003) found little evidence for the "causal relations in Granger's sense" between land use changes and their explanatory variables in any direction. They concluded that while the change in land use did not Granger cause the changes in the productivity of land or labor in each sector, or the total investments in capital construction, these factors did not cause the change in land use either. There must have been unobserved variables outside the model that drive the land use changes in China.

Noting that the econometric models in Seto and Kaufmann (2003) and Liu, Zhan and Deng (2005) are based on anecdotal evidence and wide belief, the relations they have found between land use changes and the factors they selected in the *ad hoc* fashion cannot be taken as causal relationships. Thus, their findings do not convey sound policy implications for what can lead to slower agricultural land loss or slower urban land expansion. Careful empirical application of insightful theoretical analysis will offer much more interpretive power for policy-making. Studies by Deng et al. (2008) and Lichtenberg and Ding (2009) make significant improvement in this aspect to the literature on China's land use changes.

In the examination of the driving forces for the urban land expansion between 1995 and 2000 in China, Deng et al. (2008) identified their explanatory variables based on the monocentric urban expansion model. Implied directly by this model, urban areas would be increasing in population and income and decreasing in transportation costs and agricultural land rents. To test the hypotheses of the monocentric urban model, they started their empirical investigation with the basic model including such explanatory variables as GDP growth, population growth, agricultural investment as a measure for agricultural land rent, and highway density as a measure for the commuting cost.

The basic model was extended to include factors influencing land use changes in developing countries including China, such as the structural changes. To account for the influence of structural changes in China's economy, Deng et al. (2008) included the growth of industrial GDP and the growth of GDP from the service sector. To account for climatic effects, they included variables for temperature and rainfalls. To account for the geophysical factors, they included the average elevation, slope, and the share of flat land in a county. Finally, they included the distance of the county to the nearest port city, the distance of the county to its provincial capital, and the size of the urban core of the county in 1988.

Their results indicated that local GDP growth was important in explaining the growth of the urban core in the late 1990s. Holding GDP constant, population growth and highway density were positively correlated with the urban core growth, and the growth of agricultural investment was negatively correlated with the urban core growth.

Noting that GDP was an explanatory variable in all regressions, the results of Deng et al. (2008) may be subject to endogeneity problems. Recently proved by Ding and Lichtenberg (2011), urban land expansion has been an important factor driving China's economic growth, suggesting that incomes measured by GDP are endogenous and thus need to be instrumented for. Deng et al. (2008) failed to address the endogeneity issues. Their regression results may be biased, and the interpretation of their results needs to be treated with caution.

A more recent study by Lichtenberg and Ding (2009) offered a different approach to examine the relationship between economic driving forces and urban land expansion in China. Instead of addressing urban land expansion as a result of economic growth or population growth, Lichtenberg and Ding (2009) examined the incentive structure of Chinese local officials for cultivated land conversion that had ultimately led to urban land expansion in China. They portrayed local officials in charge of land use as private individuals whose goal is to maximize the rewards from the central government in accordance with their performance in local economic growth, fiscal management, as well as maintaining agricultural production. Based on this framework, Lichtenberg and Ding found the rate of urban spatial expansion would be higher in areas where land conversion was more profitable, i.e., where urban land value is higher, and lower in areas where agricultural land value, and hence compensation for land conversion, was higher. In addition, the rate of urban spatial expansion would be higher in areas where expected tax revenues were larger.

In the empirical analysis, Lichtenberg and Ding (2009) examined the strength of the identified factors affecting urban spatial expansion in Chinese cities using the official land use data. Their dataset consisted of 99 prefecture-level cities in ten coastal provinces[14] in China from 1997 to 2004. The dependent variable was defined as the change in urban land area from year *t* to year *t*+1, in both level and percentage terms. As clarification, urban land in Lichtenberg and Ding (2009) is defined as the land classified as cities in Table 2.1, and the urban land in this thesis is defined as cities and towns because many prefectures in western China do not have land classified as cities.

Socioeconomic data was collected from published provincial statistical yearbooks. The dependent variable in estimation is defined as the change in the area of land defined as city by the MLR from year *t* to year *t*+1. Although motivated by different rationales, Lichtenberg and Ding (2009) defined the value of land in different sectors in the same way as Seto and Kaufmann (2003). Specifically, the average values of urban land agricultural land were defined as local nonagricultural GDP divided by urban land areas and agricultural GDP divided by cultivated land area, respectively. An alternative measure for average agricultural land was defined as total agricultural output value divided by cultivated land area. Another key explanatory variable was the local government budgetary revenue per unit of urban land.

The change in urban land area from year *t* to year *t*+1 was then estimated on the urban land value, agricultural land value, and local government budgetary revenue per

[14] They are Beijing, Tianjin, Shanghai, Liaoning, Hebei, Shandong, Jiangsu, Zhejiang, Fujian, and Guangdong.

unit of urban land in the initial time period (year *t*). Assume the land use changes in the following year (*t*+1) would not affect the economic factors in current year (*t*), the model set up by Lichtenberg and Ding (2009) did not face the problems associated endogeneity. This is also an important assumption adopted by this thesis.

Using prefecture and year fixed effects estimation, Lichtenberg and Ding (2009) found that changes in urban land area were positively correlated with the value of urban land and local government budgetary revenue per unit of urban land, and negatively correlated with the value of agricultural land. Based on these findings, Lichtenberg and Ding (2009) concluded that empirical evidence from coastal provinces was consistent with the theoretical investigation that Chinese local officials responded to land values in a manner similar to private land developers in competitive land markets. In addition, government revenues influenced the changes in urban land area as expected by the theoretical model. These results suggested that policies aiming to slow down cultivated land conversion and urban land expansion should be made to restrain the incentives of local officials for buying low and selling high in the land conversion process.

As mentioned earlier, Liu, Zhan and Deng (2005) was the only study that attempted to evaluate the effectiveness of any cultivated land protection policies in China, but they did not execute their evaluation properly. This thesis is the first economic paper to examine one of the most important land use policies in China, with well-grounded theoretical and empirical approaches.

This thesis adopts the theoretical approach of Lichtenberg and Ding (2009) in that the goal of this thesis is to examine the impacts of the Dynamic Balance Policy. As discussed in Chapters 3 and 4, Chinese local officials play a dual role in land use management. They are the policy enforcement and at the same time the agent to carry out land conversion. The incentives for enforcing the policy are likely to be weakened by the economic incentives for converting cultivated land to urban uses. Analyzing such an incentive structure at the micro level serves the research goal of this dissertation, although the empirical implementation of the theoretical analysis adopts macro data. Further, this dissertation extends the model of Lichtenberg and Ding (2009) to include the land conversion from unused land to cultivated land, an indispensable element for the study of the Dynamic Balance Policy.

This dissertation exploits the official land use data and economic data from the same sources as Lichtenberg and Ding (2009). The variable definitions, as well as the estimation specifications and procedures, have some similarities to those adopted by Lichtenberg and Ding (2009). An improvement in the econometric estimation made by this thesis is the testing and correction for autocorrelation and heteroskedasticity in panel data analysis. Without this adjustment, the estimation technique adopted by this thesis would be the same as Lichtenberg and Ding's (2009). If autocorrelation and/or heteroskedasticity present, failure to correct them would lead to incorrect variance estimators, which would affect the hypothesis testing. These technical details will be spelt out in the empirical chapters.

The remainder of the dissertation will develop the theoretical and empirical models for examining the effects of the DBP as well as the economic driving forces, and detail the empirical exploration from the data collection to estimation techniques.

6 Theoretical Models

This chapter establishes a theoretical model to analyze the incentive structure of agricultural land conversion to urban uses, and derives testable hypotheses for the empirical analysis. Specifically, section 6.1 defines the variables and sets up the general model. Sections 6.2 and 6.3 analyze the model in the pre-policy and post-policy cases, respectively, and derive the optimal amount of agricultural land converted to urban uses and the optimal amount of other land converted to agricultural use in each case. In addition, their comparative statics are developed with respect to the parameters in the model.

The theoretical model is based on the dynamic land transition model formulated by Lichtenberg and Ding in their 2009 study on Chinese local officials as land developers in urban spatial expansion. As argued in Chapter 4, local officials in China use land acquisition and development to promote economic growth and relieve budgetary pressure (Ping 2006; Cao, Feng, and Tao 2008; Lichtenberg and Ding 2009). Lichtenberg and Ding (2009) formulate such incentives of Chinese local officials into a dynamic land transition model where only the conversion from agricultural to urban land is examined. This dissertation extends their model to include the conversion of other types of land to agricultural land as required by the Dynamic Balance Policy (DBP). For simplicity, the continuous process of land conversion formulated by Lichtenberg and Ding (2009) is adapted into a static model of changes in land use from one year to another. This modification simplifies the mathematical derivation of a dynamic function of two choice variables, but yields a set of results comparable to those from the dynamic model.

6.1 Variable Definitions and the General Model

Let L_u, L_a, and L_o denote the initial area of urban, agricultural, and all other land, respectively. Let $X_a > 0$ denote the area of agricultural land converted to urban uses, and $X_o \geq 0$ denote the area of all other land converted to agricultural uses. By assumption, agricultural land that is converted to urban land is not always replaced with other land. It is also assumed that no land other than agricultural land is converted to urban uses, an assumption supported by observations in Chapter 2 that other land is not a primary source for new urban land. Additionally, assume that agricultural land is not converted to any use other than urban construction.

To account for the quality differential of land, define the relative productivity of other land to existing agricultural land as $0 \leq \varphi \leq 1$, and thus the area of other land converted to agricultural land, adjusted for quality, is φX_o. The DBP requires that $X_a \leq \varphi X_o$.

As discussed earlier, the first objective of local officials in China is to promote local economic growth. Assume the local economy consists of two sectors: agriculture and urban. Local officials face the problem of maximizing the value of agricultural production and urban production. Let functions $R(X_a, X_o)$ and $\pi(X_a, X_o)$ represent the instantaneous revenues from agricultural and urban sectors, respectively. Discounting them by factor $\delta > 0$ yields their present value at time *t*. Following the specification of Lichtenberg and Ding (2009), assume labor and capital used in production are not constrained and that they adjust instantaneously with the land, thus the revenue functions, $R(X_a, X_o)$ and $\pi(X_a, X_o)$, are functions of land only. They preserve the common properties of a revenue function: increasing and concave in input, i.e., $R', \pi' > 0$, and $R'', \pi'' \leq 0$.

The second objective of local officials is to maintain the local budgetary balance. Local budgetary revenues come from two sources: first, taxes on the value-added of urban production, $\tau\pi(X_a, X_o)$, where τ denotes the aggregate tax rate; and second, taxes and fees collected from urban land users, $\rho^u * (L_u + X_a)$, where ρ^u denotes the aggregate taxes and fees per unit of land. Local budgetary expenditure on providing urban infrastructure is defined as a function of the size of the urban area, $e(L_u + X_a)$. Assume the expenditure function has the common property of convexity, i.e., $e' > 0$ and $e'' \geq 0$.

Following the analytical mechanism of Lichtenberg and Ding (2009), to facilitate the analysis, shifters are included for the value of agricultural production, $\alpha \geq 1$, the value of urban production, $\beta \geq 1$, and the local budgetary balance, $\gamma \geq 1$. The initial values of these shifters are set to be one. Such shifters can be understood as any external shocks that could increase the value of agricultural and urban production, or the weights that local officials place on agricultural, urban, and government sectors. They also allow cross-sectional comparison of different locations.

In addition to maximizing the present value of agricultural and urban production and the present value of net budgetary revenues, local officials engage in the profit maximization in land conversion and sales at time *t*. As discussed earlier, land conversion and development further promote urban production, and revenues generated from land transactions relieve the local budgetary pressure. Profits from converting agricultural land and selling it on the primary urban land market are expressed as $[p^a - c(L_a)]X_a$, where p^a denotes the unit price of agricultural land on the urban primary land market (i.e., the conveyance fee per unit of land), and $c(L_a)$ denotes the unit cost of converting agricultural land to urban uses.

As discussed in Chapter 3, the cost of converting agricultural land to urban uses is mainly comprised of land compensation fees and resettlement fees, which are calculated based on the average agricultural land productivity in the past three years. The average cost, as well as the marginal cost, of agricultural land conversion, $c(L_a)$, is thus predetermined on the initial amount of agricultural land, L_a, and constant in the amount of land being converted, X_a. Due to diminishing marginal productivity, unit compensation is decreasing in the initial amount of agricultural land at a decreasing rate, i.e. $c' < 0$, and $c'' \geq 0$ (Lichtenberg and Ding 2009).

Unlike the cost of agricultural land conversion, the cost of converting other land to agricultural land, $g(X_o, L_o)$, has the increasing and convex properties of a standard cost function, i.e., $g' > 0$ and $g'' \geq 0$. To help analyze the effects of different costs of converting other land to agricultural land in different locations on the optimal rates of conversions from agricultural land to urban land and from other land to agricultural land, a shifter $\omega \geq 1$ is added to the cost function of other land conversion.

The final presentation of the profit maximization problem facing local officials is

$\max V(X_a, X_o)$

$$= \frac{\alpha R(L_a - X_a + \varphi X_o)}{\delta}$$

$$+ \frac{\beta\pi(L_u + X_a) + \gamma[\tau\pi(L_u + X_a) + \rho^u * (L_u + X_a) - e(L_u + X_a)]}{\delta}$$

$$+ [p^a - c(L_a)]X_a - \omega g(X_o, L_o)$$

subject to

$X_a > 0$ and $X_o \geq 0$.

The DBP adds an additional constraint, $X_a \leq \varphi X_o$.

6.2 Optimal Land Conversion without the Dynamic Balance Policy

In the absence of the DBP, the Lagrangian function for this problem is

$L(X_a, X_o, \theta) = V(X_a, X_o) + \theta X_o$.

The Kuhn-Tucker first-order necessary conditions with respect to X_a, X_o, and θ are

$$L_a = V_a = -\frac{\alpha R'}{\delta} + \frac{1}{\delta}[(\beta + \gamma\tau)\pi' + \gamma\rho^u - \gamma e'] + [p^a - c(L_a)] = 0; \quad (6.1)$$

$$L_o = V_o + \theta = \frac{\varphi\alpha R'}{\delta} - \omega g' + \theta = 0; \quad (6.2)$$

$L_\theta = X_o \geq 0, \theta \geq 0$, with complementary slackness. (6.3)

The Kuhn-Tucker conditions (6.1) – (6.3) define the optimal amount of land conversion of each kind in the absence of the DBP.

When $X_o^* > 0$ and $\theta^* = 0$, it is a case in which local officials voluntarily convert other land to agricultural land. Equations (6.1) and (6.2) together imply

$$\frac{\omega g\prime}{\varphi} = \frac{1}{\delta}[(\beta + \gamma\tau)\pi' + \gamma\rho^u - \gamma e'] + [p^a - c(L_a)]. \quad (6.4)$$

Equation (6.4) implies that X_a^* and X_o^* are chosen to equate the marginal cost of converting other land to agricultural land with the marginal benefit of converting agricultural land to urban land.

For interior solutions, $X_a^* > 0$ and $X_o^* > 0$, the second-order sufficient conditions for a maximum ensure that

$$L_{aa} = \frac{1}{\delta}[\alpha R'' + (\beta + \gamma\tau)\pi'' - \gamma e''] < 0,$$

$$L_{oo} = \frac{\varphi^2 \alpha R''}{\delta} - \omega g'' < 0,$$

and

$$L_{aa}L_{oo} - L_{ao}L_{oa}$$

$$= \frac{1}{\delta}\varphi^2\alpha R''[(\beta + \gamma\tau)\pi'' - \gamma e''] - \omega g''[\alpha R'' + (\beta + \gamma\tau)\pi'' - \gamma e''] > 0.$$

Total differentiating equations (6.1) and (6.2) and applying the Cramer's rule, we obtain the following comparative statics of X_a^* and X_o^* with respect to the model parameters.

Results 6.2.1 Comparative statics with respect to α:

$\frac{\partial X_a^*}{\partial \alpha} = -\delta\omega g'' R'/H < 0$, where $H = \varphi^2\alpha R''[(\beta + \gamma\tau)\pi'' - \gamma e''] - \delta\omega g''[\alpha R'' + (\beta + \gamma\tau)\pi'' - \gamma e''] > 0$, guaranteed by the second-order sufficient conditions for a maximum;

$$\frac{\partial X_o^*}{\partial \alpha} = \varphi R' [\gamma e'' - (\beta + \gamma\tau)\pi'']/H > 0.$$

This pair of comparative statics indicates that the optimal amount of agricultural land converted to urban land is lower in areas where the value of agricultural production, and thus the value of agricultural land, is higher. Likewise, the optimal amount of other land converted to agricultural land is higher in areas where the value of agricultural production, and thus the value of agricultural land, is higher.

Results 6.2.2 Comparative statics with respect to β:

$$\frac{\partial X_a^*}{\partial \beta} = \pi'(\delta\omega g'' - \varphi^2 \alpha R'')/H > 0;$$

$$\frac{\partial X_o^*}{\partial \beta} = -\varphi \alpha R'' \pi'/H > 0.$$

Results 6.2.2 indicate that the optimal amount of agricultural land converted to urban land and the optimal amount of other land converted to agricultural land are both higher in areas where the value of urban production, and thus the value of urban land, is higher.

Results 6.2.3 Comparative statics with respect to γ:

$$\frac{\partial X_a^*}{\partial \gamma} = (\varphi^2 \alpha R'' - \delta\omega g'')(e' - \tau\pi' - \rho^u)/H;$$

$$\frac{\partial X_o^*}{\partial \gamma} = \varphi \alpha R''(e' - \tau\pi' - \rho^u)/H.$$

Because $\varphi^2 \alpha R'' - \delta\omega g'' < 0$ and $\varphi \alpha R'' < 0$, the signs of results 6.2.3 are determined by the sign of $e' - \tau\pi' - \rho^u$. If the marginal expenditure of urban land is greater than the marginal revenue, i.e., $e' - \tau\pi' - \rho^u > 0$, then $\frac{\partial X_a^*}{\partial \gamma} < 0$ and $\frac{\partial X_o^*}{\partial \gamma} < 0$, implying that both the conversion of agricultural land to urban land and the conversion of other land to agricultural land is slower in areas where maintaining budgetary balance is more important. By the same token, if the marginal expenditure of urban land is less than the marginal revenue, i.e., $e' - \tau\pi' - \rho^u < 0$, then $\frac{\partial X_a^*}{\partial \gamma} > 0$ and $\frac{\partial X_o^*}{\partial \gamma} > 0$, implying more agricultural land will be converted to urban land and more other land will be converted to agricultural land in areas where government revenue generation from urban production is deemed more important.

Results 6.2.4 Comparative statics with respect to τ:

$$\frac{\partial X_a^*}{\partial \tau} = \gamma\pi'(\delta\omega g'' - \varphi^2\alpha R'')/H > 0;$$

$$\frac{\partial X_o^*}{\partial \tau} = -\gamma\pi'\varphi\alpha R''/H > 0.$$

Results 6.2.4 indicate that the optimal amount of agricultural land conversion and other land conversion is both higher in areas where the aggregate tax rate on urban production is higher.

Results 6.2.5 Comparative statics with respect to ρ^u:

$$\frac{\partial X_a^*}{\partial \rho^u} = \gamma(\delta\omega g'' - \varphi^2\alpha R'')/H > 0;$$

$$\frac{\partial X_o^*}{\partial \rho^u} = -\gamma\varphi\alpha R''/H > 0.$$

Similar to results 6.2.4, these results indicate that the optimal amount of agricultural land conversion and other land conversion is both higher in areas where the aggregate tax rate on urban land is higher.

Results 6.2.6 Comparative statics with respect to p^a:

$$\frac{\partial X_a^*}{\partial p^a} = \delta(\delta\omega g'' - \varphi^2\alpha R'')/H > 0;$$

$$\frac{\partial X_o^*}{\partial p^a} = -\delta\varphi\alpha R''/H > 0.$$

Similar to results 6.2.4 and 6.2.5, these results indicate that the optimal amount of agricultural land conversion and other land conversion is both higher in areas where the price of converted agricultural land on the urban land market is higher.

Results 6.2.7 Comparative statics with respect to L_a:

$$\frac{\partial X_a^*}{\partial L_a} = [\delta c'(\varphi^2 \alpha R'' - \delta\omega g'') - \alpha R''\delta\omega g'']/H > 0;$$

$$\frac{\partial X_o^*}{\partial L_a} = \varphi\alpha R''[\gamma e'' - (\beta + \gamma\tau)\pi'' + \delta c']/H.$$

Result $\frac{\partial X_a^*}{\partial L_a} > 0$ implies that the optimal amount of agricultural land converted to urban land is larger in areas where there is initially more agricultural land. The sign of $\frac{\partial X_o^*}{\partial L_a}$ cannot be determined because the sign of $\gamma e'' - (\beta + \gamma\tau)\pi'' + \delta c'$ cannot be determined, where $\gamma e'' - (\beta + \gamma\tau)\pi'' + \delta c' > 0$ and $\delta c' < 0$ by assumption.

Results 6.2.8 Comparative statics with respect to L_u:

$$\frac{\partial X_a^*}{\partial L_u} = (\varphi^2 \alpha R'' - \delta\omega g'')[\gamma e'' - (\beta + \gamma\tau)\pi'']/H < 0;$$

$$\frac{\partial X_o^*}{\partial L_u} = \varphi\alpha R''[\gamma e'' - (\beta + \gamma\tau)\pi'']/H < 0.$$

Results 6.2.8 imply that the conversion of agricultural land to urban land and the conversion of other land to agricultural land are both slower in areas where there is initially more urban land.

