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DOES URBAN PROXIMITY ENHANCE RURAL DEVELOPMENT IN CHINA?

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ABSTRACT: This dissertation studies whether cities enhance development in nearby rural areas in China. First, we recount the evolution of urban-rural relations since the Maoist period (Chapter 1). While rural areas were sacrificed in favor of cities for decades, since the early 2000s the government has indicated that cities should "support the countryside". Nowadays, a high number of investments have been realized to strengthen linkages between urban and rural areas with the aim of enabling cities to promote rural development. However, very little is known about the effective impact of cities on nearby rural areas in the specific Chinese context. The present dissertation aims at providing a detailed analysis of the role of cities on rural areas in order to assess whether strengthening urban-rural linkages is an effective rural development strategy. After having defined what we mean by urban and rural areas in China (Chapter 2), we provide a review of the literature on the role of cities in rural development (Chapter 3). The following three chapters present empirical investigations. The first empirical test focuses on the effect of cities on the agricultural sector of nearby rural areas (Chapter 4). We then study the impact of cities on the rural non-agricultural sector (Chapter 5). Finally, after having focused on the economic impact of cities, we investigate the effect of cities on rural development by testing whether urban proximity significantly increases rural pollution in China (Chapter 6). In the light of the results obtained, we consider whether relying on cities to enhance rural development could be an effective strategy (Chapter 7).

RESUME: Cette thèse étudie si les villes stimulent le développement économique des zones rurales voisines en Chine. Dans un premier temps, la thèse retrace l'évolution des relations entre zones urbaines et rurales depuis la période maoïste (Chapitre 1). Alors que durant des décennies entières les zones rurales ont été sacrifiées au profit des villes, depuis le début des années 2000 est apparue l'idée que les villes devaient à leur tour "soutenir les zones rurales". A l'heure actuelle, de nombreux investissements visant à renforcer les liens entre villes et campagnes sont réalisés dans le but de favoriser la croissance rurale. Cependant, l'effet des villes sur le développement rural en Chine demeure profondément méconnu. L'objectif de cette thèse est ainsi de fournir une analyse détaillée de l'effet des villes sur le développement rural afin de comprendre si renforcer les liens urbains-ruraux peut constituer une stratégie de développement rural efficace. Après avoir défini ce que l'on entend par zones urbaines et rurales en Chine (Chapitre 2), nous passons en revue la littérature sur l'effet des villes sur le développement rural (Chapitre 3). Les trois chapitres suivants fournissent des analyses empiriques. La première analyse empirique s'attache à l'effet des villes sur le secteur agricole des zones rurales avoisinantes (Chapitre 4). Ensuite, nous étudions l'effet des villes sur le secteur rural non-agricole (Chapitre 5). Enfin, alors que les deux premières analyses empiriques se concentrent sur l'effet des villes sur la performance économique rurale, la dernière étude analyse l'effet des villes sur le développement rural, en estimant l'impact de la proximité urbaine sur la pollution rurale (Chapitre 6). À la lumière des résultats obtenus, nous nous interrogeons sur l'efficacité d'une politique visant à renforcer les liens villes-campagnes en Chine (Chapter 7).

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Chapter 1

General Introduction

From Uncoordinated to Coordinated Urban-Rural Development?

Since the establishment of the People's Republic of China in 1949, urban-rural relations have always been at the core of the national development strategy (Lin, 2002).

With the adoption of an urban-centered industrial development strategy in the 1950s, China began implementing numerous policies favoring the industrial sector and cities at the expense of agriculture and the countryside. It was then assumed that industrialization was exclusively an urban phenomenon and that it could therefore be achieved by exclusively focusing on the development of cities (Mc Gee, 2008). Indeed, it was considered that achieving rapid and widespread industrialization required investing all economic resources, including those from rural areas, in urban areas.