Results 6.2.9 Comparative statics with respect to ω:

$$\frac{\partial X_a^*}{\partial \omega} = \varphi\alpha R'' g'/H < 0;$$

$$\frac{\partial X_o^*}{\partial \omega} = g'[\alpha R'' + (\beta + \gamma\tau)\pi'' - \gamma e'']/H < 0.$$

These results suggest that the optimal amount of both agricultural land conversion and other land conversion is lower if the cost of converting other land to agricultural land is higher.

Results 6.2.10 Comparative statics with respect to φ:

$$\frac{\partial X_a^*}{\partial \varphi} = -\alpha R''(\alpha R' + \delta\omega g'' X_o^*)/H > 0;$$

$$\frac{\partial X_o^*}{\partial \varphi} = -\{\alpha^2 R' R'' + \alpha R'[(\beta + \gamma\tau)\pi'' - \gamma e''] + \varphi\alpha R'' X_o^*[(\beta + \gamma\tau)\pi'' - \gamma e'']\}/H.$$

Result $\frac{\partial X_a^*}{\partial \varphi} > 0$ suggests that the optimal amount of agricultural land converted to urban land is larger in areas where the soil quality of other land is higher. Also, the effect of the soil quality of other land on the optimal amount of agricultural land conversion is dependent on the optimal amount of other land converted to agricultural land. Furthermore, the relationship between the optimal amount of other land converted to agricultural land and the soil quality of other land is unclear, because the sign of $\frac{\partial X_o^*}{\partial \varphi}$ cannot be determined.

Results 6.2.11 Comparative statics with respect to L_o:

$\frac{\partial X_a^*}{\partial L_o} = \delta\omega \frac{\partial g'}{\partial L_o} \varphi^2 \alpha R''/H > 0$, where $\frac{\partial g'}{\partial L_o} < 0$ because like in any natural resource extraction, the cost is lower if the initial endowment is larger. Similarly,

$$\frac{\partial X_o^*}{\partial L_o} = \delta\omega \frac{\partial g'}{\partial L_o}[\alpha R'' + (\beta + \gamma\tau)\pi'' - \gamma e'']/H > 0.$$

Results 6.2.11 point out that the optimal amounts of agricultural land converted to urban uses and other land converted to agricultural land are both higher in areas where there is initially more land other and agricultural and urban land available.

Implied by the Kuhn-Tucker conditions (6.1) – (6.3), another possibility in the absence of the DBP is that it is never optimal to convert other land to agricultural land, i.e., $X_o^* = 0$ and $\theta^* > 0$, because the marginal cost of replacing agricultural land with other land is always greater than the marginal benefit of converting agricultural land to urban land:

$$\frac{\omega g'}{\varphi} > \frac{1}{\delta}[(\beta + \gamma\tau)\pi' + \gamma\rho^u - \gamma e'] + [p^a - c(L_a)]. \quad (6.5)$$

In this case, the only condition defining X_a^* is (6.1) with $X_o^* = 0$:

$$-\frac{\alpha R'(L_a - X_a)}{\delta} + \frac{1}{\delta}[(\beta + \gamma\tau)\pi'(L_u + X_a) + \gamma\rho^u - \gamma e'(L_u + X_a)] + [p^a - c(L_a)] = 0. \quad (6.6)$$

Differentiating equation (6.6) with respect to each parameter gives us the following comparative statics:

$$\left.\frac{\partial X_a^*}{\partial \alpha}\right|_{X_o^* = 0} = R'/h < 0; \quad (6.2.12)$$

where $h = \alpha R'' + (\beta + \gamma\tau)\pi'' - \gamma e'' < 0$, implied by the second-order sufficient condition for a maximum;

$$\left.\frac{\partial X_a^*}{\partial \beta}\right|_{X_o^* = 0} = -\pi'/h > 0; \quad (6.2.13)$$

$$\left.\frac{\partial X_a^*}{\partial \gamma}\right|_{X_o^* = 0} = (e' - \tau\pi' - \rho^u)/h \underset{<}{\geq} 0 \text{ if } e' - \tau\pi' - \rho^u \underset{>}{\leq} 0; \quad (6.2.14)$$

$$\left.\frac{\partial X_a^*}{\partial \tau}\right|_{X_o^* = 0} = -\gamma\pi'/h > 0; \quad (6.2.15)$$

$$\left.\frac{\partial X_a^*}{\partial \rho^u}\right|_{X_o^* = 0} = -\gamma/h > 0; \quad (6.2.16)$$

$$\left.\frac{\partial X_a^*}{\partial p^a}\right|_{X_o^* = 0} = -\delta/h > 0; \quad (6.2.17)$$

$$\left.\frac{\partial X_a^*}{\partial L_a}\right|_{X_o^* = 0} = (\delta c' + \alpha R'')/h > 0; \quad (6.2.18)$$

$$\left.\frac{\partial X_a^*}{\partial L_u}\right|_{X_o^* = 0} = [\gamma e'' - (\beta + \gamma\tau)\pi'']/h < 0. \quad (6.2.19)$$

Results 6.2.12 – 6.2.19 are essentially the same as the comparative statics of X_a^* when $X_o^* > 0$ in the corresponding results 6.2.1 – 6.2.8. In the absence of the DBP, whether there is voluntary conversion of other land to agricultural land or not, the optimal amount of agricultural land converted to urban land is always smaller in areas where the value of agricultural land is higher; and larger in areas where the value of urban land is higher. In addition, the optimal amount of agricultural land conversion is always larger in areas where the aggregate tax rates on urban production and urban land are higher, and where the price of the converted land in the urban land market is higher. Moreover, the optimal amount of agricultural land conversion is higher in areas where there is initially more agricultural land or less urban land. Finally, the relationship between agricultural land conversion and local budgetary balance is compounded by the fact that while more urban land may increase the tax revenue from the urban sector, it may also increase the expenditure for providing urban infrastructure.

6.3 Optimal Land Conversion with the Dynamic Balance Policy

The previous section analyzes the optimal land conversion rate in the absence of the DBP and develops the comparative statics and testable hypotheses. This section performs a similar analysis for the case when the DBP is enforced, and compares the results with the corresponding results in the pre-policy case.

The problem facing local officials in the presence of the DBP is

$$V(X_a, X_o) = \frac{\alpha R(L_a - X_a + \varphi X_o)}{\delta} + \frac{\beta\pi(L_u + X_a) + \gamma[\tau\pi(L_u + X_a) + \rho^u * (L_u + X_a) - e(L_u + X_a)]}{\delta} + [p^a - c(L_a)]X_a - \omega g(X_o)$$

subject to

$X_a > 0$, $X_o > 0$, and $X_a \leq \varphi X_o$.

The Lagrangian function for this problem is

$$L(X_a, X_o, \mu) = V(X_a, X_o) + \mu(\varphi X_o - X_a).$$

The Kuhn-Tucker first-order necessary conditions with respect to X_a, X_o, and μ are

$$L_a = V_a - \mu = -\frac{\alpha R'}{\delta} + \frac{1}{\delta}[(\beta + \gamma\tau)\pi' + \gamma\rho^u - \gamma e'] + [p^a - c(L_a)] - \mu = 0; \quad (6.7)$$

$$L_o = V_o + \varphi\mu = \frac{\varphi\alpha R'}{\delta} - \omega g' + \varphi\mu = 0; \quad (6.8)$$

$$L_\mu = \varphi X_o - X_a \geq 0, \mu \geq 0, \text{ with complementary slackness.} \quad (6.9)$$

Because of the cost of agricultural land reclamation and development, local officials would only want to meet the minimum requirement of the DBP, i.e., $X_a^{*d} = \varphi X_o^{*d}$. The superscript, *d*, is used to distinguish the solutions from those to the pre-policy model derived in section 6.2. In this case, the first-order necessary conditions for a maximum are

$$-\frac{\alpha R'}{\delta} + \frac{1}{\delta}[(\beta + \gamma\tau)\pi' + \gamma\rho^u - \gamma e'] + [p^a - c(L_a)] - \mu = 0; \quad (6.10)$$

$$\frac{\alpha\varphi R'}{\delta} - \omega g' + \varphi\mu = 0; \quad (6.11)$$

$$\varphi X_o - X_a = 0. \quad (6.12)$$

When $X_a^{*d} = \varphi X_o^{*d}$, equation (6.11) implies $\mu^* = \frac{\omega g'(X_o^{*d})}{\varphi} - \frac{\alpha R'(L_a)}{\delta} > 0$. The Lagrangian multiplier at the optimum can be interpreted as the marginal value of relaxing the policy constraint. It is the shadow price local officials would be willing to pay for a small relaxation of the constraint.

Substituting μ^* into equation (6.10) gives us

$$\frac{\omega g\prime(X_o^{*d})}{\varphi} = \frac{1}{\delta}[(\beta + \gamma\tau)\pi'(L_u + X_a^{*d}) + \gamma\rho^u - \gamma e'(L_u + X_a^{*d})] + [p^a - c(L_a)]. \quad (6.13)$$

Comparing equation (6.13) with (6.4), because $X_o^{*d} > X_o^*$, a result of the DBP requiring more conversion of other land to agricultural land, and $g'(X_o) > 0$, the following inequality is obtained.

$$\frac{\omega g'(X_o^{*d})}{\varphi} = \frac{1}{\delta}[(\beta + \gamma\tau)\pi'(L_u + X_a^{*d}) + \gamma\rho^u - \gamma e'(L_u + X_a^{*d})] + [p^a - c(L_a)]$$

$$> \frac{\omega g'(X_o^*)}{\varphi} = \frac{1}{\delta}[(\beta + \gamma\tau)\pi'(L_u + X_a^*) + \gamma\rho^u - \gamma e'(L_u + X_a^*)] + [p^a - c(L_a)]$$

Due to the concavity of the revenue function, $\pi(L_u + X_a)$, and the convexity of the expenditure function, $e(L_u + X_a)$, the above inequality implies $X_a^{*d} < X_a^*$. Thus, the DBP will decrease the amount of agricultural land converted to urban uses.

To yield a set of comparative statics of X_a^{*d} and X_o^{*d} as in the pre-policy analysis, first simplify the equation system (6.10) - (6.12) to

$$\frac{1}{\delta}[(\beta + \gamma\tau)\pi' + \gamma\rho^u - \gamma e'] + [p^a - c(L_a)] - \frac{\omega g'}{\varphi} = 0; \quad (6.14)$$

$$\varphi X_o - X_a = 0. \quad (6.15)$$

Implied by equations (6.14) and (6.15), X_a^{*d} and X_o^{*d} are invariant with respect to α, i.e.,

$$\frac{\partial X_a^{*d}}{\partial \alpha} = \varphi \frac{\partial X_o^{*d}}{\partial \alpha} = 0. \quad (6.3.1)$$

Total differentiating equations (6.14) and (6.15) with respect to β, γ, τ, ρ^u, p^a, L_a, L_u, ω, and φ yields the following comparative statics.

$$\frac{\partial X_a^{*d}}{\partial \beta} = \varphi \frac{\partial X_o^{*d}}{\partial \beta} = -\pi'/\hat{h} > 0; \quad (6.3.2)$$

where $\hat{h} = (\beta + \gamma\tau)\pi'' - \gamma e'' - \delta\omega g''/\varphi^2 < 0$, implied by the second-order sufficient condition for a maximum;

$$\frac{\partial X_a^{*d}}{\partial \gamma} = \varphi \frac{\partial X_o^{*d}}{\partial \gamma} = (e' - \tau\pi' - \rho^u)/\hat{h} \underset{<}{\geq} 0 \text{ if } e' - \tau\pi' - \rho^u \underset{>}{\leq} 0; \tag{6.3.3}$$

$$\frac{\partial X_a^{*d}}{\partial \tau} = \varphi \frac{\partial X_o^{*d}}{\partial \tau} = -\gamma\,\pi'/\hat{h} > 0; \tag{6.3.4}$$

$$\frac{\partial X_a^{*d}}{\partial \rho^u} = \varphi \frac{\partial X_o^{*d}}{\partial \rho^u} = -\gamma/\hat{h} > 0; \tag{6.3.5}$$

$$\frac{\partial X_a^{*d}}{\partial p^a} = \varphi \frac{\partial X_o^{*d}}{\partial p^a} = -\delta/\hat{h} > 0; \tag{6.3.6}$$

$$\frac{\partial X_a^{*d}}{\partial L_a} = \varphi \frac{\partial X_o^{*d}}{\partial L_a} = \delta c'/\hat{h} > 0; \tag{6.3.7}$$

$$\frac{\partial X_a^{*d}}{\partial L_u} = \varphi \frac{\partial X_o^{*d}}{\partial L_u} = [\gamma e'' - (\beta + \gamma\tau)\pi'']/\hat{h} < 0; \tag{6.3.8}$$

$$\frac{\partial X_a^{*d}}{\partial \omega} = \varphi \frac{\partial X_o^{*d}}{\partial \omega} = \delta g'/\varphi\hat{h} < 0; \tag{6.3.9}$$

$$\frac{\partial X_a^{*d}}{\partial \varphi} = \varphi \frac{\partial X_o^{*d}}{\partial \varphi} = -\delta\omega g'/\varphi^2\hat{h} > 0; \tag{6.3.10}$$

$$\frac{\partial X_a^{*d}}{\partial L_o} = \varphi \frac{\partial X_o^{*d}}{\partial L_o} = \delta\omega \frac{\partial g'}{\partial L_o}/\varphi\hat{h} > 0. \tag{6.3.11}$$

Note that results (6.3.2) - (6.3.11) are essentially the same as their corresponding results in the pre-policy case. This finding suggests that the DBP will not change the directions of the effects of each factor influencing the optimal amount of land conversion, but it may change the magnitude of the effects. While it is mathematically challenging to compare the magnitude of the post-policy results and the pre-policy results, it is easy to test empirically whether the DBP has changed the effects of other factors on the changes in land use. The testing techniques will be spelt out in Chapter 7.

Results derived in this chapter serve as the testable hypotheses in the empirical examination. Not all of the hypotheses can be tested due to data constraint. The next chapter discusses the data availability, proxies used to measure each parameter, and their limitations.

7 Data

The empirical examination of the relation between land use changes and their driving forces requires two types of data—land use data and economic data. In China, land use data is collected and managed by the MLR and land bureaus at the local levels, while economic data is collected and managed by the National Statistical Bureau and statistical offices at the local levels. The effort on data collection and compilation of this thesis involves extracting land use and economic data from their respective sources and merging them by space and years. The data thus has the panel data nature. This chapter describes the sources, units, and the spatial and temporal dimensions of the data, and provides a summary of descriptive statistics of the data used in this analysis.

7.1 Sources

7.1.1 Land Use Data

As discussed in the literature review, there are two main sources of data for measuring land use changes in China. One is the GIS data estimated from the remote sensing images, and the other is the official data collected and maintained by the MLR. This dissertation adopts the latter. This section will first address the accuracy issue of China's land use data, an issue raised by many researchers, and then introduce the unit of the data.

This thesis covers the period from 1996 to 2004, in which reliable and accurate data for China's cultivated land have been collected. Prior to 1996, areas of land by use were reported by local governments in the hierarchical order and given to the central government. It is well-documented that villages and townships tended to underreport their cultivated land areas for tax relief. Estimates obtained from satellite images reveal that the actual cultivated land in China was nearly 40% more than what had been reported by local land bureaus prior to 1996 (Heilig 1997; Ash and Edmonds 1998; Smil 1999; Lin and Ho 2003). Not only was the total amount underreported, the rate of converting cultivated land to nonagricultural uses was also underestimated by the statistics reported to the central government (Seto and Kaufmann 2003). For example, satellite photos taken of seventeen large urban areas in China in 1987, 1991, and 1995 estimated the rate of land being converted from cultivation to urban uses to be two and half times faster than the official statistics (The United State Embassy 1997).

To obtain accurate and reliable measurement of China's land resources, a comprehensive national land survey was conducted by the MLR between 1984 and 1996. It was the first national land survey in China that adopted a standardized methodology for classifying and measuring land across the country (The Central People's Government of China 2007). More than 50,000 survey personnel were trained and sent to measure every village, town, and city. Data collected during this period was adjusted to the standard time of October 31, 1996, forming the so-called 1996 Land Survey Data. Since 1996, changes in land use at the end of each year were reported by local land bureaus at the county level and above, and added to the 1996 Land Survey Data (Lin and Ho 2003).

While official land data rounded to 10,000 *mu* or sometimes 1,000 hectare can be found in published statistical yearbooks, data as accurate as to 0.1 *mu* is kept confidential by the Chinese government. Thanks to the collaboration of the Lincoln Institute of Land Policy and the MLR of China, this study was granted access to the official land use data rounded to 0.1 *mu* at the county, prefecture, and provincial levels from 1996 to 2004. To avoid confusion caused by the less commonly used Chinese unit for area (*mu*), the land use data in the analysis is scaled to hectares.

7.1.2 Economic Data

The economic data used in this thesis is compiled from published provincial statistical yearbooks. Led by the National Bureau of Statistics of China, each province publishes an annual statistical yearbook which contains data at the provincial, prefecture, and county levels.

The economic variables compiled by this thesis include local GDP from the primary, secondary, and tertiary industries, and local government revenues and expenditures. The primary, secondary, and tertiary industries can be loosely referred to as agricultural, industry, and services sectors, respectively.[15] In the Chinese statistics, GDP and government revenues and expenditures are recorded at the end of the year as the increment in the year (National Statistic Bureau of China). Therefore, they are flow variables, parallel to the annual changes in land areas.

Following Lichtenberg and Ding (2009), the value of land is measured by GDP divided by land areas. Specifically, the average value of cultivated land is calculated as local GDP from primary industry per unit of cultivated land, which is also a measure for the cost of land conversion because land compensation is linear in the agricultural output value according to the compensation formula specified in the LAL. Similarly, the

[15] In China, primary industry refers to agriculture including farming, forestry, animal husbandry and fishery. Secondary industry refers to industry including mining and quarrying, manufacturing, and the production and supply of electricity, water and gas. Tertiary industry refers to all other industries not included in primary or secondary industry, such as services. Source: National Bureau of Statistics of China, http://www.stats.gov.cn/english/indicators/currentsurveysindicators/t20020419_17997.htm

average value of urban land is defined as local GDP from secondary and tertiary industries per unit of urban land.

Additionally, local government revenue and expenditure per unit of urban land are included to capture the relationship between land use changes and local fiscal performance. Local government revenue is a close approximation to the tax revenue generated from the urban sectors, because agricultural taxes accounted for only 4% of China's fiscal income and they were abolished, altogether, in 2004 (Xinhua News Agency, March 6, 2004). It is important to note that data on local government revenues and expenditures published in China’s statistical yearbooks measures the budgetary revenues and expenditures. They are exogenous of the changes of land use, in that land conversions and conveyances only contribute to the off-budgetary revenues, as discussed in Chapter 4.

A final note on the economic data is that all monetary variables in Chinese RMB are normalized to the real year 2004 terms, and then converted to US dollars using the 2004 average annual exchange rate.[16] GDP deflators for agricultural, industry, and services sectors are used to deflate the local GDP from respective sectors. In addition, the GDP deflator for agricultural sector is used to deflate the total output value of farming while the overall GDP deflator is used to deflate the local government expenditures and revenues.

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[16] Chinese GDP deflators and the exchange rate of RMB per US dollar are from the World Development Indicators 2010 published by the World Bank.

7.2 Spatial and Temporal Dimensions

The official land use data is available at three local administrative levels—county, prefecture, and provincial. Based on earlier discussions, the DBP requirement is postulated at the county level in practice, but economic data at the county level is not always available for all counties and all years. Thus, the empirical analysis is implemented at the prefecture level. In addition to data aggregated at the prefecture level, data for four provincial-level municipalities are included for two reasons. First, like in prefectures, the subdivisions of provincial-level municipalities are called urban districts and rural counties. The transitions between urban and rural land within a provincial-level municipality resemble the same transitions within a prefecture. Thus, they can be studied together. Second, the provincial-level municipalities are administered directly by the central government and play a central role in the regional economy. The rate of urbanization and cultivated land loss in these municipalities has been phenomenal and cannot be left out in the study. In the remainder of this dissertation, data is referred to as prefecture-level data, even though it contains some provincial-level observations.

For many prefectures and counties in China, rapid economic growth has demanded some administrative adjustments. Theoretically, prefecture-level cities are more urbanized than prefectures and, likewise, county-level urban districts and cities are more urbanized than counties. When prefectures grow to certain size in their economy and population, they seek the approval of upper-level governments to become prefecture-level cities. Counties upgrade to county-level cities and county-level cities upgrade to urban districts in the same way. It is believed that such upgrades will bring more favorable economic regulations, tax policies, and make the upgraded areas more competitive among jurisdictions of similar population and economic scales in the country (Chan, Henderson, and Tsui 2008).

There are commonly five types of administrative adjustments: (1) move of counties or county-level cities from one prefecture or prefecture-level city to another (hereafter referred to as Type 1); (2) upgrade of counties to county-level cities; (3) upgrade of county-level cities to urban districts; (4) upgrade of prefectures to prefecture-level cities; and (5) name changes. The main concern over the administrative adjustments is regarding the Type 1 adjustment because it causes changes in geographical boundaries which lead to significant changes in land areas and economic variables that cannot be explained by the land conversion process. Sometimes there is a lag between the changes in land use data due to boundary adjustments and the changes in economic data. In other words, some prefectures may still have reported their economic data for the areas under the old administration during the years when such boundary adjustments occurred.

To smooth out the time-series dimension of the data, some cleaning procedures have been applied to make data comparable over time for affected prefectures. For example, if certain counties of prefecture A are merged into prefecture B in 2000, data for these counties, when available, are taken out of prefecture A and added to prefecture B for the entire study period of 1996 – 2004. In doing so, prefectures A and B can be treated as all other prefectures with unchanged total land areas. For many provinces, however, economic data at the county level is not consistently available. To cope with the Type 1 adjustments, data for prefectures A and B are combined for the entire study period, and the "new" prefecture named as A-B is then treated as a single analytical unit. This is also the cleaning procedure adopted by Deng et al. (2008) to cope with the boundary shifts among Chinese counties.

Table 7.1 lists the prefectures that have experienced Type 1 administrative boundary changes in the study period along with the provinces to which they belong, years in which such changes occurred, brief descriptions of the changes, what cleaning procedures applied, and the names of the "made-up" prefectures. After treatment for administrative boundary changes, the data retains 326 prefectural-level divisions as opposed to the 333 prefecture-level divisions as listed in the official record.[17] Along with the four provincial-level municipalities, the cross-sectional component of the data has a total of 330 units.

On the temporal dimension of the data, the study period expands from 1996 to 2004, as determined by the availability of the land use data. First-differencing the land use data leads to the drop of the 2004 data and creates eight time periods for study. Combined with the cross-sectional dimension, the panel dataset of the entire country contains a maximum of 2,640 observations for each variable.

The whole China sample is split into an East China sample and a West and Central China sample in the same manner as in Chapter 2. The eastern and coastal sample has 98 prefectural-level divisions and three provincial-level municipalities over eight years. The West and Central sample has the remaining 228 prefecture-level divisions and one provincial-level municipality.

Table 7.2 summarizes the land variables and economic variables used in the empirical estimation for each of the three samples. Land variables include the contemporary amount of cultivated land, urban land, and unused land, and their annual

[17] The Official Website of the Administrative Division of China. www.xzqh.org

changes in both absolute and percentage terms. The annual percentage changes in land use is calculated as the difference between the logarithm of land area in year *t*+1 and the logarithm of land area in year *t*. Prefectures in China on average have experienced an annual loss of cultivated land, an annual increase of urban land, and an annual loss of unused land. Table 7.3 presents the correlation coefficients between each pair of land use changes.

As shown in Table 7.2, the average annual absolute loss of cultivated land at the prefecture level in West and Central China is nearly twice of that in East China. This is likely due to the Grain for Green (GfG) program discussed in Chapter 2, which has resulted in the reversion of a large amount of marginal cultivated land to forests and grasslands (The Central People's Government of China 2007). However, because prefectures in West and Central China tend to be much larger than their counterparts in East China, the base amount of cultivated land is larger. Consequently, the average annual percentage loss of cultivated land is actually lower in West and Central prefectures than it is in eastern coastal prefectures by 0.1 percentage points. Moreover, the average annual percentage increase in urban land at the prefecture level is faster in East China in both level and percentage terms.

Table 7.2 also shows that the average value of cultivated land, proxied by local GDP from primary industry per unit of cultivated land, and the average value of urban land, proxied by local GDP from secondary and tertiary industries per unit of urban land, are both higher in eastern prefectures than they are in western prefectures. Average annual local budgetary revenue is higher in eastern prefectures, while average annual local budgetary expenditure is higher in western prefectures.

As mentioned in Chapter 2, most of the loss of marginal cultivated land due to the GfG policy is not subject to the DBP. As a result, the impacts of the DBP on land use changes in West and Central China are expected to be different from its impacts in East China, where cultivated land lost to urban uses is mostly prime farmland. Moreover, given the disparities in land values in eastern and western regions of China, as revealed by the descriptive statistics of the economic variables, it would be necessary to examine the economic incentives for cultivated land conversion for these two regions separately.

For these reasons, same empirical analysis is conducted using the whole China, East China, and West and Central China samples separately in the following chapters. Results from the whole China sample will provide a general idea of the driving forces for land use changes and the policy impacts. Results from the eastern and coastal sample would be the most appropriate for analyzing the economic incentives for land use changes between cultivation and urban uses and the impacts of the Dynamic Balance Policy. Results from the West and Central sample will serve as a comparison to illustrate the driving forces for cultivated land loss in West and Central China may be different than they are in East China.

7.3 Indicator for the Dynamic Balance Policy

In addition to the land use and economic variables, another important variable is the indicator for the Dynamic Balance Policy (DBP), which equals one when the policy is in effect and zero otherwise. Its value is determined by when the provincial implementing acts of the 1998 LAL were issued (see Table 3.2). If the provincial implementing act takes effect in the first half of year t, then the policy indicators for year t and thereafter are assigned to be one, meaning that the land conversion in year *t*, i.e., the change in cultivated land area from year *t* to *t*+1, has been influenced by the new law. If the provincial implementing act takes effect in the second half of year *t*, then the policy indicators for year *t*+1 and thereafter are assigned to be one, meaning that the land conversion in year *t*+1, i.e., the change in cultivated land area from year *t*+1 to *t*+2 will capture the impacts of the new law. For example, the Shandong and Guangdong Provincial Implementing Acts of the 1998 LAL took effect on August 22, 1999 and January 8, 2000, respectively. The policy indicators for the prefectures in both provinces are set to be one for the years 2000 - 2003, and zero otherwise.

The last update of the Implementing Acts of the Land Administration Law in Beijing was in 1993. Shown in Table 3.2, Beijing did not issue an implementing act of the 1998 LAL and no clear documentation is found when Beijing adopted the DBP. Regulations on the Collection and Use of Cultivated Land Reclamation Fees promulgated by the Beijing Land Bureau and Finance Bureau on November 26, 2002[18] suggest that Beijing has been following the DBP at least since 2002. Because Beijing is the nation's capital, it is reasonable to assume that Beijing adopted the national law in its land administration when the law became effective on January 1, 1999.

[18] Source: http://www.bjtd.com/article_view.asp?article_id=298

Table 7.1   Prefectures with Boundary Changes

Affected Prefectures/ Prefecture-level Cities	Province	Year	Description of the Boundary Changes	Cleaning Procedures	Names of the Prefectures/Prefecture-level Cities in Data
Tongling Chaohu Liu'an	Anhui	1998 1999	Some boundary adjustments among these three adjacent prefectures.	Data for Tongling, Chaohu, and Liu'an are combined for the entire time series.	Tongling-Chaohu-Liu'an
Bozhou Fuyang	Anhui	2000	The prefecture-level city Bozhou was created, and the county-level city Bozhou that used to be in Fuyang Prefecture became the urban district of the new prefecture level city.	Data for Bozhou and Fuyang are combined for the entire time series.	Fuyang-Bozhou
Hefei Huainan	Anhui	2004	Part of Hefei became under the administration of Huainan.	Data for Hefei and Huainan are combined for the entire time series.	Hefei-Huainan
Bengbu	Anhui	2004	There was a slight increase in the total land area of Bengbu since 2004, but no record for this change. Economic data for Bengbu seem to have captured this change.	None.	Bengbu
Shenzhen	Guangdong	2000	There was a slight increase in the total land area of Shenzhen since 2000, but no record for this change. Economic data for Shenzhen seem to have captured this change.	None.	Shenzhen

Table 7.1 (Continued)

Affected Prefectures/ Prefecture-level Cities	**Province**	**Year**	**Description of the Boundary Changes**	**Cleaning Procedures**	**Names of the Prefectures/Prefecture-level Cities in Data**
Nanning Chongzuo	Guangxi	2002	Chongzuo Prefecture was upgraded to Chongzuo City at the prefecture level. Five counties of Chongzuo Prefecture (Heng, Binyang, Shanglin, Longan, and Mashan) became counties of the prefecture-level city, Nanning.	Data for these five counties from 1996 to 2002 are taken out of Chongzuo, and added into Nanning.	Nanning Chongzuo
Liuzhou Laibin	Guangxi	2002	Laibin Prefecture was upgraded to Laibin City at the prefecture level. Four counties of Laibin Prefecture (Luzhai, Rongan, Sanjiang, and Rongshui) became counties of the prefecture-level city, Liuzhou.	Data for these four counties from 1996 to 2001 are taken out of Laibin, and added into Liuzhou.	Liuzhou Laibin
Wuzhou Hezhou	Guangxi	1997	Hezhou Prefecture was upgraded to Hezhou City at the prefecture level. Three counties of Hezhou Prefecture (Cenxi, Teng, and Mengshan) became counties of the prefecture-level city, Wuzhou.	Data for these four counties of 1996 are taken out of Hezhou, and added into Wuzhou.	Wuzhou Hezhou
Harbin Songhuajiang	Heilongjiang	1996	Songhuajiang was incorporated into Heilongjiang in 1996, but the economic data for the following years have not been adjusted for this change.	Added the data for Harbin and Songhuajiang for the entire time series.	Harbin

Table 7.1 (Continued)

Affected Prefectures/ Prefecture-level Cities	**Province**	**Year**	**Description of the Boundary Changes**	**Cleaning Procedures**	**Names of the Prefectures/Prefecture-level Cities in Data**
Jingmen Jingzhou	Hubei	1997 2003	Part of Jingzhou became under the administration by Jingmen in 1997. Jingshan County and Zhongxiang County that used to be administrated by Jingzhou, became counties of Jingmen in 2003.	Added the data for Jingmen and Jingzhou for the entire time series.	Jingmen-Jingzhou
Suizhou	Hubei	2000	The county-level city, Suizhou, became a prefecture-level city in 2000. The county-level city, Guangshui, became a county-level city of Suizhou.	The county-level data of Suizhou and Guangshui are combined to get the prefecture data for Suizhou 1996-2000. Prefecture-level data for Suizhou after 2000 already exist.	Suizhou
Xianyang Yangling	Shaanxi	1998	The county-level city, Yangling, was taken out of Xianyang Prefecture, and designated as a prefecture-level sample district in 1998.	Data for Xianyang and Yangling are combined for the entire time series.	Xianyang-Yangling
Leshan Meishan	Sichuan	1997	Five counties-Renshou, Pengshan, Hongya, Danling, and Qingshen-were taken out of Leshan Prefecture, and formed a new prefecture-level city, Meishan.	Data for Leshan and Meishan are combined for the entire time series.	Leshan-Meishan
Neijiang Ziyang	Sichuan	1999	Two county-level cities, Ziyang and Jianyang, and two counties, Lezhi and Anyue, were taken out of Neijiang Prefecture, and formed a new prefecture-level city, Ziyang.	Data for Neijiang and Ziyang are combined for the entire time series.	Neijiang-Ziyang

Table 7.1 (Continued)

Affected Prefectures/ Prefecture-level Cities	**Province**	**Year**	**Description of the Boundary Changes**	**Cleaning Procedures**	**Names of the Prefectures/Prefecture-level Cities in Data**
Ili Kazak Ili	Xinjiang	NA	Ili Kazak Autonomous Prefecture includes Ili Prefecture. The data reported for Ili Kazak sometimes include Ili Prefecture and sometimes not.	Data for Ili Kazak and Ili Prefecture are combined for the entire time series.	Ili Kazak
Kunming Dongchuan Qujing	Yunnan	1998	The prefecture-level city, Dongchuan, was incorporated into the prefecture-level city, Kunming. Xundian County was taken out of Qujing City at the prefecture-level, and moved Kunming.	Data for Kunming, Dongchuan, and Qujing are combined for the entire time series.	Kunming-Dongchuan-Qujing (Dongchuan no longer exist)

Table 7.2 Descriptive Statistics of Data Used in Analysis

A. Whole China

Variable	No. of Obs.	Mean	Standard Deviation	Minimum	Maximum
Cultivated Land Area in Year *t* (Ha)	2,640	385,579	333,361	1,392	2,545,017
Urban Land Area in Year *t* (Ha)	2,640	8,893	8,354	77	85,876
Unused Land Area in Year *t* (Ha)	2,640	745,094	2,994,557	601	36,700,000
Absolute Change in Cultivated Land Area from Year *t* to Year *t* +1 (Ha)	2,640	-2,754	9,242	-155,187	95,450
Absolute Change in Urban Land Area from Year *t* to Year *t* +1 (Ha)	2,640	285	952	-15,489	11,174
Absolute Change in Unused Land Area from Year *t* to Year *t* +1 (Ha)	2,640	-177	26,211	-79,217	1,289,941
Log(Cultivated Land in Year *t* +1) - Log(Cultivated Land in Year *t*)	2,640	-0.00856	0.03307	-0.70990	0.37496
Log(Urban Land in Year *t* +1) - Log(Urban Land in Year *t*)	2,640	0.03239	0.08309	-0.31085	1.48984
Log(Unused Land in Year *t* +1) - Log(Unused Land in Year *t*)	2,640	-0.00202	0.07235	-0.85232	1.85253
Local GDP from Primary Industry per Unit of Cultivated Land in Year *t* (2004US$/Ha)	2,562	2,738	3,243	110	43,075
Local GDP from Secondary and Teriary Industries per Unit of Urban Land in Year *t* (2004US$/Ha)	2,562	340,734	236,140	8,549	2,302,404
Local Budgetary Revenue per Unit of Urban Land in Year *t* (2004US$/Ha)	2,538	21,938	17,494	1,268	186,162
Local Budgetary Expenditure per Unit of Urban Land in Year *t* (2004US$/Ha)	2,538	42,294	32,845	2,811	390,032

B. East China

Variable	No. of Obs.	Mean	Standard Deviation	Minimum	Maximum
Cultivated Land Area in Year *t* (Ha)	808	311,088	227,036	5,566	1,132,309
Urban Land Area in Year *t* (Ha)	808	12,915	9,960	1,379	85,876
Unused Land Area in Year *t* (Ha)	808	99,999	161,842	601	1,115,495
Absolute Change in Cultivated Land Area from Year *t* to Year *t*+1 (Ha)	808	-1,772	6,304	-97,537	15,423
Absolute Change in Urban Land Area from Year *t* to Year *t*+1 (Ha)	808	453	1,334	-15,489	10,129
Absolute Change in Unused Land Area from Year *t* to Year *t*+1 (Ha)	808	-519	4,095	-73,634	59,920
Log(Cultivated Land in Year *t*+1) - Log(Cultivated Land in Year *t*)	808	-0.00926	0.04116	-0.70990	0.12109
Log(Urban Land in Year *t*+1) - Log(Urban Land in Year *t*)	808	0.03534	0.07055	-0.26987	0.81878
Log(Unused Land in Year *t*+1) - Log(Unused Land in Year *t*)	808	-0.00394	0.09920	-0.85232	1.13107
Local GDP from Primary Industry per Unit of Cultivated Land in Year *t* (2004US$/Ha)	808	4,722	4,614	358	43,075
Local GDP from Secondary and Teriary Industries per Unit of Urban Land in Year *t* (2004US$/Ha)	808	475,754	279,016	56,454	1,670,239
Local Budgetary Revenue per Unit of Urban Land in Year *t* (2004US$/Ha)	808	27,981	24,225	4,150	186,162
Local Budgetary Expenditure per Unit of Urban Land in Year *t* (2004US$/Ha)	808	40,477	30,183	8,763	390,032

C. West and Central China

Variable	No. of Obs.	Mean	Standard Deviation	Minimum	Maximum
Cultivated Land Area in Year *t* (Ha)	1,832	418,433	365,955	1,392	2,545,017
Urban Land Area in Year *t* (Ha)	1,832	7,119	6,824	77	50,570
Unused Land Area in Year *t* (Ha)	1,832	1,029,612	3,556,458	1,709	36,700,000
Absolute Change in Cultivated Land Area from Year *t* to Year *t*+1 (Ha)	1,832	-3,187	10,245	-155,187	95,450
Absolute Change in Urban Land Area from Year *t* to Year *t*+1 (Ha)	1,832	211	710	-1,546	11,174
Absolute Change in Unused Land Area from Year *t* to Year *t*+1 (Ha)	1,832	-26	31,349	-79,217	1,289,941
Log(Cultivated Land in Year *t*+1) - Log(Cultivated Land in Year *t*)	1,832	-0.00825	0.02879	-0.37598	0.37496
Log(Urban Land in Year *t*+1) - Log(Urban Land in Year *t*)	1,832	0.03109	0.08805	-0.31085	1.48984
Log(Unused Land in Year *t*+1) - Log(Unused Land in Year *t*)	1,832	-0.00118	0.05661	-0.32707	1.85253
Local GDP from Primary Industry per Unit of Cultivated Land in Year *t* (2004US$/Ha)	1,754	1,824	1,707	110	23,704
Local GDP from Secondary and Teriary Industries per Unit of Urban Land in Year *t* (2004US$/Ha)	1,754	278,536	182,625	8,549	2,302,404
Local Budgetary Revenue per Unit of Urban Land in Year *t* (2004US$/Ha)	1,730	19,115	12,252	1,268	127,117
Local Budgetary Expenditure per Unit of Urban Land in Year *t* (2004US$/Ha)	1,730	43,143	33,992	2,811	372,127

Data Sources: The Ministry of Land and Resources of China, and various provincial statistical yearbooks from 1997 to 2005.
Units of Variables: Land areas are in hectares (Ha). Local GDP, total output value of farming, and local budgetary revenues and expenditures per unit of land are in real year 2004 US$ per hectare (2004US$/Ha).

Table 7.3 Correlation Coefficients of Each Pair of Land Use Changes

A. Absolute Change

	Whole China			East China			West and Central China		
	Cultivated	Urban	Unused	Cultivated	Urban	Unused	Cultivated	Urban	Unused
Cultivated	1.0000			1.0000			1.0000		
Urban	-0.0900	1.0000		-0.1871	1.0000		-0.0759	1.0000	
Unused	-0.0035	-0.0197	1.0000	0.2735	-0.0591	1.0000	-0.0128	-0.0238	1.0000

B. Percentage Change

	Whole China			East China			West and Central China		
	Cultivated	Urban	Unused	Cultivated	Urban	Unused	Cultivated	Urban	Unused
Cultivated	1.0000			1.0000			1.0000		
Urban	-0.1622	1.0000		-0.4460	1.0000		-0.0277	1.0000	
Unused	-0.0171	-0.0831	1.0000	0.0470	-0.1971	1.0000	-0.0885	-0.0217	1.0000

8 Empirical Models and Estimation Methods

The empirical goal of this thesis is to examine whether the Dynamic Balance Policy (DBP) has reduced the conversion of cultivated land to urban land in China, and to estimate the strength of the economic incentives for land conversion compared to the strength of the DBP. Based on the theoretical discussion in the previous chapter, this chapter presents the econometric models and estimation methods for achieving this goal. The first section specifies the linear model of the level changes in land areas. The second section transforms the linear model into a log-log model of the percent changes in land areas. Following the model specifications, the third section discusses the estimation methods.

8.1 Model Specification

8.1.1 Linear Model—Level Changes

The theoretical models in Chapter 6 assume that the changes in agricultural land are equal to the changes in urban land in their absolute values. In reality, as shown in the land use trends discussed in Chapter 2, this equality does not hold. Therefore, the empirical analysis requires examining the changes in cultivated land as well as the changes in urban land. In other words, there are two alternative dependent variables in the estimation of optimal cultivated land conversion: X_{it}^{c} for the annual change in cultivated land and X_{it}^{u} for the annual change in urban land. The dependent variable in the estimation of the annual change in unused land is X_{it}^{o}. The subscript, *i*, indicates the cross-sectional unit, and *t* indicates the year.

According to the theoretical analysis in Chapter 6, there are three types of factors influencing the annual changes in cultivated land, urban land, and unused land. The first group includes the economic factors, specifically, the contemporary value of cultivated land measured as GDP from primary industry per unit of cultivated land ($\frac{GDP1_{it}}{L_{it}^{c}}$), the contemporary value of urban land ($\frac{GDP2_{it}+GDP3}{L_{it}^{u}}$) measured as GDP from secondary and tertiary industries per unit of urban land, and the contemporary budgetary revenue and expenditure per unit of urban land ($\frac{GovRev_{it}}{L_{it}^{u}}$ and $\frac{GovExp_{it}}{L_{it}^{u}}$ respectively).

The second type of factors influencing China's land use changes is the administrative factors. In particular, the DBP may change the average changes in land areas as well as the economic incentives for conversion of cultivated land to urban uses. The policy effects are estimated by a policy indicator, d_{it}, which is equal to one if the policy is in effect, and zero if not. The values of d_{it} are assigned based on Table 3.2.

The third type of factors is the initial amounts of cultivated land, urban land, and unused land. Among these factors, the initial amount of unused land, L_{it}^{o}, has the most important policy interest, because it can be used to proxy the cost of converting unused land to cultivated land, a variable that cannot be directly measured.

In light of the policy importance of each type of factors, the basic model of land use changes is comprised of the economic and administrative factors, and the initial amount of unused land is included in the extended model. The basic model is expressed as follows:

$$X_{it}^{k} = L_{it+1}^{k} - L_{it}^{k} = \alpha_0^k + \alpha_1^k \frac{GDP1_{it}}{L_{it}^{c}} + \alpha_2^k \frac{GDP2_{it}+GDP3}{L_{it}^{u}} + \alpha_3^k \frac{GovRev_{it}}{L_{it}^{u}} + \alpha_4^k \frac{GovExp_{it}}{L_{it}^{u}}$$

$$+\alpha_5^k d_{it} + e_i + e_t + e_{it}, \qquad (8.1)$$

where k is an indicator for whether the dependent variable is the annual change in cultivated land ($k = c$), urban land ($k = u$), or unused land ($k = o$). Equation (8.1) is essentially an extended version of the model specified in Lichtenberg and Ding (2009). It includes additionally the government expenditure and the policy dummy.

To control for the cost of converting unused land to cultivated land and to examine how the DBP affects the incentive structure, equation (8.1) is extended to include the initial amount of unused land and the interaction terms between the policy indicator and each explanatory variable:

$$X_{it}^k = L_{it+1}^k - L_{it}^k = \alpha_0^k + \alpha_1^k \frac{GDP1_{it}}{L_{it}^c} + \alpha_2^k \frac{GDP2_{it}+GDP3}{L_{it}^u} + \alpha_3^k \frac{GovRev_{it}}{L_{it}^u} + \alpha_4^k \frac{GovExp_{it}}{L_{it}^u}$$

$$+\alpha_5^k d_{it} + \alpha_6^k L_{it}^o + \alpha_7^k d_{it} \frac{GDP1_{it}}{L_{it}^c} + \alpha_8^k d_{it} \frac{GDP2_{it}+GDP3}{L_{it}^u} + \alpha_9^k d_{it} \frac{GovRev_{it}}{L_{it}^u}$$

$$+\alpha_{10}^k d_{it} \frac{GovExp_{it}}{L_{it}^u} + \alpha_{11}^k d_{it} L_{it}^o + e_i + e_t + e_{it}. \qquad (8.2)$$

Because both land and economic data are reported at the end of the year, equations (8.1) and (8.2) essentially capture the relations between the changes in land areas in year *t*+1 and their influencing factors at the end of year *t*.

As a common practice in panel data analysis, the error terms in equations (8.1) and (8.2) are decomposed into three components. The cross-section component (e_i) accounts for the unobserved heterogeneities among prefectures over the entire sample period. Likewise, the time component (e_t) accounts for the unobserved heterogeneities over time. The third component (e_{it}) captures the idiosyncratic errors that change across *i* as well as across *t*.

The signs of the estimated coefficients in equations (8.1) and (8.2) can be determined by the comparative statics derived in Chapter 6. Specifically, the annual change in urban land is expected to decrease in the value of cultivated land ($\alpha_1^u < 0$), but increase in the value of urban land ($\alpha_2^u > 0$) and the average local budgetary revenue ($\alpha_3^u > 0$). The sign of α_4^u cannot be determined because faster conversion of cultivated land to urban uses can raise more revenues, but at the same time it also requires more expenditure for the provision of public infrastructures on the urban land. The net effect of these two opposite forces is unclear.

Additionally, the DBP is expected to slow down the increase in urban land, i.e., $\alpha_5^u < 0$. Moreover, the annual change in urban land is expected to be larger in areas where there is more unused land ($\alpha_6^u > 0$). Or the annual change in urban land is not related to the initial amount of unused land if the conversion of unused land to cultivated land is not accompanied by conversion of cultivated land to urban land. In this case, $\alpha_6^u = 0$. Whether $\alpha_6^u > 0$ or $\alpha_6^u = 0$ can be tested easily. Also implied by the theoretical results, the DBP will not change the signs of the same comparative statics from the pre-policy analysis, but it will change their magnitudes. If the DBP is effective, it should attenuate the economic incentives for land conversion. Thus, the coefficients, α_7^u, α_8^u, …, α_{11}^u, are expected to be negative.

Because the changes in urban land and changes in cultivated land are in opposite directions, when the dependent variable in equations (8.1) and (8.2) is the annual change in cultivated land (X_{it}^c), a set of opposite signs is expected, i.e., $\alpha_1^c > 0$, $\alpha_2^c < 0$, $\alpha_3^c < 0$, $\alpha_5^c > 0$, and $\alpha_6^c < 0$. Likewise, the coefficients, α_7^c, α_8^c, …, α_{11}^c, are expected to be positive.

Moreover, according to the theoretical results, the annual change in unused land is expected to be negatively correlated with both the value of cultivated land ($\alpha_1^o < 0$) and the value of urban land ($\alpha_2^o < 0$), and also negatively correlated with the average local budgetary revenue ($\alpha_3^o < 0$). Again, the sign of α_4^o cannot be determined due to the compounding effects of the budgetary expenditure. The annual change in unused land and its own initial amount are negatively correlated, i.e., $\alpha_6^o < 0$, implying that areas with more unused land endowment will experience a faster loss of unused land. additionally, the DBP is postulated to increase the conversion of unused land to cultivated land, and thus, $\alpha_5^o < 0$, and α_7^o, α_8^o, …, $\alpha_{11}^o < 0$.

In addition to the statistical significance of each individual coefficient, the joint significance of the coefficients of the policy dummy and the policy interaction terms will be tested to give a sense of the overall effectiveness of the DBP. Furthermore, the theoretical analysis indicates that the relationship between changes in land areas and the value of cultivated land vanishes when the DBP is enforced, i.e., $\alpha_1^k + \alpha_7^k = 0$. This hypothesis can be tested easily using a *t*-test.

8.1.2 Log-Log Model—Percentage Changes

Following Lichtenberg and Ding (2009), the linear model of level changes in land areas is transformed into a log-log model to account for possible nonlinearities in the relations between land use changes and their driving forces. The respective log-log forms of equations (8.1) and (8.2) appear as follows:

$$\log L_{it+1}^k - \log L_{it}^k = \log \frac{L_{it+1}^k}{L_{it}^k}$$

$$= \beta_0^k + \beta_1^k \log \frac{GDP1_{it}}{L_{it}^c} + \beta_2^k \log \frac{GDP2_{it} + GDP3}{L_{it}^u} + \beta_3^k \log \frac{GovRev_{it}}{L_{it}^u}$$

$$+\beta_4^k \log \frac{GovExp_{it}}{L_{it}^u} + \beta_5^k d_{it} + \varepsilon_i + \varepsilon_t + \varepsilon_{it}, \quad (8.3)$$

and

$$\log L_{it+1}^k - \log L_{it}^k = \log \frac{L_{it+1}^k}{L_{it}^k}$$

$$= \beta_0^k + \beta_1^k \log \frac{GDP1_{it}}{L_{it}^c} + \beta_2^k \log \frac{GDP2_{it} + GDP3}{L_{it}^u} + \beta_3^k \log \frac{GovRev_{it}}{L_{it}^u}$$

$$+\beta_4^k \log \frac{GovExp_{it}}{L_{it}^u} + \beta_5^k d_{it} + \beta_6^k \log L_{it}^o + \beta_7^k d_{it} \log \frac{GDP1_{it}}{L_{it}^c}$$

$$+\beta_8^k d_{it} \log \frac{GDP2_{it} + GDP3}{L_{it}^u} + \beta_9^k d_{it} \log \frac{GovRev_{it}}{L_{it}^u} + \beta_{10}^k d_{it} \log \frac{GovExp_{it}}{L_{it}^u}$$

$$+\beta_{11}^k d_{it} \log L_{it}^o + \varepsilon_i + \varepsilon_t + \varepsilon_{it}. \tag{8.4}$$

Mathematically, first differencing the logarithms of the variable in two time periods is approximately the same as the percentage change in the variable if the time horizon is short, in this case, one year. Therefore, the dependent variables in equations (8.3) and (8.4) are in essence the same as the dependent variable in Lichtenberg and Ding's (2009) linear-log model, $\frac{L_{it+1}^k - L_{it}^k}{L_{it}^k}$.

In addition to taking into account the possible nonlinearities in the model, the log-log model allows us to examine the change in the rate of land use changes. Instead of the marginal effects in absolute terms indicated by the estimated coefficients from the linear model, the estimated coefficients in the log-log model can be interpreted as the elasticity of the ratio of land area in *t*+1 over land area in *t* with respect to each parameter. In general notations, the elasticity is expresses as

$$\eta = \frac{\frac{\partial(y_{t+1}/y_t)}{y_{t+1}/y_t}}{\frac{\partial x_t}{x_t}},$$

where η denotes a generic coefficient estimator, *x* denotes a generic explanatory variable, and *y* in this case denotes the land area in any use. Because the annual percentage change in *y* can be expressed as

$$r = y_{t+1}/y_t - 1,$$

with some mathematical manipulation, the change in *r* implied by 1% change in *x* can be expressed as

$$\Delta r = \eta \cdot \frac{y_{t+1}}{y_t} = \eta(r + 1). \tag{8.5}$$

With the estimation results generated in the next chapter, equation (8.5) will be used to calculate the change in the annual rate of urban land expansion and the change in the annual rate of cultivated land loss with a 1% change in the average value of cultivated land or urban land, or a 1% change in the average local budgetary revenue or expenditure.

The log-log model helps us pinpoint important factors influencing land use when their marginal effects are small in hectares, but large in percentages. Such findings are especially valuable for small prefectures where the land use changes may not be sizeable by absolute measures but could be very significant in percentage terms.

The error terms in the log-log model is specified in the same fashion as they are in the linear model. The same estimation methods will be adopted for both models, which are discussed in the next section. The functional-form transformation does not change the predicted signs of the coefficient estimators. And the same hypothesis testing will be performed on both the linear and the log-log models.

8.2 Fixed Effects and Difference-in-Difference Estimations

Equations (8.1) - (8.4) specify the error terms into three components: the cross-section component accounting for the unobserved heterogeneities among prefectures over the entire sample period, the time component accounting for the unobserved heterogeneities over time, and the idiosyncratic component that changes across sections as well time. In the panel data analysis, the unobserved heterogeneities among prefectures and over time can be treated either as fixed effects (FE) or random effects (RE). When they are treated as FE, the estimation is essentially the difference-in-difference (DID) estimation in the literature of policy evaluation, and the policy estimator, α_5^k or β_5^k, can be interpreted as a DID estimator.

Wooldridge (2002) and Bertrand, Duflo, and Mullainathan (2004) argue when there are multiple time periods, and groups are exposed to the policy intervention at various times, the DID estimation is an application of the two-way FE model. Specifically, the cross-sectional FE control for the unobserved permanent differences between the treatment group (group experiencing the policy intervention) and the control group (group not experiencing the policy intervention); likewise, the time FE control for the trend in the outcome variable that exists in both groups.

As shown in Table 3.2, the effective date of the DBP varies by province, which divides the sample into a control group (prefectures not subject to the DBP) and a treatment group (prefectures subject to the DBP). The prefecture-specific FE control for the differences across prefectures (either in the control or treatment group) that are constant over time, and the year-specific FE control for the differences over time that are common to all prefectures. Modeling the error terms as FE removes the bias in the estimated policy impact that arises from other influential factors unrelated to the policy.

Furthermore, Figure 8.1 demonstrates that the timing of the passage of provincial implementing acts of the 1998 LAL is uncorrelated with the average annual percentage loss of cultivated land before their implementation of the new law, ruling out the possibility that provinces with faster cultivated land loss tend to wait for longer to implement the national policies of curtailing cultivated land conversion. This finding suggests that provincial implementation of the Dynamic Balance Policy in China is purely determined by administrative forces outside the model. And thus, the policy indicator can be treated as exogenous.

Standard FE estimators are prone to problems of cross-sectional heteroskedasticity and autocorrelation within each cross-section. The estimators will still be unbiased and consistent if heteroskedasticity and/or autocorrelation present, but they will have improper variance matrix estimates, which will affect the hypothesis testing (Wooldridge 2002). Moreover, as Bertrand, Duflo, and Mullainathan (2004) point out, the DID estimator of the policy in this case has a potential problem with clustered error terms as the unit of observation (prefectures) is more detailed than the level of variation (provinces). To obtain correct variance estimates, the next section performs a series of specification tests to determine the regression models.

8.3 Specification Tests

8.3.1 Heteroskedasticity with Clusters and/or Autocorrelation

Panel heteroskedasticity is tested using the Stata command *xttest3*, which performs a modified Wald test for groupwise heteroskedasticity in fixed effect models. The *xttest3* command tests the hypothesis that

sigma(i)^2 = sigma^2 for i=1,…, N,

where *N* is the number of cross-sectional units. The resulting test statistic is distributed Chi-squared (*N*) under the null hypothesis of homoskedasticity (Stata Manual).

Table 8.1 lists the modified Wald test results for each regression specified in section 8.1, using three samples discussed earlier. The statistics of all tests reject the null hypothesis that the model of homoskedastic error terms fits better than the model of heteroskedastic error terms, indicating the existence of heteroskedasticity.

The first-order autocorrelation (AR(1)) within each prefecture is tested for each regression using the method developed by Wooldridge. A brief account of Wooldridge's method is given in the appendix. Table 8.2 lists the Wooldridge test results for serial correlation for each regression. The test statistics show that AR(1) exists in changes in urban land area in both level and percentage terms, with or without policy interaction terms, and whether estimation uses the whole China sample or the East China sample. The test statistics support the existence of AR(1) in changes in cultivated land area only in the East China sample, and the existence of AR(1) in changes in unused land area only when policy interaction terms are included. Accordingly, models with

AR(1) disturbances should be estimated using the two-way FE regression with the autocorrelation correction.

To illustrate how heteroskedasticity and AR(1) corrections affect the estimates, each model is estimated by two-way FE without such corrections. The standard panel data FE estimations without corrections are carried out using the Stata command *xtreg*, *fe*. Note that this command fits data with group-specific one-way FE models. Dummy variables for years 1997 – 2003 are added manually.

For the coexistence of panel heteroskedasticity with cross-sectional correlation (or so-called clusters) and panel-level AR(1) in error terms, only two commands in Stata have the full options to obtain heteroskedastic and autocorrelation-consistent (HAC) and cluster-robust variance estimates: *xtgls* and *xtpcse*. The *xtgls* command fits panel-data linear models using feasible generalized least squares (FGLS), and allows estimation in the presence of AR(1) within panels, cross-sectional correlation, and heteroskedasticity across panels. However, to use *xtgls*, the data needs to have many time series and few panels for consistent estimates (Wiggins 1999). Since our data has 8 time periods and 330 panels, *xtgls* would be inappropriate. Therefore, the estimations opt for the command *xtpcse*, with the option *correlation(ar1)*. When computing the standard errors and the variance-covariance estimates, *xtpcse* assumes that the disturbances are heteroskedastic and contemporaneously correlated across panels. With the *correlation(ar1)* option, the model is estimated by Prais-Winsten FGLS assuming an AR(1) process in the disturbances (Stata Manual). Note that estimates produced by *xtpcse* are consistent but inefficient (Wiggins 1999).

8.3.2 Omitted Variable Bias

Limited by data, this thesis by no means would have controlled all factors that influence the land use changes in China. However, the omitted variable bias (OVB) should be minimal as the prefecture-specific and year-specific FE adopted in the empirical estimation serve to control for the influences of unobserved variables across prefectures and over time, respectively. Nevertheless, if the unobserved variables are correlated with one or more of the included explanatory variables, then the coefficient estimates would still be biased. Based on earlier discussions on the GfG policy driving the majority of the cultivated land loss in West and Central China, it is necessary to examine whether this policy is correlated with any of the included explanatory variables, and whether omitting this variable would cause OVB.

One possible correlation is between the GfG payment and the agricultural GDP, which is the main regressor in the specified models above. The discussion in Chapter 2 reveals that compensation of the GfG program consists of grain, cash, and/or seedlings. Free seedlings are only given to farmers who agree to convert their cultivated land to forests, and the value of seedlings is independent of the agricultural productivity on the previously cultivated land. The grain and cash compensation varies slightly by location based on agricultural productivity. Specifically, compensation in the upper reaches of Yangtze River is about 30-50% higher than the compensation in the middle and upper reaches of Yellow River (Uchida, Xu, and Rozelle 2005; The Central People's Government of China 2007). Moreover, disclosed by the policy document in 2007, the compensation standard has not changed since its promulgation in 1999 (The Central People's Government of China 2007). While data on the average amount of compensation per hectare of land in the GfG program for the study period is not found, available data indicates that the average compensation per hectare of participating land from 2004 to 2009 is practically the same (Table 8.3). Because the GfG payment is not serially correlated with agricultural GDP, and the cross-sectional variations have been controlled by the prefecture-specific FE, the OVB should not be a problem for the estimator of the agricultural GDP per unit of cultivated land.

Another possible correlation is between the GfG payment and the indicator for the DBP. Because cultivated land lost to forests and grasslands due to the GfG policy does not need to meet the DBP requirement, the estimated effect of the DBP in the models of cultivated land changes may be biased downwards. Such biases may especially exist in the regressions for West and Central China where a vast amount of cultivated land loss is due to the GfG policy.

8.4 Two-Stage Estimations

The theoretical analysis assumes that the conversion of cultivated land to urban uses and the conversion of unused land to cultivated land are simultaneous decisions, and solves the equation system simultaneously to get the optimal rate of land conversions of each type. Therefore, the estimation equations of changes in urban land, changes in cultivated land, and changes in unused land can be estimated independently.

Implied by the requirement of the DBP to compensate for the loss of cultivated land with unused land, there seems to be a recursive structure in China’s land conversion. In particular, the amount of unused land converted to cultivated land may depend on the amount of cultivated land converted to urban uses. If the DBP is effective, then faster conversion of cultivated land to urban uses will result in faster conversion of unused land to cultivated land. It would be interesting for policy makers to determine the effects of changes in urban land and changes in cultivated land on changes in unused land.

Under this scenario, the econometric model can be formulated as a two-stage FE model. In the first stage, annual changes in urban land or cultivated land are estimated according to the specifications in section 8.1. Then, in the second stage, annual changes in unused land are estimated using the predicted changes in urban land or cultivated land from the first-stage estimations. The two-stage least squares (2SLS) with two-way FE model is specified as

$$X_{it}^{o} = L_{it+1}^{o} - L_{it}^{o} = \gamma_0^k + \gamma_1^k \hat{X}_{it}^{k} + \gamma_2^k d_{it} + \gamma_3^k L_{it}^{o} + \epsilon_i + \epsilon_t + \epsilon_{it}, \tag{8.6}$$

and

$$\log L_{it+1}^{o} - \log L_{it}^{o} = {\gamma'}_0^k + {\gamma'}_1^k \widehat{\log} \frac{L_{it+1}^{k}}{L_{it}^{k}} + {\gamma'}_2^k d_{it} + {\gamma'}_3^k \log L_{it}^{o} + \epsilon_i' + \epsilon_t' + \epsilon_{it}', \tag{8.7}$$

where $\hat{X}_{it}^{k}$ and $\widehat{\log} \frac{L_{it+1}^{k}}{L_{it}^{k}}$ are the predicted value of the first-stage regressions specified as models (8.1) - (8.4).

The predicted signs of the estimated coefficients of the initial level of unused land and the policy indicator are the same as before, i.e., $\gamma_2^k, {\gamma'}_2^k < 0$ and $\gamma_3^k, {\gamma'}_3^k < 0$ When $k = c$, meaning equations (8.6) and (8.7) capture the relationship between the change in cultivated land area and the change in unused land area. Because unused land is supposed to be used to make up of the loss of cultivated land, the change in cultivated land and the change in unused land are expected to be positively correlated, i.e., $\gamma_1^c, {\gamma'}_1^c > 0$. When $k = u$, if the data supports the assumption that the loss of cultivated land is approximately equal to the increase in urban land, then the change in urban land and the change in unused land are expected to be negatively correlated, i.e., $\gamma_1^u, \gamma'^u_1 < 0$.

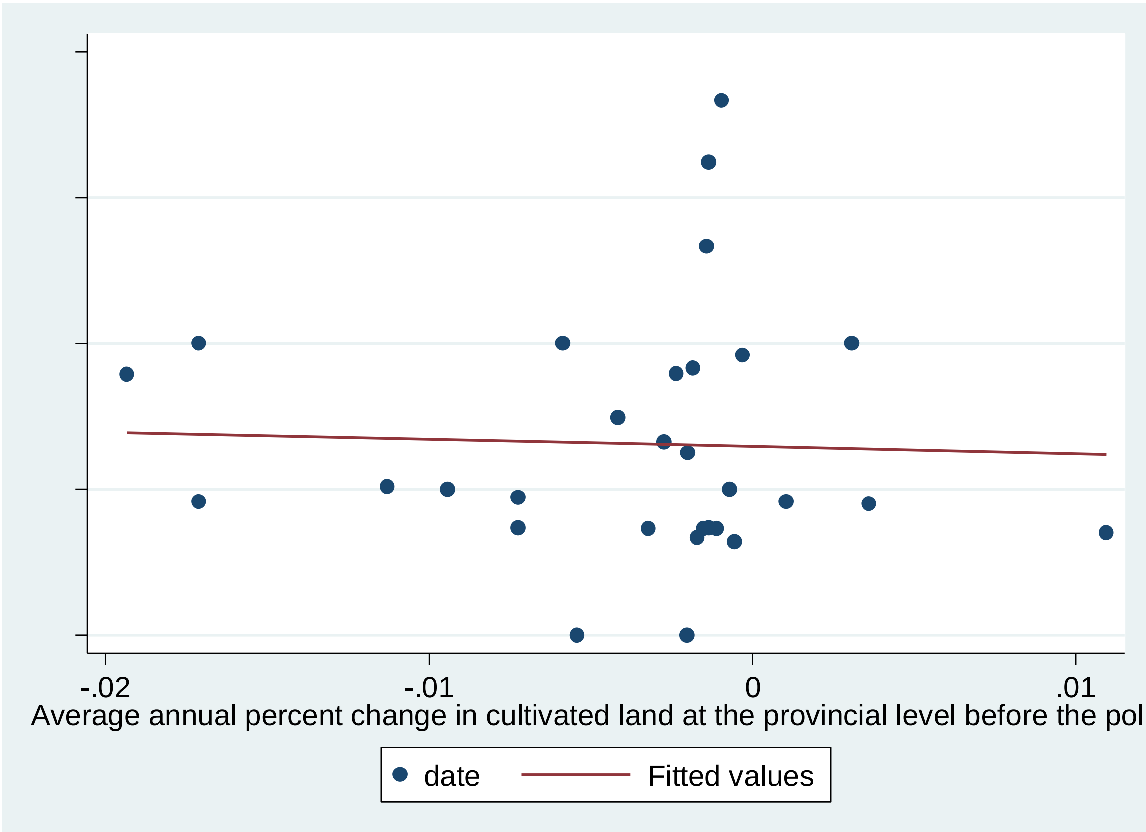
In the setup of (8.6) and (8.7), the explanatory variables used in the first-stage regressions of changes in cultivated land and urban land are essentially the instrumental variables (IV) of the second-stage regressions of changes in unused land. The two-stage FE regressions are executed using the Stata command *xtivreg2*, *fe*, which implements IV estimation of the FE panel data models with possibly endogenous regressors. This command also performs HAC and cluster-robust variance estimation though options *bw(#)* and *cluster(prefecture)*. The option *bw(#)* requests kernel-based autocorrelation-consistent variance-covariance estimation. The default kernel is the Bartlett kernel. The option *cluster(prefecture)* causes *xtivreg2* to report variance-covariance estimation that are robust to both arbitrary heteroskedasticity and arbitrary cross-sectional correlation (Stata Manual).

In the IV estimation, a series of tests need to be conducted for the validity of the instruments. The command *xtivreg2* performs the over-, under- and weak identification tests automatically after the IV estimation.

The two requirements for an IV are first, it must be correlated with the dependent variable in the first stage; second, it must be uncorrelated with the error terms in the second-stage regression. The over-identification test is performed to test whether the instruments are valid (which is the null hypothesis), i.e., uncorrelated with the error term, and that the excluded instruments are correctly excluded from the estimated equation. Under the null, the test statistic (called Hansen J statistic) is distributed as chi-squared (Stata Manual).

The under-identification test is an LM test of whether the equation is identified, i.e., that the excluded instruments are correlated with the endogenous regressors. A rejection of the null indicates that the model is identified. The weak identification test tests whether the excluded instruments are correlated with the endogeous regressors, but only weakly. The Stata reports the Cragg-Donald F statistic for the weak identification test, and the Stock-Yogo critical values if available (Stata Manual).

Figure 8.1 No Correlation between the Provincial Effective Dates of the Dynamic Balance Policy and Cultivated Land Loss before the Policy



Note:
Qinghai is not included in the graph. Qinghai had a very high rate of cultivated land loss and much delayed implementation of the 1998 LAL. The inclusion of Qinghai in this test would imply a negative correlation between the effective date of the Dynamic Balance Policy and the rate of cultivated land loss. However, the major cause of cultivated land loss in Qinghai is the reversion to forests and grasslands, and the reasons for Qinghai to delay passing the provincial implementing act of the 1998 LAL may not explain the decision-making in other provinces. Thus, it is appropriate to exclude Qinghai in the test.

Table 8.1 Modified Wald Test Results for Panel Heteroskedasticity

A. Whole China

Dependent Variable	Without Policy Interaction Terms		With Policy Interaction Terms	
	Chi2 (330)	*P*-Value	Chi2 (330)	*P*-Value
Absolute Change in Cultivated Land Area from Year *t* to *t*+1 (Ha)	1.5e+06	0.0000	1.2e+06	0.0000
Absolute Change in Urban Land Area from Year *t* to *t*+1 (Ha)	8.0e+07	0.0000	1.5e+07	0.0000
Absolute Change in Unused Land Area from Year *t* to *t*+1 (Ha)	8.0e+07	0.0000	1.4e+08	0.0000
Percentage Change in Cultivated Land Area from Year *t* to *t*+1 (Ha)	1.3e+06	0.0000	9.8e+05	0.0000
Percentage Change in Urban Land Area from Year *t* to *t*+1 (Ha)	4.0e+05	0.0000	5.2e+05	0.0000
Percentage Change in Unused Land Area from Year t to t+1 (Ha)	2.3e+08	0.0000	3.7e+07	0.0000

B. East China

Dependent Variable	Without Policy Interaction Terms		With Policy Interaction Terms	
	Chi2 (101)	*P*-Value	Chi2 (101)	*P*-Value
Absolute Change in Cultivated Land Area from Year *t* to *t*+1 (Ha)	1.4e+05	0.0000	45829.95	0.0000
Absolute Change in Urban Land Area from Year *t* to *t*+1 (Ha)	4.7e+05	0.0000	3.3e+05	0.0000
Absolute Change in Unused Land Area from Year *t* to *t*+1 (Ha)	2.5e+06	0.0000	1.5e+06	0.0000
Percentage Change in Cultivated Land Area from Year *t* to *t*+1 (Ha)	2.2e+05	0.0000	2.0e+05	0.0000
Percentage Change in Urban Land Area from Year *t* to *t*+1 (Ha)	31048.17	0.0000	34178.11	0.0000
Percentage Change in Unused Land Area from Year t to t+1 (Ha)	3.6e+06	0.0000	3.2e+07	0.0000

C. West and Central China

Dependent Variable	Without Policy Interaction Terms		With Policy Interaction Terms	
	Chi2 (229)	*P*-Value	Chi2 (229)	*P*-Value
Absolute Change in Cultivated Land Area from Year *t* to *t*+1 (Ha)	5.3e+05	0.0000	5.5e+05	0.0000
Absolute Change in Urban Land Area from Year *t* to *t*+1 (Ha)	2.8e+06	0.0000	3.7e+06	0.0000
Absolute Change in Unused Land Area from Year *t* to *t*+1 (Ha)	4.5e+07	0.0000	3.9e+07	0.0000
Percentage Change in Cultivated Land Area from Year *t* to *t*+1 (Ha)	1.2e+06	0.0000	9.1e+05	0.0000
Percentage Change in Urban Land Area from Year *t* to *t*+1 (Ha)	4.7e+05	0.0000	8.3e+05	0.0000
Percentage Change in Unused Land Area from Year t to t+1 (Ha)	1.9e+07	0.0000	2.2e+07	0.0000

Table 8.2 Wooldridge Test Results for Panel-Level Autocorrelation

A. Whole China

Dependent Variable	Without Policy Interaction Terms		With Policy Interaction Terms	
	Test Statistic	*P*-Value	Test Statistic	*P*-Value
Absolute Change in Cultivated Land Area from Year *t* to *t*+1 (Ha)	0.012	0.9115	0.009	0.9253
Absolute Change in Urban Land Area from Year *t* to *t*+1 (Ha)	27.645	0.0000	38.185	0.0000
Absolute Change in Unused Land Area from Year *t* to *t*+1 (Ha)	1.540	0.2155	1609.867	0.0000
Percentage Change in Cultivated Land Area from Year *t* to *t*+1 (Ha)	0.244	0.6216	0.222	0.6381
Percentage Change in Urban Land Area from Year *t* to *t*+1 (Ha)	18.251	0.0000	18.473	0.0000
Percentage Change in Unused Land Area from Year t to t+1 (Ha)	1.690	0.1946	473.656	0.0000

B. East China

Dependent Variable	Without Policy Interaction Terms		With Policy Interaction Terms	
	Test Statistic	*P*-Value	Test Statistic	*P*-Value
Absolute Change in Cultivated Land Area from Year *t* to *t*+1 (Ha)	5.207	0.0246	4.081	0.0460
Absolute Change in Urban Land Area from Year *t* to *t*+1 (Ha)	54.966	0.0000	68.258	0.0000
Absolute Change in Unused Land Area from Year *t* to *t*+1 (Ha)	0.116	0.7337	493.329	0.0000
Percentage Change in Cultivated Land Area from Year *t* to *t*+1 (Ha)	4.154	0.0442	4.372	0.0391
Percentage Change in Urban Land Area from Year *t* to *t*+1 (Ha)	27.621	0.0000	32.580	0.0000
Percentage Change in Unused Land Area from Year t to t+1 (Ha)	1.784	0.1846	254.589	0.0000

C. West and Central China

Dependent Variable	Without Policy Interaction Terms		With Policy Interaction Terms	
	Test Statistic	*P*-Value	Test Statistic	*P*-Value
Absolute Change in Cultivated Land Area from Year *t* to *t*+1 (Ha)	0.459	0.4988	0.447	0.5045
Absolute Change in Urban Land Area from Year *t* to *t*+1 (Ha)	0.708	0.4010	0.808	0.3696
Absolute Change in Unused Land Area from Year *t* to *t*+1 (Ha)	1.497	0.2224	1757.557	0.0000
Percentage Change in Cultivated Land Area from Year *t* to *t*+1 (Ha)	1.776	0.1839	1.823	0.1783
Percentage Change in Urban Land Area from Year *t* to *t*+1 (Ha)	9.577	0.0022	10.237	0.0016
Percentage Change in Unused Land Area from Year t to t+1 (Ha)	0.696	0.4052	321.618	0.0000

Table 8.3 Average Nominal Payment per Hectare of Land Participating in the Grain for Green Program

Year	Payment per Hectare (Current RMB)
2004	2,549
2005	2,771
2006	2,550
2007	2,520
2008	2,397
2009	2,365

Data Source: China Land and Resources Statistical Yearbooks 2004 – 2009.

9 Estimation Results and Policy Implications

9.1 Estimation Results

Based on the discussion in the previous chapter, the econometric implementation of the empirical models first performs the two-way FE regressions without corrections for heteroskedasticity with clusters or AR(1), and then correct the variance-covariance estimates for heteroskedasticity with clusters for all regressions and AR(1) for regressions in which AR(1) is detected (see Table 8.2). In Tables 9.1 - 9.4, regressions corrected for AR(1) according to Table 8.2 are highlighted in bold.

This chapter discusses the results with HAC and cluster-robust variance estimates. The results from the standard two-way FE regressions without corrections serve as the comparison to show how correct variance estimation can affect hypothesis testing. For example, correcting for heteroskedasticity with clusters has made many standard errors smaller, and consequently changed many coefficient estimates from statistically insignificant to significant. Such changes will lead to very divergent policy implications.

The discussion of the policy implications of these results is organized as follows. Section 9.2 investigates the impacts of the Dynamic Balance Policy on land use changes and on economic incentives driving the land use changes. Section 9.3 discusses the strength of the economic incentives for cultivated land conversion. Section 9.4 examines whether changes in unused land correspond to changes in cultivated land or urban land. Section 9.5 considers a few policy recommendations. Section 9.6 addresses the limitations of the empirical results.

9.2 Impacts of the Dynamic Balance Policy

The Dynamic Balance Policy (DBP) is expected to have positive effects on the average change in cultivated land area and negative effects on the average change in urban land area. Estimated coefficients of the policy indicator from regressions without policy interaction terms mostly have the expected signs, but they are all statistically insignificant except the one from the model of percent change in urban land area in West and Central China (Tables 9.1 and 9.2).

Moreover, the DBP is expected to affect both the average changes in land areas (the intercept in the regression equation) and the economic incentives faced by local officials (the slope of the regression equation with respect to each economic factor). The empirical results summarized in Tables 9.3 and 9.4 show that regressions with policy interaction terms yield some evidence for the policy effects on the average changes in cultivated land and urban land areas, as well as the joint effects of the policy on the average land use changes and on how other variables affects the average land use changes.

Although some coefficients of the policy indicator from the regressions with interaction terms have the expected signs and are statistically significant, whether the policy has been effective needs to be evaluated by its overall effects using all of the interaction terms. Accordingly, the coefficient of each interaction term is multiplied by the mean of the associated variable over the subsample where the DBP is in effect, and then the sum of the products is added to the coefficient of the policy indicator. The result is the difference in the dependent variable between setting the policy indicator equal to one and setting it equal to zero, i.e., the incremental effect of the DBP. A Wald test is performed to determine if this means-weighted sum of coefficients is significantly from zero. For the linear models, the Wald test for linear constraints is used, and for the log-log models, the Wald test for nonlinear constraints is used.

The nonlinearity of the test is introduced because in the log-log functional form, the estimated coefficient of the policy indicator needs be transformed according to the function below in order to be interpreted as the percentage effect of the policy on the dependent variables:

$$s = exp(b - V(b)/2) - 1 \quad , \tag{9.1}$$

where *s* is the percentage impact of the policy, *b* is the estimated coefficient of the policy indicator, and *V*(*b*) is the estimated variance of *b* (Halvorsen and Palmquist 1980; Kennedy 1981). Thus, in the weighted sum of coefficients described above, the coefficient of the policy indicator is transformed according to equation (9.1).

Table 9.7 summarizes the overall effects of the DBP on cultivated land, urban land, and unused land areas, along with the Wald test statistics and *p*-values. As shown in Table 9.7, when the effect of the DBP is evaluated jointly with its interactions with the economic factors, the overall policy effect is statistically insignificant in both level and percentage terms in most cases. Specifically, there is no evidence for any effects of the DBP on changes in cultivated land or urban land areas. The only statistically significant evidence indicates that the ratio of unused land area in year *t*+1 over its area in year *t* increases by 0.004% in West and Central China if the DBP is in effect.

Perhaps, the results from the 2SLS FE estimation render more evidence for the policy impacts on unused land. Table 9.5 and 9.6 report the second-stage regression results only because the first-stage regressions in the 2SLS estimations are the same as those presented in Tables 9.1 - 9.4. Also reported are the results of over-, under- and weak identification tests. All of the over-identification test statistics do not reject the null hypothesis of valid instruments, except the model of testing the relationship between the level change in unused land area and the level change in urban land area in whole China (at the 10% significance level). More than half of the under-identification test statistics (15 out of 24) reject the null hypothesis, meaning the model is indentified. Some of the weak-identification test statistics do not reject the null hypothesis at any significance levels, indicating that the excluded variables may be weakly correlated with the error terms in some regressions.

Results in Table 9.5 and 9.6 indicate that when the DBP is in effect, the annual level change in unused land areas will increase in East China and in China as a whole, but the percentage change will not be affected. Results consistently suggest that the changes in unused land areas, in both level and percentage terms, are strongly correlated with the initial amount of unused land in a prefecture. Prefectures with more unused land to start with tend to experience faster losses of unused land.

Overall, there is no empirical evidence for the effects of the DBP. The absence of the overall effects of the policy may be attributed to the overpowering economic incentives for cultivated land conversion. The next section details the effects of the economic incentives on land use changes and compares the strength of the policy impacts with that of the economic incentives.

9.3 Strength of the Economic Incentives

In the estimations of changes in cultivated land and urban land areas, most of the estimated coefficients of the average values of cultivated land and urban land, and the average values of local budgetary revenue and expenditure have the predicted signs, and a majority of them are statistically significant. One unexpected result is the positive and statistically significant correlations between the value of urban land and the level changes in cultivated land. However, this correlation becomes negative or statistically insignificant in the regressions of percentage changes in cultivated land. Thus, it is the best to interpret the correlation between the value of urban land and changes in cultivated land as ambiguous.

Another peculiar result is that in the regressions of percentage change in cultivated land with the whole China sample, nearly all of the coefficient estimates become statistically insignificant, even though they are significant in the corresponding regressions of level changes. Because the results from the whole China regressions may not be robust, the implications in the discussion are mainly drawn from the results from the East and West and Central samples.

To sum, the annual changes in cultivated land, in both level and percentage terms are positively correlated with the value of cultivated land, and negatively correlated with local budgetary revenue and expenditure per unit of land. Likewise, the annual changes in urban land, in both level and percentage terms, are positively correlated with the value of urban land, local budgetary revenue per unit of land, and local budgetary expenditure per unit of land. These relationships are consistent with the findings in Lichtenberg and Ding (2009), using the same data and similar estimation procedures. Moreover, very few results show any relationships between changes in urban land area and the value of cultivated land. In the models with policy interaction terms, the test for the effects of cultivated land value on changes in urban land area under the DBP concludes that there are no such effects, consistent with the theoretical prediction.

These results reveal that local officials facing a higher value of cultivate land, and thus, a higher cost of land conversion, will slow down the rate of cultivated land conversion. Local officials facing a higher value of urban land will increase the rate of cultivated land conversion. Also, in areas where the average local government expenditure is expected to rise, more cultivated land will be converted to urban land to finance the anticipated expenditure. As a result, urban land expansion accelerates if the average local government revenue and/or expenditure increase.

The magnitudes of the estimated coefficients in the models of level changes in land areas are fairly small. On average, an increase of US$1 per hectare in the cultivated land value will reduce the annual loss of cultivated land by about one hectare. The absolute effects of a US$1 per hectare change in the urban land value, and the average local budgetary revenue and expenditure on changes in cultivated land and urban land areas are even smaller, ranging from 0.001 to 0.1 hectares.

Argued by Lichtenberg and Ding (2009), the strength of the economic incentives for land use changes may be best gauged by the coefficients from the log-log models, because they indicate the elasticity of the ratio of land area in t+1 over land area in t with respect to each influencing factor. Overall, the elasticities of the ratios of land area in t+1 over land area in t with respect to each economic factor are mostly comparable in East China and in West and Central China, with some higher in East China, indicating that changes in land areas in this region have been more responsive to the economic incentives than they are in other parts of the country.

On average, the elasticity of the ratios of cultivated land area in *t*+1 over cultivated land area in *t* with respect to agricultural land value is about 0.11 in East China, 0.02 in West and Central China, zero in China as a whole. The elasticity of the ratios of urban land area in *t*+1 over urban land area in *t* with respect to urban land value is about 0.11-0.13 in all three regions. These elasticities indicate that the average effect of a 1% increase in cultivated land value or urban land value is smaller than the direct effect of the DBP on the percentage land use changes. However, in reality, China is experiencing some 10% or higher increases in land values, especially in the urban areas. For this reason, the strength of the economic incentives for cultivated land conversion still outweighs that of the policy disincentives. This in part explains why the overall effect of the policy interacted with economic incentives appears so small.

Using equation (8.5) and the average annual percent changes in land areas in Table 7.2, the elasticities of the ratios of land area in *t*+1 over land area in *t* can be converted to the percentage point changes in land areas for a 1% increase in economic factors. After the conversion, the results indicate that on average, the annual percentage change in urban land area in East China increases by 0.11 percentage points with a 1% increase in the value of urban land. This result is in the range of those found by Lichtenberg and Ding (2009) using the sample of prefecture-level cities in East China. They found that a 1% increase in urban land value was associated with a 0.12-0.13 percentage point increase in urban land area.

In addition to the estimation of the economic incentives for changes in cultivated land and urban land areas, the third equation in the estimation model is the change in unused land as a function of the same economic incentives. Empirical results indicate that the conversion of unused land to cultivated land is not driven by economic factors in East China. In West and Central China and in China as a whole, changes in unused land are found to be negatively correlated with the value of cultivated land. One possible explanation for this correlation is that in areas where the value of cultivated land is higher, more unused land is converted to cultivated land, regardless of the DBP.

Nevertheless, when the DBP is in effect, the conversion of unused land to cultivated land in China is maybe a sequential action of cultivated land conversion. The next section discusses the relationship between the change in cultivated land or urban land area and the change in unused land area.

9.4 Impacts of Cultivated Land Conversion on Unused Land

As mentioned before, the examination of the relationship between the change in cultivated land or urban land area and the change in unused land area would be of policy interest as the conversion of unused land to cultivated land in China may be merely a sequential action of cultivated land conversion. This section discusses the impacts of cultivated land conversion on unused land based on the 2SLS or IV estimation results summarized in Table 9.5 and 9.6.

Overall, there is a lack of evidence for any relationships between the change in unused land and the change in cultivated land or urban land. The initial amount of unused land in a prefecture remains as the dominating force for the changes in unused land area. Results consistently show that areas with more unused land in the initial time period experience a faster loss of unused land.

9.5 Policy Recommendations

Empirical evidence suggests that the DBP has had no effects of reducing China's cultivated land loss. Economic incentives, such as the values of urban and cultivated land, emerge as the most influential factors for China's land use changes. The government's heavy weighting of the tax revenues from the urban sector may also lead to faster cultivated land conversion, but this incentive is sometimes weakened by the expanding expenditure for providing basic urban infrastructures. These economic incentives jointly may also weaken or completely override the effects of the DBP, if any.

Based on the results of this thesis, policies aiming to slow down cultivated land conversion could be made more effective through shrinking the profit margin of land conversion and conveyance, specifically through raising the costs and/or reducing the revenues of land conversion. The following measures are considered.

First, polices could be enacted so that the government faces the true opportunity cost of land acquisition. Local governments in China currently pay the cost of cultivated land conversion determined by the agricultural output value of land. However, many western countries determine the value of rural land at the urban fringes based on not only the physical characteristics of the land to be sold, such as the size of the tract and the proportion of cultivated land, and the value of the land in its existing use, but also its location with respect to urban areas, natural amenities, and access to economic and recreational activities. The determination of the shadow price of the land is facilitated by the hedonic price model, which can evaluate both the physical and accessibility and environmental characteristics of rural land in an urbanizing area (Shonkwiler and Reynolds 1986). China may consider abandoning the idea of using a fixed formula to determine the compensation for farmers. The compensation should be calculated based on the market conditions at the time of the conversion. The calculation of the compensation may adopt the hedonic price model, so that farmers can benefit from the value increment during the land conversion from a low-value use to a high-value use. By doing so, local governments will retain a smaller portion of the value increment in land conversion and sales, and will lose some of the economic incentives for cultivated land conversion. At the same time, farmers will be pleased and the tension between farmers and government caused by government land acquisition can be eased.

Second, land acquisition cost could be raised through increased transparency and accountability during the land acquisition process. Anecdotal evidence suggests resettlement subsidies are normally set by negotiations between village leaders and land acquisition agencies. Village leaders may not adequately represent the interests of their fellow villagers and may be enticed to sell the land at a low price, resulting in low resettlement subsidies paid to the farmers (Henderson 2009). By involving more farmers in the land acquisition procedures, the cost of land conversion faced by local land bureaus will likely increase. More importantly, this is a practical way to acknowledge farmers' property rights over their land.

Third, land acquisition cost can be raised through elevating the cost of reclaiming new cultivated land. As discussed in this study, many local governments and private land developers simply consider the land reclamation fees as a fixed cost and a necessary expense for their industrial and residential development priorities. The land reclamation fees can be raised substantially to abate the incentives for land conversion.

Fourth, land acquisition cost can also be raised through elevating the expected costs facing local officials of getting caught out of compliance of the laws. The central government needs to seek methods of overseeing local land activities in a more timely and effective manner and increasing the probability of uncovering unapproved and illegal land development projects. Instead of the prevailing periodic inspections conducted by the central government, oversight agencies outside the government may be a better instrument to increase the control over local land activities and help the central government gain control over land activities at local levels.

Fifth, on the revenue side, land acquisition revenues can be reduced through taxation. Local government officials currently act like private developers in profit-seeking land transactions. However, they currently do not pay any taxes on the value appreciation of the land during the conversion process. On-going taxation reforms in China may design a measure to impose taxes on land revenues and redistribute such tax revenues to deserving farmers through social protection programs. Such a measure can downplay the economic incentives of local officials for land conversion and, at the same time, promote social equity and harmony. Also, if land is taxed, it will be less likely left idle. Taxation will intensify the land use efficiency.

Sixth, policies can also be made to give incentives to local officials for promoting agricultural production and cultivated land protection. As revealed by this thesis, the current cadre evaluation system promotes urban growth fueled by land conversion. The central government should include cultivated land protection in their cadre evaluation system, in addition to the traditional evaluation criteria based on GDP, investment, and local fiscal balance.

The above recommended measures will reduce the economic incentives for land conversion and lead to more efficient land use. Facing higher conversion costs, local governments will be discouraged from converting cultivated land before they have a definite source of investment, therefore, they will be less likely to leave the land idle and more likely to ensure the land goes to the highest-value and best use. As discussed earlier, the current practice in the sales of land use rights is negotiations or listing that often grant land use rights to favored developers at lower prices (see Chapter 3). If local land bureaus incur a much higher cost in acquiring the land, they will be motivated to adopt English auctions to find the highest bidders. Moreover, a higher cost of cultivated land conversion may also encourage redevelopment of existing urban land under other policies that facilitate urban redevelopment.

9.6 Limitations of the Empirical Results

Despite meticulous attention paid to the empirical methodology, the empirical results discussed above are not without their limitations. One obvious limitation is that the land use data does not capture the quality of cultivated land. The DBP requires each province to designate 80% of their farmland as basic farmland, and keep it at a fixed level. However, data on cultivated land area is not differentiated by quality of the land. As discussed in Chapter 4, local officials have the incentives to report low-quality cultivated land as good-quality cultivated land in order to meet the dynamic balance requirement. Admitted the noises in the data, this thesis has, at best, answered the questions how the policy affects the annual changes in cultivated land and urban land areas and whether the policy can curb the loss of cultivated land. Given the data limitation, this thesis cannot answer the question whether the policy has achieved its intended effect of maintaining China's high-quality and good-quality cultivated land.

Another limitation is the potential biases in the estimated effects of the DBP on the change in cultivated land. The coefficient of the DBP is likely biased downwards by any omitted variables related to the Grain for Green (GfG) program. As discussed earlier, even if the DBP has had any effects on the average change in cultivated land area, the effects may have been washed out by the counter effects of the GfG policy.

If the correlation between the GfG policy and the DBP exists, this thesis may have underestimated the effects of the DBP on cultivated land areas. The underestimation may not be severe in East China because the loss of cultivated land due to the GfG policy is relatively small compared with the loss of cultivated land to urban uses in this region. However, the underestimation could be the reason for the lack of evidence for the effect of the DBP on cultivated land in West and Central China. This thesis could not isolate the effects of the DBP from the effects of the GfG. Therefore, findings here should be used with caution to conclude whether the DBP has had the effect of reducing cultivated land loss in West and Central China or in China as a whole.

Table 9.1 Two-Way FE Estimation Results of Level Changes in Land Area without Policy Interaction Terms
A. Whole China

	Without Corrections for Heteroskedasticity or AR(1)			With Corrections for Heteroskedasticity and/or AR(1)§		
	Level Change in Cultivated Land Area	Level Change in Urban Land Area	Level Change in Unused Land Area	Level Change in Cultivated Land Area	**Level Change in Urban Land Area**	Level Change in Unused Land Area
Real GDP from Primary Industry per Unit of Cultivated Land in Year *t* (US$/Ha)	1.403***	-0.0678**	0.174	1.403***	**-0.0842**	0.174
	(0.262)	(0.0304)	(0.980)	(0.170)	**(0.154)**	(0.158)
Real GDP from Secondary and Tertiary Industries per Unit of Urban Land in Year *t* (US$/Ha)	0.00309	0.00117***	0.00102	0.00309**	**0.00122****	0.00102
	(0.00244)	(0.000284)	(0.00913)	(0.00125)	**(0.000475)**	(0.00150)
Real Budgetary Revenue per Unit of Urban Land in Year *t* (US$/Ha)	-0.0415	0.0258***	0.00633	-0.0415	**0.0271*****	0.00633
	(0.0307)	(0.00357)	(0.115)	(0.0282)	**(0.00538)**	(0.0259)
Real Budgetary Expenditure per Unit of Urban Land in Year *t* (US$/Ha)	-0.0406***	0.00137	0.00358	-0.0406***	**0.00147***	0.00358
	(0.0153)	(0.00178)	(0.0574)	(0.00759)	**(0.000761)**	(0.00587)
Dynamic Balance Policy in Effect	460.5	-56.51	1356.4	460.5	**-68.20**	1356.4**
	(745.3)	(86.62)	(2788.9)	(455.1)	**(55.38)**	(637.1)
N	2475	2475	2475	2475	**2475**	2475
R^2	0.110	0.092	0.005	0.407	**0.323**	0.112

Standard errors in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$
§All results are corrected for heteroskedasticity with clusters. Results in bold are also corrected for AR(1) based on the Wooldridge test results in Table 8.2.

B. East China

	Without Corrections for Heteroskedasticity or AR(1)			With Corrections for Heteroskedasticity and/or AR(1)[§]		
	Level Change in Cultivated Land Area	Level Change in Urban Land Area	Level Change in Unused Land Area	**Level Change in Cultivated Land Area**	**Level Change in Urban Land Area**	Level Change in Unused Land Area
Real GDP from Primary Industry per Unit of Cultivated Land in Year *t* (US$/Ha)	1.270***	-0.0568	-0.166	**1.342*** **	**-0.0594**	-0.166*
	(0.238)	(0.0539)	(0.166)	**(0.296)**	**(0.0941)**	(0.0960)
Real GDP from Secondary and Tertiary Industries per Unit of Urban Land in Year *t* (US$/Ha)	0.00477	0.00328***	0.000676	**0.00405**	**0.00333** **	0.000676
	(0.00404)	(0.000916)	(0.00282)	**(0.00373)**	**(0.00134)**	(0.00310)
Real Budgetary Revenue per Unit of Urban Land in Year *t* (US$/Ha)	-0.0733**	0.0193**	-0.0265	**-0.0752**	**0.0193**	-0.0265
	(0.0340)	(0.00771)	(0.0237)	**(0.0511)**	**(0.0166)**	(0.0280)
Real Budgetary Expenditure per Unit of Urban Land in Year *t* (US$/Ha)	-0.00562	0.000113	-0.00735	**-0.00271**	**0.000122**	-0.00735**
	(0.0170)	(0.00386)	(0.0119)	**(0.00899)**	**(0.00187)**	(0.00375)
Dynamic Balance Policy in Effect	-73.99	-19.05	780.6	**-154.4**	**-22.99**	780.6
	(969.6)	(219.9)	(677.2)	**(1139.2)**	**(205.8)**	(560.5)
N	808	808	808	**808**	**808**	808
R^2	0.102	0.110	0.019	**0.357**	**0.293**	0.290

Standard errors in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$
[§]All results are corrected for heteroskedasticity with clusters. Results in bold are also corrected for AR(1) based on the Wooldridge test results in Table 8.2.

C. West and Central China

	Without Corrections for Heteroskedasticity or AR(1)			With Corrections for Heteroskedasticity and/or AR(1)[§]		
	Level Change in Cultivated Land Area	Level Change in Urban Land Area	Level Change in Unused Land Area	Level Change in Cultivated Land Area	Level Change in Urban Land Area	Level Change in Unused Land Area
Real GDP from Primary Industry per Unit of Cultivated Land in Year *t* (US$/Ha)	1.168**	-0.0416	0.129	1.168***	-0.0416**	0.129
	(0.545)	(0.0408)	(2.258)	(0.354)	(0.0171)	(0.271)
Real GDP from Secondary and Tertiary Industries per Unit of Urban Land in Year *t* (US$/Ha)	0.00407	0.000672***	-0.0000931	0.00407***	0.000672***	-0.0000931
	(0.00310)	(0.000232)	(0.0128)	(0.00104)	(0.000227)	(0.00131)
Real Budgetary Revenue per Unit of Urban Land in Year *t* (US$/Ha)	-0.167***	0.0252***	-0.0769	-0.167***	0.0252***	-0.0769*
	(0.0634)	(0.00475)	(0.262)	(0.0343)	(0.00699)	(0.0405)
Real Budgetary Expenditure per Unit of Urban Land in Year *t* (US$/Ha)	-0.0424*	0.00215	0.0561	-0.0424***	0.00215***	0.0561***
	(0.0245)	(0.00184)	(0.102)	(0.0121)	(0.000780)	(0.0123)
Dynamic Balance Policy in Effect	290.8	-38.23	1435.5	290.8	-38.23	1435.5
	(1003.3)	(75.15)	(4154.9)	(680.0)	(34.97)	(943.0)
N	1667	1667	1667	1667	1667	1667
R^2	0.132	0.085	0.007	0.421	0.421	0.113

Standard errors in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$
[§]All results are corrected for heteroskedasticity with clusters. Results in bold are also corrected for AR(1) based on the Wooldridge test results in Table 8.2.

Table 9.2 Two-Way FE Estimation Results of Percent Changes in Land Area without Policy Interaction Terms
A. Whole China

	Without Corrections for Heteroskedasticity or AR(1)			With Corrections for Heteroskedasticity and/or AR(1)[§]		
	Percent Change in Cultivated Land Area	Percent Change in Urban Land Area	Percent Change in Unused Land Area	Percent Change in Cultivated Land Area	**Percent Change in Urban Land Area**	Percent Change in Unused Land Area
Log (Real GDP from Primary Industry per Unit of Cultivated Land in Year *t*)	0.0361***	-0.0318**	-0.0156	0.0361	**-0.0366**	-0.0156*
	(0.00558)	(0.0133)	(0.0132)	(0.0275)	**(0.0299)**	(0.00806)
Log (Real GDP from Secondary and Tertiary Industries per Unit of Urban Land in Year *t*)	-0.0116**	0.121***	-0.00555	-0.0116	**0.129*** **	-0.00555
	(0.00518)	(0.0124)	(0.0123)	(0.0150)	**(0.0308)**	(0.00577)
Log (Real Budgetary Revenue per Unit of Urban Land in Year *t*)	-0.000391	0.0349***	0.0125	-0.000391	**0.0320**	0.0125
	(0.00442)	(0.0106)	(0.0105)	(0.00364)	**(0.0202)**	(0.00955)
Log (Real Budgetary Expenditure per Unit of Urban Land in Year *t*)	-0.0101*	0.107***	-0.0229*	-0.0101	**0.110*** **	-0.0229***
	(0.00577)	(0.0138)	(0.0137)	(0.00862)	**(0.0272)**	(0.00601)
Dynamic Balance Policy in Effect	0.00506	-0.0110	0.00263	0.00506	**-0.0106**	0.00263
	(0.00319)	(0.00763)	(0.00756)	(0.00511)	**(0.00649)**	(0.0121)
N	2475	2475	2475	2475	**2475**	2475
R^2	0.078	0.203	0.008	0.245	**0.308**	0.144

Standard errors in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$
[§]All results are corrected for heteroskedasticity with clusters. Results in bold are also corrected for AR(1) based on the Wooldridge test results in Table 8.2.

B. East China

	Without Corrections for Heteroskedasticity or AR(1)			With Corrections for Heteroskedasticity and/or AR(1)[§]		
	Percent Change in Cultivated Land Area	Percent Change in Urban Land Area	Percent Change in Unused Land Area	**Percent Change in Cultivated Land Area**	**Percent Change in Urban Land Area**	Percent Change in Unused Land Area
Log (Real GDP from Primary Industry per Unit of Cultivated Land in Year *t*)	0.0952***	-0.0496**	-0.0366	**0.114*****	**-0.0527**	-0.0366
	(0.0143)	(0.0232)	(0.0373)	**(0.0380)**	**(0.0360)**	(0.0259)
Log (Real GDP from Secondary and Tertiary Industries per Unit of Urban Land in Year *t*)	-0.00508	0.108***	-0.0135	**-0.0125**	**0.112*****	-0.0135
	(0.0150)	(0.0242)	(0.0390)	**(0.0248)**	**(0.0421)**	(0.0318)
Log (Real Budgetary Revenue per Unit of Urban Land in Year *t*)	-0.00165	0.0870***	-0.0188	**-0.00519**	**0.0873*****	-0.0188
	(0.0126)	(0.0204)	(0.0328)	**(0.0164)**	**(0.0235)**	(0.0132)
Log (Real Budgetary Expenditure per Unit of Urban Land in Year *t*)	-0.0330**	0.0626***	-0.0183	**-0.0298****	**0.0626*****	-0.0183
	(0.0144)	(0.0232)	(0.0374)	**(0.0128)**	**(0.0233)**	(0.0209)
Dynamic Balance Policy in Effect	-0.00251	-0.00381	0.00253	**-0.00345**	**-0.00378**	0.00253
	(0.00693)	(0.0112)	(0.0180)	**(0.00668)**	**(0.00914)**	(0.0197)
N	808	808	808	808	808	808
R^2	0.111	0.208	0.013	0.250	0.345	0.149

Standard errors in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$
[§]All results are corrected for heteroskedasticity with clusters. Results in bold are also corrected for AR(1) based on the Wooldridge test results in Table 8.2.

C. West and Central China

	Without Corrections for Heteroskedasticity or AR(1)			With Corrections for Heteroskedasticity and/or AR(1)§		
	Percent Change in Cultivated Land Area	Percent Change in Urban Land Area	Percent Change in Unused Land Area	Percent Change in Cultivated Land Area	**Percent Change in Urban Land Area**	Percent Change in Unused Land Area
Log (Real GDP from Primary Industry per Unit of Cultivated Land in Year *t*)	0.0191***	-0.0297*	-0.0107	0.0191	**-0.0323***	-0.0107**
	(0.00550)	(0.0166)	(0.0121)	(0.0119)	**(0.0196)**	(0.00522)
Log (Real GDP from Secondary and Tertiary Industries per Unit of Urban Land in Year *t*)	-0.00872*	0.121***	-0.00749	-0.00872*	**0.130*****	-0.00749
	(0.00499)	(0.0150)	(0.0110)	(0.00480)	**(0.0222)**	(0.00590)
Log (Real Budgetary Revenue per Unit of Urban Land in Year *t*)	-0.00749	0.0160	0.0145	-0.00749	**0.0115**	0.0145*
	(0.00478)	(0.0144)	(0.0105)	(0.00785)	**(0.0111)**	(0.00815)
Log (Real Budgetary Expenditure per Unit of Urban Land in Year *t*)	0.00325	0.125***	-0.0154	0.00325	**0.129*****	-0.0154**
	(0.00605)	(0.0182)	(0.0133)	(0.00717)	**(0.0367)**	(0.00707)
Dynamic Balance Policy in Effect	0.00638*	-0.0151	0.00486	0.00638	**-0.0142****	0.00486
	(0.00333)	(0.0100)	(0.00732)	(0.00771)	**(0.00612)**	(0.00367)
N	1667	1667	1667	1667	1667	1667
R^2	0.113	0.207	0.013	0.276	0.296	0.147

Standard errors in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$
§All results are corrected for heteroskedasticity with clusters. Results in bold are also corrected for AR(1) based on the Wooldridge test results in Table 8.2.

Table 9.3 Two-Way FE Estimation Results of Level Changes in Land Area with Policy Interaction Terms
A. Whole China

	Without Corrections for Heteroskedasticity or AR(1)			With Corrections for Heteroskedasticity and/or AR(1)§		
	Level Change in Cultivated Land Area	Level Change in Urban Land Area	Level Change in Unused Land Area	Level Change in Cultivated Land Area	**Level Change in Urban Land Area**	**Level Change in Unused Land Area**
Real GDP from Primary Industry per Unit of Cultivated Land in Year *t* (US$/Ha)	1.189***	-0.102***	-0.383	1.189***	**-0.111**	**-0.336****
	(0.336)	(0.0391)	(1.097)	(0.229)	**(0.164)**	**(0.160)**
Real GDP from Secondary and Tertiary Industries per Unit of Urban Land in Year *t* (US$/Ha)	0.000948	0.00124***	0.00259	0.000948	**0.00127*****	**0.00295**
	(0.00266)	(0.000309)	(0.00868)	(0.00101)	**(0.000397)**	**(0.00267)**
Real Budgetary Revenue per Unit of Urban Land in Year *t* (US$/Ha)	-0.0345	0.0239***	-0.0602	-0.0345**	**0.0263*****	**-0.0873**
	(0.0427)	(0.00497)	(0.139)	(0.0167)	**(0.00357)**	**(0.0848)**
Real Budgetary Expenditure per Unit of Urban Land in Year *t* (US$/Ha)	-0.0239	0.00323	-0.00549	-0.0239*	**0.00311*****	**-0.00127**
	(0.0194)	(0.00225)	(0.0632)	(0.0144)	**(0.000863)**	**(0.0114)**
Dynamic Balance Policy in Effect	-3.031	-42.57	298.3	-3.031	**-36.08**	**1134.1**
	(1003.9)	(116.8)	(3281.0)	(1100.7)	**(103.5)**	**(1969.8)**
Area of Unused Land in Year *t* (Ha)	0.00119	-0.000366	-0.345***	0.00119	**-0.000344**	**-0.427*****
	(0.00407)	(0.000474)	(0.0133)	(0.00214)	**(0.000224)**	**(0.0276)**
Policy Interaction with Real GDP from Primary Industry per Unit of Cultivated Land	0.158	0.0196	0.228	0.158***	**0.0166**	**0.186****
	(0.122)	(0.0142)	(0.399)	(0.0308)	**(0.0151)**	**(0.0799)**

Table 9.3A (Continued)

	Without Corrections for Heteroskedasticity or AR(1)			With Corrections for Heteroskedasticity and/or AR(1)[§]		
	Level Change in Cultivated Land Area	Level Change in Urban Land Area	Level Change in Unused Land Area	Level Change in Cultivated Land Area	**Level Change in Urban Land Area**	**Level Change in Unused Land Area**
Policy Interaction with Real GDP from Secondary and Tertiary Industries per Unit of Urban Land	0.00480**	-0.000138	0.00266	0.00480***	**-0.000114**	**0.000641**
	(0.00227)	(0.000264)	(0.00742)	(0.000546)	**(0.000379)**	**(0.00192)**
Policy Interaction with Real Budgetary Revenue per Unit of Urban Land	-0.0514	0.00249	-0.0320	-0.0514**	**0.00152**	**-0.00981**
	(0.0370)	(0.00430)	(0.121)	(0.0227)	**(0.00490)**	**(0.0642)**
Policy Interaction with Real Budgetary Expenditure per Unit of Urban Land	-0.00805	-0.00202	-0.00166	-0.00805	**-0.00188*** **	**-0.00993**
	(0.0142)	(0.00165)	(0.0463)	(0.0127)	**(0.000553)**	**(0.0113)**
Policy Interaction with Area of Unused Land	-0.000140	0.0000113	-0.000252	-0.000140*	**0.0000107**	**-0.000222***
	(0.000115)	(0.0000134)	(0.000377)	(0.0000786)	**(0.0000184)**	**(0.000125)**
F Test for Joint Significance of Policy Estimators	0.89	1.09	0.13	0.00	**1.44**	**3.44**
P-Value	0.4458	0.3514	0.9423	0.9978	**0.4876**	**0.1792**
T Test for Effects of Cultivated Land Value on Changes in Land Areas under the Policy	23.50***	6.45**	0.03	39.13***	**0.37**	**1.41**
P-Value	0.0000	0.0112	0.8649	0.0000	**0.5421**	**0.2352**
N	2475	2475	2475	2475	**2475**	**2475**
R^2	0.115	0.094	0.245	0.410	**0.325**	**0.300**

Standard errors in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$
[§]All results are corrected for heteroskedasticity with clusters. Results in bold are also corrected for AR(1) based on the Wooldridge test results in Table 8.2.

B. East China

	Without Corrections for Heteroskedasticity or AR(1)			With Corrections for Heteroskedasticity and/or AR(1)§		
	Level Change in Cultivated Land Area	Level Change in Urban Land Area	Level Change in Unused Land Area	**Level Change in Cultivated Land Area**	**Level Change in Urban Land Area**	**Level Change in Unused Land Area**
Real GDP from Primary Industry per Unit of Cultivated Land in Year *t* (US$/Ha)	1.328***	-0.173**	-0.0743	**1.346*** **	**-0.179**	**-0.0800**
	(0.293)	(0.0739)	(0.227)	**(0.375)**	**(0.122)**	**(0.100)**
Real GDP from Secondary and Tertiary Industries per Unit of Urban Land in Year *t* (US$/Ha)	0.00335	0.00345***	0.000205	**0.00329**	**0.00365*** **	**0.000140**
	(0.00412)	(0.00104)	(0.00318)	**(0.00394)**	**(0.00132)**	**(0.00243)**
Real Budgetary Revenue per Unit of Urban Land in Year *t* (US$/Ha)	-0.0923*	0.0351***	-0.0226	**-0.0920**	**0.0362***	**-0.0249**
	(0.0480)	(0.0121)	(0.0371)	**(0.0576)**	**(0.0202)**	**(0.0320)**
Real Budgetary Expenditure per Unit of Urban Land in Year *t* (US$/Ha)	0.00399	0.000308	-0.00566	**0.00412**	**0.000276**	**-0.00546***
	(0.0155)	(0.00391)	(0.0120)	**(0.00683)**	**(0.00200)**	**(0.00299)**
Dynamic Balance Policy in Effect	3214.7**	197.1	969.9	**3197.7*** **	**212.7**	**1044.4**
	(1290.9)	(325.0)	(996.4)	**(1068.6)**	**(243.1)**	**(663.2)**
Area of Unused Land in Year *t* (Ha)	0.217***	0.00701	-0.111***	**0.215**	**0.00712**	**-0.134**
	(0.0391)	(0.00985)	(0.0302)	**(0.167)**	**(0.00727)**	**(0.161)**
Policy Interaction with Real GDP from Primary Industry per Unit of Cultivated Land	-0.171	0.0709**	-0.0481	**-0.173**	**0.0705**	**-0.0507**
	(0.110)	(0.0277)	(0.0849)	**(0.116)**	**(0.0581)**	**(0.0549)**

Table 9.3B (Continued)

	Without Corrections for Heteroskedasticity or AR(1)			With Corrections for Heteroskedasticity and/or AR(1)§		
	Level Change in Cultivated Land Area	Level Change in Urban Land Area	Level Change in Unused Land Area	**Level Change in Cultivated Land Area**	**Level Change in Urban Land Area**	**Level Change in Unused Land Area**
Policy Interaction with Real GDP from Secondary and Tertiary Industries per Unit of Urban Land	-0.00111	-0.000508	0.00226	**-0.00112**	**-0.000526**	**0.00225***
	(0.00221)	(0.000556)	(0.00170)	**(0.00274)**	**(0.000797)**	**(0.00127)**
Policy Interaction with Real Budgetary Revenue per Unit of Urban Land	-0.00259	0.00462	-0.0268	**-0.00252**	**0.00384**	**-0.0254**
	(0.0485)	(0.0122)	(0.0374)	**(0.0442)**	**(0.0148)**	**(0.0318)**
Policy Interaction with Real Budgetary Expenditure per Unit of Urban Land	0.00178	-0.0121	0.00280	**0.00157**	**-0.0119***	**0.00219**
	(0.0324)	(0.00815)	(0.0250)	**(0.0265)**	**(0.00650)**	**(0.0162)**
Policy Interaction with Area of Unused Land	-0.0187***	0.000664	-0.00381*	**-0.0186****	**0.000656***	**-0.00473**
	(0.00269)	(0.000676)	(0.00207)	**(0.00932)**	**(0.000365)**	**(0.00632)**
F Test for Joint Significance of Policy Estimators	2.97**	2.67**	0.60	**9.87****	**4.28**	**2.67**
P-Value	0.0313	0.0465	0.6130	**0.0197**	**0.2324**	**0.4457**
T Test for Effects of Cultivated Land Value on Changes in Land Areas under the Policy	24.18	2.99*	0.45	**12.78****	**1.36**	**2.66**
P-Value	0.0000	0.0840	0.5009	**0.0003**	**0.2440**	**0.1026**
N	808	808	808	**808**	**808**	**808**
R^2	0.281	0.121	0.040	**0.501**	**0.297**	**0.281**

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

§All results are corrected for heteroskedasticity with clusters. Results in bold are also corrected for AR(1) based on the Wooldridge test results in Table 8.2.

C. West and Central China

	Without Corrections for Heteroskedasticity or AR(1)			With Corrections for Heteroskedasticity and/or AR(1)§		
	Level Change in Cultivated Land Area	Level Change in Urban Land Area	Level Change in Unused Land Area	Level Change in Cultivated Land Area	Level Change in Urban Land Area	**Level Change in Unused Land Area**
Real GDP from Primary Industry per Unit of Cultivated Land in Year *t* (US$/Ha)	0.637	-0.0232	-0.602	0.637***	-0.0232	**-0.366**
	(0.617)	(0.0462)	(2.233)	(0.239)	(0.0225)	**(0.522)**
Real GDP from Secondary and Tertiary Industries per Unit of Urban Land in Year *t* (US$/Ha)	0.00220	0.000788***	0.00607	0.00220***	0.000788***	**0.00569**
	(0.00338)	(0.000253)	(0.0122)	(0.000849)	(0.000229)	**(0.00354)**
Real Budgetary Revenue per Unit of Urban Land in Year *t* (US$/Ha)	-0.147**	0.0183***	-0.211	-0.147***	0.0183***	**-0.248**
	(0.0735)	(0.00551)	(0.266)	(0.0416)	(0.00497)	**(0.157)**
Real Budgetary Expenditure per Unit of Urban Land in Year *t* (US$/Ha)	-0.0349	0.00690**	0.00228	-0.0349	0.00690***	**0.00818**
	(0.0396)	(0.00297)	(0.143)	(0.0341)	(0.00129)	**(0.0363)**
Dynamic Balance Policy in Effect	-1373.7	78.38	388.6	-1373.7	78.38**	**2426.5**
	(1474.4)	(110.5)	(5334.9)	(1655.7)	(37.32)	**(2949.7)**
Area of Unused Land in Year *t* (Ha)	-0.000851	-0.000408	-0.347***	-0.000851	-0.000408*	**-0.434*** **
	(0.00451)	(0.000338)	(0.0163)	(0.00297)	(0.000210)	**(0.0280)**
Policy Interaction with Real GDP from Primary Industry per Unit of Cultivated Land	0.930***	-0.0428	0.927	0.930***	-0.0428**	**0.616**
	(0.359)	(0.0269)	(1.298)	(0.343)	(0.0176)	**(0.378)**

Table 9.3C (Continued)

	Without Corrections for Heteroskedasticity or AR(1)			With Corrections for Heteroskedasticity and/or AR(1)§		
	Level Change in Cultivated Land Area	Level Change in Urban Land Area	Level Change in Unused Land Area	Level Change in Cultivated Land Area	Level Change in Urban Land Area	**Level Change in Unused Land Area**
Policy Interaction with Real GDP from Secondary and Tertiary Industries per Unit of Urban Land	0.00662*	-0.000306	-0.00190	0.00662***	-0.000306	**-0.00409**
	(0.00402)	(0.000301)	(0.0145)	(0.000897)	(0.000278)	**(0.00486)**
Policy Interaction with Real Budgetary Revenue per Unit of Urban Land	-0.107	0.0108**	-0.0513	-0.107***	0.0108**	**-0.0539**
	(0.0656)	(0.00491)	(0.237)	(0.0213)	(0.00477)	**(0.0630)**
Policy Interaction with Real Budgetary Expenditure per Unit of Urban Land	0.00527	-0.00390**	0.00615	0.00527	-0.00390***	**-0.00225**
	(0.0215)	(0.00161)	(0.0779)	(0.0187)	(0.000940)	**(0.0182)**
Policy Interaction with Area of Unused Land	-0.000129	0.0000133	-0.000298	-0.000129	0.0000133	**-0.000273***
	(0.000131)	(0.00000980)	(0.000473)	(0.000103)	(0.0000203)	**(0.000134)**
F Test for Joint Significance of Policy Estimators	3.36**	3.22**	0.24	51.54***	59.91***	**12.91***
P-Value	0.0183	0.0220	0.8665	0.0000	0.0000	**0.0016**
T Test for Effects of Cultivated Land Value on Changes in Land Areas under the Policy	7.90***	2.50	0.03	15.02***	5.21**	**1.73**
P-Value	0.0050	0.1140	0.8718	0.0001	0.0225	**0.1883**
N	1667	1667	1667	1667	1667	**1667**
R^2	0.140	0.093	0.249	0.426	0.426	**0.304**

Standard errors in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$
§All results are corrected for heteroskedasticity with clusters. Results in bold are also corrected for AR(1) based on the Wooldridge test results in Table 8.2.

Table 9.4 Two-Way FE Estimation Results of Percent Changes in Land Area with Policy Interaction Terms
A. Whole China

	Without Corrections for Heteroskedasticity or AR(1)			With Corrections for Heteroskedasticity and/or AR(1)§		
	Percent Change in Cultivated Land Area	Percent Change in Urban Land Area	Percent Change in Unused Land Area	Percent Change in Cultivated Land Area	**Percent Change in Urban Land Area**	**Percent Change in Unused Land Area**
Log (Real GDP from Primary Industry per Unit of Cultivated Land in Year *t*)	0.0376***	-0.0362***	-0.00776	0.0376	**-0.0388**	**-0.00714**
	(0.00577)	(0.0138)	(0.0129)	(0.0263)	**(0.0249)**	**(0.0106)**
Log (Real GDP from Secondary and Tertiary Industries per Unit of Urban Land in Year *t*)	-0.0150***	0.133***	0.0127	-0.0150	**0.138*** **	**0.0139**
	(0.00539)	(0.0129)	(0.0121)	(0.0142)	**(0.0270)**	**(0.0109)**
Log (Real Budgetary Revenue per Unit of Urban Land in Year *t*)	0.00314	0.00516	-0.000759	0.00314*	**0.00537**	**-0.00533**
	(0.00520)	(0.0124)	(0.0116)	(0.00174)	**(0.0197)**	**(0.0127)**
Log (Real Budgetary Expenditure per Unit of Urban Land in Year *t*)	-0.00878	0.128***	-0.00885	-0.00878	**0.129*** **	**-0.00528**
	(0.00630)	(0.0151)	(0.0141)	(0.0119)	**(0.0277)**	**(0.00889)**
Dynamic Balance Policy in Effect	0.0946**	-0.274***	-0.0280	0.0946	**-0.263*** **	**-0.0266**
	(0.0408)	(0.0976)	(0.0913)	(0.0725)	**(0.0954)**	**(0.0940)**
Log (Area of Unused Land in Year *t*)	0.0196***	-0.0123	-0.268***	0.0196**	**-0.00859**	**-0.325*** *
	(0.00710)	(0.0170)	(0.0159)	(0.0100)	**(0.0170)**	**(0.144)**
Policy Interaction with Log (Real GDP from Primary Industry per Unit of Cultivated Land)	0.00111	0.00613	-0.00871*	0.00111	**0.00604**	**-0.00872**
	(0.00203)	(0.00486)	(0.00454)	(0.00515)	**(0.00992)**	**(0.00548)**

Table 9.4A (Continued)

	Without Corrections for Heteroskedasticity or AR(1)			With Corrections for Heteroskedasticity and/or AR(1)[§]		
	Percent Change in Cultivated Land Area	Percent Change in Urban Land Area	Percent Change in Unused Land Area	Percent Change in Cultivated Land Area	**Percent Change in Urban Land Area**	**Percent Change in Unused Land Area**
Policy Interaction with Log (Real GDP from Secondary and Tertiary Industries per Unit of Urban Land)	0.00497	-0.00415	0.0151	0.00497	**-0.00316**	**0.0145**
	(0.00463)	(0.0111)	(0.0104)	(0.00447)	**(0.0106)**	**(0.0134)**
Policy Interaction with Log (Real Budgetary Revenue per Unit of Urban Land)	-0.00783	0.0319**	-0.0157	-0.00783	**0.0311****	**-0.0147**
	(0.00531)	(0.0127)	(0.0119)	(0.00481)	**(0.0137)**	**(0.0130)**
Policy Interaction with Log (Real Budgetary Expenditure per Unit of Urban Land)	-0.00629	-0.00647	0.00883	-0.00629	**-0.00809**	**0.00848*****
	(0.00385)	(0.00922)	(0.00863)	(0.00399)	**(0.0187)**	**(0.00217)**
Policy Interaction with Log (Area of Unused Land)	-0.00147	0.00193	-0.00244	-0.00147	**0.00212**	**-0.00232**
	(0.000951)	(0.00227)	(0.00213)	(0.00131)	**(0.00180)**	**(0.00186)**
F Test for Joint Significance of Policy Estimators	4.20***	4.47***	1.14	5520.89***	**5536.61*****	**3503.51*****
P-Value	0.0003	0.0002	0.3391	0.0000	**0.0000**	**0.0000**
T Test for Effects of Cultivated Land Value on Changes in Land Areas under the Policy	46.47***	4.90**	1.68	1.74	**1.21**	**3.25***
P-Value	0.0000	0.0270	0.1950	0.1868	**0.2707**	**0.0712**
N	2475	2475	2475	2475	**2475**	**2475**
R^2	0.091	0.212	0.126	0.255	**0.320**	**0.246**

Standard errors in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$
[§]All results are corrected for heteroskedasticity with clusters. Results in bold are also corrected for AR(1) based on the Wooldridge test results in Table 8.2.

B. East China

	Without Corrections for Heteroskedasticity or AR(1)			With Corrections for Heteroskedasticity and/or AR(1)[§]		
	Percent Change in Cultivated Land Area	Percent Change in Urban Land Area	Percent Change in Unused Land Area	**Percent Change in Cultivated Land Area**	**Percent Change in Urban Land Area**	**Percent Change in Unused Land Area**
Log (Real GDP from Primary Industry per Unit of Cultivated Land in Year *t*)	0.103***	-0.0545**	0.00212	**0.115*** **	**-0.0573**	**-0.00292**
	(0.0153)	(0.0249)	(0.0387)	**(0.0352)**	**(0.0353)**	**(0.0296)**
Log (Real GDP from Secondary and Tertiary Industries per Unit of Urban Land in Year *t*)	-0.0159	0.115***	0.00457	**-0.0205**	**0.119*** **	**0.00626**
	(0.0155)	(0.0252)	(0.0393)	**(0.0243)**	**(0.0398)**	**(0.0261)**
Log (Real Budgetary Revenue per Unit of Urban Land in Year *t*)	0.00920	0.0668***	-0.00722	**0.00541**	**0.0679** **	**-0.0199**
	(0.0144)	(0.0234)	(0.0365)	**(0.0186)**	**(0.0281)**	**(0.0212)**
Log (Real Budgetary Expenditure per Unit of Urban Land in Year *t*)	-0.0359**	0.0724***	-0.0387	**-0.0322** **	**0.0716*** **	**-0.0342* **
	(0.0152)	(0.0246)	(0.0384)	**(0.0164)**	**(0.0239)**	**(0.0203)**
Dynamic Balance Policy in Effect	0.181*	-0.193	-0.175	**0.186* **	**-0.194**	**-0.211**
	(0.0976)	(0.158)	(0.247)	**(0.101)**	**(0.130)**	**(0.135)**
Log (Area of Unused Land in Year *t*)	0.0167	0.00994	-0.193***	**0.0162**	**0.0114**	**-0.288* **
	(0.0123)	(0.0200)	(0.0311)	**(0.0176)**	**(0.0360)**	**(0.152)**
Policy Interaction with Log (Real GDP from Primary Industry per Unit of Cultivated Land)	-0.00511	0.00576	-0.0490***	**-0.00444**	**0.00565**	**-0.0522*** **
	(0.00515)	(0.00837)	(0.0130)	**(0.00588)**	**(0.00837)**	**(0.0155)**

Table 9.4B (Continued)

	Without Corrections for Heteroskedasticity or AR(1)			With Corrections for Heteroskedasticity and/or AR(1)§		
	Percent Change in Cultivated Land Area	Percent Change in Urban Land Area	Percent Change in Unused Land Area	**Percent Change in Cultivated Land Area**	**Percent Change in Urban Land Area**	**Percent Change in Unused Land Area**
Policy Interaction with Log (Real GDP from Secondary and Tertiary Industries per Unit of Urban Land)	0.00781	0.000551	0.0710***	**0.00775**	**0.000476**	**0.0724*** **
	(0.0102)	(0.0166)	(0.0258)	**(0.0105)**	**(0.0193)**	**(0.0227)**
Policy Interaction with Log (Real Budgetary Revenue per Unit of Urban Land)	-0.00610	0.0193	-0.0770**	**-0.00468**	**0.0186**	**-0.0769*** **
	(0.0124)	(0.0202)	(0.0314)	**(0.0135)**	**(0.0137)**	**(0.0206)**
Policy Interaction with Log (Real Budgetary Expenditure per Unit of Urban Land)	-0.0156	-0.00797	0.0574*	**-0.0179**	**-0.00709**	**0.0634*** **
	(0.0119)	(0.0193)	(0.0301)	**(0.0126)**	**(0.0183)**	**(0.0216)**
Policy Interaction with Log (Area of Unused Land)	-0.00169	0.00227	-0.0151***	**-0.00170**	**0.00235**	**-0.0164*** **
	(0.00227)	(0.00369)	(0.00575)	**(0.00240)**	**(0.00225)**	**(0.00588)**
F Test for Joint Significance of Policy Estimators	1.85*	0.96	3.57***	**24.23*** **	**5.52**	**29.14*** **
P-Value	0.0872	0.4530	0.0017	**0.0005**	**0.4786**	**0.0001**
T Test for Effects of Cultivated Land Value on Changes in Land Areas under the Policy	43.73***	4.14**	1.58	**8.68*** **	**2.03**	**4.04** **
P-Value	0.0000	0.0424	0.2093	**0.0032**	**0.1545**	**0.0444**
N	808	808	808	**808**	**808**	**808**
R^2	0.127	0.215	0.082	**0.265**	**0.350**	**0.207**

Standard errors in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$
§All results are corrected for heteroskedasticity with clusters. Results in bold are also corrected for AR(1) based on the Wooldridge test results in Table 8.2.

C. West and Central China

	Without Corrections for Heteroskedasticity or AR(1)			With Corrections for Heteroskedasticity and/or AR(1)[§]		
	Percent Change in Cultivated Land Area	Percent Change in Urban Land Area	Percent Change in Unused Land Area	Percent Change in Cultivated Land Area	**Percent Change in Urban Land Area**	**Percent Change in Unused Land Area**
Log (Real GDP from Primary Industry per Unit of Cultivated Land in Year *t*)	0.0202***	-0.0311*	-0.00438	0.0202*	**-0.0317***	**-0.00247**
	(0.00566)	(0.0171)	(0.0108)	(0.0118)	**(0.0177)**	**(0.00518)**
Log (Real GDP from Secondary and Tertiary Industries per Unit of Urban Land in Year *t*)	-0.0112**	0.134***	0.0164*	-0.0112**	**0.137*****	**0.0161*****
	(0.00521)	(0.0157)	(0.00994)	(0.00538)	**(0.0212)**	**(0.00569)**
Log (Real Budgetary Revenue per Unit of Urban Land in Year *t*)	-0.00366	-0.0133	-0.0183*	-0.00366	**-0.0127**	**-0.0190*****
	(0.00539)	(0.0163)	(0.0103)	(0.00891)	**(0.0188)**	**(0.00688)**
Log (Real Budgetary Expenditure per Unit of Urban Land in Year *t*)	0.00416	0.148***	0.00832	0.00416	**0.149*****	**0.0114****
	(0.00660)	(0.0199)	(0.0126)	(0.00883)	**(0.0415)**	**(0.00487)**
Dynamic Balance Policy in Effect	0.0285	-0.302**	0.0462	0.0285	**-0.285****	**0.0554**
	(0.0425)	(0.128)	(0.0811)	(0.0647)	**(0.118)**	**(0.0520)**
Log (Area of Unused Land in Year *t*)	0.0315***	-0.0307	-0.383***	0.0315**	**-0.0301**	**-0.458*****
	(0.00894)	(0.0270)	(0.0171)	(0.0123)	**(0.0188)**	**(0.0456)**
Policy Interaction with Log (Real GDP from Primary Industry per Unit of Cultivated Land)	0.00243	0.00686	-0.00157	0.00243	**0.00679**	**-0.00183**
	(0.00233)	(0.00705)	(0.00446)	(0.00364)	**(0.0107)**	**(0.00359)**

Table 9.4C (Continued)

	Without Corrections for Heteroskedasticity or AR(1)			With Corrections for Heteroskedasticity and/or AR(1)§		
	Percent Change in Cultivated Land Area	Percent Change in Urban Land Area	Percent Change in Unused Land Area	Percent Change in Cultivated Land Area	**Percent Change in Urban Land Area**	**Percent Change in Unused Land Area**
Policy Interaction with Log (Real GDP from Secondary and Tertiary Industries per Unit of Urban Land)	0.00599	-0.00820	-0.0100	0.00599	**-0.00532**	**-0.00874****
	(0.00498)	(0.0150)	(0.00951)	(0.00449)	**(0.0163)**	**(0.00370)**
Policy Interaction with Log (Real Budgetary Revenue per Unit of Urban Land)	-0.00462	0.0425**	0.00871	-0.00462	**0.0398**	**0.00655**
	(0.00562)	(0.0170)	(0.0107)	(0.00375)	**(0.0244)**	**(0.00430)**
Policy Interaction with Log (Real Budgetary Expenditure per Unit of Urban Land)	-0.00534	-0.00960	-0.00176	-0.00534*	**-0.0123**	**-0.00250**
	(0.00371)	(0.0112)	(0.00709)	(0.00303)	**(0.0212)**	**(0.00342)**
Policy Interaction with Log (Area of Unused Land)	-0.00107	0.00203	0.00231	-0.00107	**0.00241**	**0.00283***
	(0.000986)	(0.00298)	(0.00188)	(0.00192)	**(0.00161)**	**(0.00145)**
F Test for Joint Significance of Policy Estimators	2.97***	3.30***	0.90	566.92***	**737.84*****	**289.51*****
P-Value	0.0069	0.0031	0.4923	0.0000	**0.0000**	**0.0000**
T Test for Effects of Cultivated Land Value on Changes in Land Areas under the Policy	15.91***	2.00	0.30	3.75*	**1.56**	**0.77**
P-Value	0.0001	0.1579	0.5838	0.0527	**0.2111**	**0.3789**
N	1667	1667	1667	1667	**1667**	**1667**
R^2	0.129	0.218	0.273	0.289	**0.316**	**0.365**

Standard errors in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$
§All results are corrected for heteroskedasticity with clusters. Results in bold are also corrected for AR(1) based on the Wooldridge test results in Table 8.2.

Table 9.5 Second-Stage Two-Way FE Estimation Results of Level Changes in Unused Land Area

A. Whole China

	Without Policy Interaction Terms in the 1st Stage		With Policy Interaction Terms in the 1st Stage	
1st Stage Dependent Variable	Level Change in Unused Land Area	Level Change in Unused Land Area	Level Change in Unused Land Area	Level Change in Unused Land Area
Level Change in Cultivated Land Area	0.2002		0.2989	
	(0.1220)		(0.1370)	
Level Change in Urban Land Area		-1.0223		-0.9370
		(1.0484)		(0.9975)
Dynamic Balance Policy in Effect	797.7**	840.6**	912.6**	1020.8**
	(389.4)	(411.6)	(412.2)	(419.6)
Area of Unused Land in Year *t*	-0.345***	-0.345***	-0.345***	-0.345***
	(0.0151)	(0.0168)	(0.0143)	(0.0168)
Policy Interaction with Area of Unused Land			-0.0002**	-0.0003***
			(0.00009)	(0.00007)
Over-identification Test (Hansen J statistic)	4.937	4.728	10.771	13.985
P-Value	0.1765	0.1928	0.1489	0.0514
Under-identification Test (Kleibergen-Paap rk LM statistic)	16.997	23.443	21.749	37.929
P-Value	0.0019	0.0001	0.0054	0.0000
Weak Identification Test (Cragg-Donald Wald F statistic)	10.615	44.115	6.358	23.090
N	2475	2475	2475	2475
R^2	0.2422	0.2441	0.2394	0.2444

Standard errors in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Stock-Yogo Critical Values	Without Policy Interaction Terms	With Policy Interaction Terms
5% maximal IV relative bias	16.85	20.25
10% maximal IV relative bias	10.27	11.39
20% maximal IV relative bias	6.71	6.69
30% maximal IV relative bias	5.34	4.99
10% maximal IV size	24.58	33.84
15% maximal IV size	13.96	18.54
20% maximal IV size	10.26	13.24
25% maximal IV size	8.31	10.5

B. East China

	Without Policy Interaction Terms in the 1st Stage		With Policy Interaction Terms in the 1st Stage	
1st Stage Dependent Variable	Level Change in Unused Land Area	Level Change in Unused Land Area	Level Change in Unused Land Area	Level Change in Unused Land Area
Level Change in Cultivated Land Area	0.0220		0.0989	
	(0.0892)		(0.1019)	
Level Change in Urban Land Area		-0.5059		-0.5588
		(0.3821)		(0.3501)
Dynamic Balance Policy in Effect	658.0*	674.9*	735.1**	929.0**
	(363.5)	(377.9)	(363.2)	(458.1)
Area of Unused Land in Year *t*	-0.0855	-0.0745	-0.1199**	-0.0947
	(0.0566)	(0.0471)	(0.0597)	(0.0592)
Policy Interaction with Area of Unused Land			-0.0008	-0.0026
			(0.0019)	(0.0017)
Over-identification Test (Hansen J statistic)	3.774	4.276	5.955	5.852
P-Value	0.2869	0.2332	0.5450	0.5571
Under-identification Test (Kleibergen-Paap rk LM statistic)	7.626	15.734	12.571	18.082
P-Value	0.1063	0.0034	0.1275	0.0206
Weak Identification Test (Cragg-Donald Wald F statistic)	9.419	16.385	5.358	9.328
N	808	808	808	808
R^2	0.0295	0.0190	0.0361	0.0176

Standard errors in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$
Stock-Yogo Critical Values

	Without Policy Interaction Terms	With Policy Interaction Terms
5% maximal IV relative bias	16.85	20.25
10% maximal IV relative bias	10.27	11.39
20% maximal IV relative bias	6.71	6.69
30% maximal IV relative bias	5.34	4.99
10% maximal IV size	24.58	33.84
15% maximal IV size	13.96	18.54
20% maximal IV size	10.26	13.24
25% maximal IV size	8.31	10.5

C. West and Central China

	Without Policy Interaction Terms in the 1st Stage		With Policy Interaction Terms in the 1st Stage	
1st Stage Dependent Variable	Level Change in Unused Land Area	Level Change in Unused Land Area	Level Change in Unused Land Area	Level Change in Unused Land Area
Level Change in Cultivated Land Area	0.6997		0.6741*	
	(0.4896)		(0.3497)	
Level Change in Urban Land Area		-3.7722		-4.2454
		(3.5327)		(3.0890)
Dynamic Balance Policy in Effect	616.7	559.3	780.1	711.2
	(844. 5)	(636.4)	(834.0)	(654.1)
Area of Unused Land in Year *t*	-0.3460***	-0.3482***	-0.3460***	-0.3484***
	(0.0112)	(0.0159)	(0.0114)	(0.0156)
Policy Interaction with Area of Unused Land			-0.0002	-0.0002**
			(0.00013)	(0.00008)
Over-identification Test (Hansen J statistic)	1.682	2.496	7.293	9.952
P-Value	0.6410	0.4761	0.3990	0.1913
Under-identification Test (Kleibergen-Paap rk LM statistic)	12.774	16.470	16.798	29.002
P-Value	0.0124	0.0024	0.0323	0.0003
Weak Identification Test (Cragg-Donald Wald F statistic)	5.286	22.084	4.519	12.050
N	1667	1667	1667	1667
R^2	0.2206	0.2472	0.2227	0.2464

Standard errors in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Stock-Yogo Critical Values

5% maximal IV relative bias	16.85	20.25
10% maximal IV relative bias	10.27	11.39
20% maximal IV relative bias	6.71	6.69
30% maximal IV relative bias	5.34	4.99
10% maximal IV size	24.58	33.84
15% maximal IV size	13.96	18.54
20% maximal IV size	10.26	13.24
25% maximal IV size	8.31	10.5

Table 9.6 Second-Stage Two-Way FE Estimation Results of Percent Changes in Unused Land Area

A. Whole China

	Without Policy Interaction Terms in the 1st Stage		With Policy Interaction Terms in the 1st Stage	
1st Stage Dependent Variable	Percent Change in Unused Land Area	Percent Change in Unused Land Area	Percent Change in Unused Land Area	Percent Change in Unused Land Area
Percent Change in Cultivated Land Area	-0.2841 (0.3313)		-0.2654 (0.2967)	
Percent Change in Urban Land Area		0.02058 (0.0486)		0.0143 (0.0482)
Dynamic Balance Policy in Effect	0.0064 (0.0059)	0.0054 (0.0059)	0.0206 (0.0390)	0.0139 (0.0388)
Log (Area of Unused Land)	-0.2594*** (0.0454)	-0.2646*** (0.0486)	-0.2589*** (0.0455)	-0.2640*** (0.0493)
Policy Interaction with Log (Area of Unused Land)			-0.0012 (0.0030)	-0.0007 (0.0030)
Over-identification Test (Hansen J statistic)	1.761	1.646	8.177	8.791
P-Value	0.6235	0.6490	0.3172	0.2680
Under-identification Test (Kleibergen-Paap rk LM statistic)	13.609	20.890	22.501	27.551
P-Value	0.0087	0.0003	0.0041	0.0006
Weak Identification Test (Cragg-Donald Wald F statistic)	14.081	117.013	9.252	62.143
N	2475	2475	2475	2475
R^2	0.1150	0.1191	0.1166	0.1204

Standard errors in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$
Stock-Yogo Critical Values

	Without Policy Interaction Terms	With Policy Interaction Terms
5% maximal IV relative bias	16.85	20.25
10% maximal IV relative bias	10.27	11.39
20% maximal IV relative bias	6.71	6.69
30% maximal IV relative bias	5.34	4.99
10% maximal IV size	24.58	33.84
15% maximal IV size	13.96	18.54
20% maximal IV size	10.26	13.24
25% maximal IV size	8.31	10.5

B. East China

	Without Policy Interaction Terms in the 1st Stage		With Policy Interaction Terms in the 1st Stage	
1st Stage Dependent Variable	Percent Change in Unused Land Area	Percent Change in Unused Land Area	Percent Change in Unused Land Area	Percent Change in Unused Land Area
Percent Change in Cultivated Land Area	-0.1838		-0.0247	
	(0.3977)		(0.3730)	
Percent Change in Urban Land Area		-0.0515		-0.0983
		(0.1795)		(0.1742)
Dynamic Balance Policy in Effect	0.0039	0.0037	0.0582	0.0620
	(0.0165)	(0.0165)	(0.0871)	(0.0886)
Log (Area of Unused Land)	-0.1659***	-0.1641***	-0.1664***	-0.1612***
	(0.0374)	(0.0433)	(0.0377)	(0.0452)
Policy Interaction with Log (Area of Unused Land)			-0.0051	-0.0055
			(0.0071)	(0.0072)
Over-identification Test (Hansen J statistic)	0.906	0.857	10.077	8.538
P-Value	0.8241	0.8359	0.1842	0.2875
Under-identification Test (Kleibergen-Paap rk LM statistic)	14.432	21.827	17.221	32.055
P-Value	0.0060	0.0002	0.0279	0.0001
Weak Identification Test (Cragg-Donald Wald F statistic)	15.047	38.387	8.880	19.699
N	808	808	808	808
R^2	0.0421	0.0627	0.0515	0.0731

Standard errors in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$
Stock-Yogo Critical Values

	Without Policy Interaction Terms	With Policy Interaction Terms
5% maximal IV relative bias	16.85	20.25
10% maximal IV relative bias	10.27	11.39
20% maximal IV relative bias	6.71	6.69
30% maximal IV relative bias	5.34	4.99
10% maximal IV size	24.58	33.84
15% maximal IV size	13.96	18.54
20% maximal IV size	10.26	13.24
25% maximal IV size	8.31	10.5

West and Central China

	Without Policy Interaction Terms in the 1st Stage		With Policy Interaction Terms in the 1st Stage	
1st Stage Dependent Variable	Percent Change in Unused Land Area	Percent Change in Unused Land Area	Percent Change in Unused Land Area	Percent Change in Unused Land Area
Percent Change in Cultivated Land Area	-0.0890		-0.1526	
	(0.4819)		(0.2804)	
Percent Change in Urban Land Area		0.0370		0.0263
		(0.0240)		(0.0190)
Dynamic Balance Policy in Effect	0.0052	0.0054*	-0.0307	-0.0334
	(0.0045)	(0.0030)	(0.0190)	(0.0209)
Log (Area of Unused Land)	-0.3684***	-0.3716***	-0.3697***	-0.3750***
	(0.0535)	(0.0674)	(0.0566)	(0.0677)
Policy Interaction with Log (Area of Unused Land)			0.0030**	0.0032*
			(0.0015)	(0.0017)
Over-identification Test (Hansen J statistic)	5.378	2.200	9.371	9.176
P-Value	0.1461	0.5320	0.2271	0.2403
Under-identification Test (Kleibergen-Paap rk LM statistic)	13.026	17.370	19.775	17.966
P-Value	0.0111	0.0016	0.0112	0.0215
Weak Identification Test (Cragg-Donald Wald F statistic)	4.403	77.795	3.267	41.086
N	1667	1667	1667	1667
R^2	0.2716	0.2636	0.2746	0.2672

Standard errors in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Stock-Yogo Critical Values

5% maximal IV relative bias	16.85	20.25
10% maximal IV relative bias	10.27	11.39
20% maximal IV relative bias	6.71	6.69
30% maximal IV relative bias	5.34	4.99
10% maximal IV size	24.58	33.84
15% maximal IV size	13.96	18.54
20% maximal IV size	10.26	13.24
25% maximal IV size	8.31	10.5

Table 9.7 Overall Effects of the Dynamic Balance Policy and Wald Test

A. Linear Models

	East China	West and Central China	Whole China
Average Overall Effects on the Annual Absolute Change in Cultivated Land (Ha)	-270.56	429.43	531.46
Wald Test Statistics	0.06	0.50	1.62
P-Value	0.8009	0.4778	0.2033
Average Overall Effects on the Annual Absolute Change in Urban Land Area (Ha)	-91.84	-69.02	-81.91
Wald Test Statistics	0.13	2.20	2.31
P-Value	0.7160	0.1376	0.1287
Average Overall Effects on the Annual Absolute Change in Unused Land Area (Ha)	726.71	815.35	1,018.00
Wald Test Statistics	1.72	0.15	0.47
P-Value	0.1897	0.7015	0.4928

B. Log-Log Models

	East China	West and Central China	Whole China
Average Overall Effects on the Ratio of Cultivated Land Area in *t*+1 over Its Area in *t* (%)	-0.0088	0.0063	0.0041
Wald Test Statistics	1.13	0.73	0.69
P-Value	0.2888	0.3934	0.4049
Average Overall Effects on the Ratio of Urban Land Area in *t*+1 over Its Area in *t* (%)	0.00059	-0.0103	-0.0061
Wald Test Statistics	0.00	0.50	0.26
P-Value	0.9493	0.4798	0.6110
Average Overall Effects on the Ratio of Unused Land Area in *t*+1 over Its Area in *t* (%)	0.0180	0.0044***	0.0090
Wald Test Statistics	0.81	10.23	0.43
P-Value	0.3674	0.0014	0.5138

10 Concluding Remarks

Motivated by the prevailing problems in China's rural land acquisition and conveyance, this dissertation was conducted for the purpose of examining the economic incentives for land acquisition and conveyance and the impacts of the Dynamic Balance Policy, a policy designed to protect cultivated land. From the formulation of the policy questions to the methodology of answering such questions, this is the first in-depth analysis of its kind on this topic. The contribution of this dissertation is twofold. First, it rationalizes the incentive structure as well as the policy intervention in China's land conversion in an economic model. Second, with a solid theoretical foundation, the empirical findings provide sound policy recommendations for the decision makers in China.

This thesis finds that the DBP has had no effects of reducing cultivated land loss, although empirical evidence found by this thesis may have underestimated the effects of the DBP. Nevertheless, results do show that even if the DBP has had a direct impact on land use changes, the effects would be overriden by strong economic incentives for cultivated land conversion. These economic incentives are the main driving forces for cultivated land conversion, and are likely to grow with China's rapid economic growth. Consequently, any effects that the DBP may have are not likely to be sustainable.

Moreover, the DBP has its deficiencies in designing, which could plague its effectiveness. Specifically, the DBP is essentially a quota constraint on the scale of cultivated land conversion, and does not address the fundamental problems in land conversion, namely undefined property rights of rural land before 2007, the government taking of rural land at below the market price, the inappropriate compensation scheme, and the inefficient land use planning. China has made the successful transition from a planned economy to a market economy, yet it is no surprise that such "command-and-control"—a term dubbed by Henderson (2009)—government management would fail since such powerful economic incentives for cultivated land conversion counteract it.

This thesis suggests that the following schemes of restraining the economic incentives for land conversion may be more effective in curbing cultivated land loss: (1) making local governments pay the cost of cultivated land conversion determined by the characteristics of the land, such as the size and value of existing use, as well as its location with respect to urban areas, natural amenities, and access to economic and recreational activities; (2) raising the cost of land conversion by increasing the participation of farmers in the land acquisition process; (3) raising the cost of land conversion by increasing the land reclamation fees; (4) raising the cost of land conversion by increasing the expected costs of getting caught out of compliance of laws; (5) reducing the revenue of land conversion by imposing taxes on it; and (6) increasing the incentive for promoting agricultural production and cultivated land protection.

In addition to measures underlining the incentive structure of land conversion as proposed by this study, several regulative measures in the debate deserve mentioning. First, this thesis has found that even when the Dynamic Balance Policy is followed in some land conversion projects, the quality of the reclaimed land is much lower compared with the land lost. The government could adopt the Global Position System (GPS) to better monitor the exchange of new cultivated land for converted land. With the GPS technologies, each parcel of land can be identified and recorded. Then, full information on its agricultural productivity, measured by indicators such as soil acidity and alkalinity, climate data, access to irrigation facilities, and average annual agricultural output values, should be attached to each parcel of land. Any conversion of such land has to be compensated by land of the same quality or having the potential to have the same quality.

Second, the ongoing tax reform in China provides a platform for developing alternative revenue sources for local governments, which will lessen local government's reliance on land revenues and ultimately restrain local government from inefficient urban land expansion. Property taxes have been advocated as an alternative source of local revenue. Not only can property taxes generate revenues for local government, they can also safeguard the property rights of tax payers and discourage the abuse of power by public servants (Cao, Feng, and Tao 2008).

Third, to help China mitigate the incidence of land disputes, policies should be made to clearly define "public interests" serving the rationale for land acquisition, tighten the *de facto* protection of farmers' land use rights, improve farmers' participation in land acquisition process, design adequate compensation packages for farmers, and ensure compensation is paid to the deserving farmers. The 2011 Urban Taking Law has made important improvement in these respects. Some of the measures in the Urban Taking Law may be applied to rural land acquisition (Li 2011).

Fourth, it is also important for China to have a well-organized land dispute arbitration system. Land disputes exist even in well-functioning market systems. It is China's lack of dispute resolution institutions that intensify such problems (Clarke, Murrell, and Whiting 2008). If a well-organized land dispute arbitration system existed in China, local officials and land developers would have to calculate the potential of being brought to court for land disputes as their development costs, both time and money wise.

Fifth, a drastic reform in China's land market is arguably to liberalize the land sales between farmers and urban private land users with the adoption of strict zoning regulations, a call by both western and Chinese scholars (for example, Ding 2003; Cao, Feng, and Tao 2008; Clarke, Murrell, and Whiting 2008; Lichtenberg and Ding 2008).

As a final remark, this thesis conducts a conceptual and empirical investigation of the influence of economic incentives and the impacts of the cultivated land protection policy on China's cultivated land loss and urban land expansion. Its findings suggest that under the strong influence of economic incentives for land conversion, the effect of the existing policy for cultivated land protection may not sustain in the long term. This dissertation emphasizes that policies made to lessen the economic incentives for land conversion will help China curb its cultivated land loss and protect farmers' property rights.

Appendix

Wooldridge Test for Serial Correlation in Panel Data

Wooldridge (2002) derives a simple test for first-order autocorrelation (AR(1)) in panel-data models. The general form of panel-data regression equations is

$$y_{it} = X_{it} B_1 + Z_i \; B_2 + \alpha_i + \alpha_t + \varepsilon_{it}$$

where y is the dependent variable, X_{it} represents a vector of time-varying covariates, Z_i represents a vector of time-invariant covariates. The error term is consisted of the individual-specific unobserved effects (α_i), the time-specific unobserved effects (α_t), and idiosyncratic errors (ε_{it}).

Wooldridge test for AR(1) uses the residuals from first-differenced regressions

$$y_{it} - y_{it-1} = (X_{it} - X_{it-1})\beta + \alpha_t - \alpha_{t-1} + \varepsilon_{it} - \varepsilon_{it-1},$$

or equally

$$\Delta y_{it} = \Delta X_{it} \beta + \Delta\alpha_t + \Delta\varepsilon_{it}.$$

Denote the estimated residuals as $\Delta\hat{\varepsilon}_{it}$. Given Wooldridge's observation that, if error terms are not serially correlated, then $Corr(\Delta\varepsilon_{it}, \Delta\varepsilon_{it-1}) = -0.5$, the test regresses the residuals $\Delta\hat{\varepsilon}_{it}$ on their lags and tests whether the coefficient on the lagged residuals is equal to -0.5. Interested audience can refer to pages 282-283 of Wooldridge (2002) for details and examples.

The syntax of Wooldridge test in Stata is

xtserial depvar [*varlist*] [if *exp*] [in *range*] [, output].

You must *tsset* your data before using *xtserial*. The test statistics follow F distribution. Rejection of the null hypothesis of no AR(1) leads to the conclusion of the presence of AR(1) in the model.

Because the Wooldridge test is based on fewer assumptions, it is less powerful than tests that make specific assumptions about the nature of the individual effects or test for the individual-level effects jointly, such as the Baltagi–Wu test (Drukker 2003). However, it should be more robust. While the robustness of the test makes it attractive, it is important to verify that it has good size and power properties under these weaker assumptions. Drukker (2003) provides simulation results showing that the test has good size and power properties in reasonably sized samples. Drukker's simulations are conducted for both fixed and random effects models, with and without conditional homoskedasticity in the idiosyncratic error terms, with balanced data and unbalanced data with and without gaps in the individual series. The power simulations include both autoregressive and moving-average alternatives (2003).

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