During the reform era, and particularly since the mid-1980s, the government has carried on its urban-centered industrialization strategy and has continuously favored cities over rural areas. Indeed, while comparative advantages and efficiency were considered to be the cornerstones of the reforms, Deng Xiaoping announced that Eastern provinces and cities "should be allowed to get rich first". It was promised that once Eastern provinces and cities achieved a sufficient level of economic development, growth would spread to other regions so that "in the end everyone will get rich".

As might be expected, this national development strategy has led to a surge in urban-rural inequalities which, since the early 2000s, has constituted a major threat for China's stability (Renard, 2006). As a result, the political discourse and the national development strategy have been progressively re-oriented from the single-minded pursuit of urban-led economic growth to the aim of achieving more equity by supporting less developed areas. Since the early 2000s, the government has implemented several policies to promote rural development and to reach "coordinated urban and rural development". To realize this enormous task, the government has given priority to a number of lines of action. Among them, and consistent with Deng Xiaoping's statement, a number of initiatives attempt to strengthen linkages between urban and rural areas so that cities may promote rural development. However, until now, very little is effectively known about the role of cities on rural development in the very specific context of China. This issue is of primary importance given that rural development, as well as promoting urbanization, are both high on China's policy agenda. After having been favored for decades, are cities today able in turn to promote rural development?

1.1 Pre-reform era (1949-1978)

1.1.1 Development strategy in the Mao era: the root of the urban-rural divide

Soon after the establishment of the People's Republic of China in 1949, the country followed the economic model of the Soviet Union by implementing a centrally planned heavy-industry-based development strategy. As industry traditionally takes place in cities, the country adopted an urban-centered industrialization strategy, which favored the development of heavy industry and cities at the expense of agriculture and the countryside[1]. In other words, to achieve rapid and extensive industrialization, virtually all resources, including those resulting from agriculture, were directed toward urban capital-intensive industries.

To carry out this heavy-industry-priority development strategy, China was turned into a centrally-planned economic system. Almost all urban work units were placed under state ownership and became subject to government planning and control. As urban work units were nationalized, urban residents were progressively granted access to a wide range of state-sponsored goods and services (such as grain supplies, housing, health and education). In 1955, land in rural China, which had until 1955 been under private ownership, was collectivized and agricultural collectives began to take charge of the management of the farm economy. Within agricultural collectives, rural residents were given equal access to farmland. Moreover, agricultural collectives provided public goods and services to their members but were not given any national resources to do so and thus, these provisions heavily depended on whether collectives generated resources from the sale of agricultural surpluses (Naughton, 2007). As a result, urban residents benefited from a much higher level of access to social services and public goods than rural dwellers (Huang *et al.*, 2008). In addition, two major policies were established to extract resources and surpluses from rural areas and peasants and invest them in industry and cities: the procurement policy and the "price scissor" (Yang, 1999; Chan *et al.*, 2008). In 1953 the government established a procurement policy forcing peasants to sell part of their production to the state, at very low set prices. In addition, once the quotas were fulfilled, agricultural surpluses could be sold on the market, but again at very low prices. Indeed, the prices of agricultural produce were set

[1]China underwent rapid industrialization over the Mao era. Specifically, the industrial production increased from 14,180 to 133,720 million of yuan. While in 1952 primary and secondary industries represented 51% and 21% of GDP respectively, when Mao died in 1976 they represented 33% and 45% of GDP respectively (data is from the China Data Online website).

artificially low, leading to a distorted price structure favoring cities and the industrial sector ("price scissor"). Thus, cities sold their expensive industrial goods to rural areas whereas the latter sold their low-priced agricultural and primary products to cities.

This system obviously favored urban residents, who benefited from both higher incomes and a higher provision of public goods than rural residents. As a result, farmers had incentives to migrate to urban areas and, consequently, a large number of rural residents began migrating to cities at the end of the 1950s (Naughton, 2007). To keep the system functioning, *i.e.* in order to retain the large agricultural labor force in the countryside so that it could produce the necessary agricultural products for the small urban industrial labor force, the government used the household registration system or *hukou* (Lin, 2002)[2]. In 1958, the government issued the *Regulations of Hukou Registration* to strictly control labor mobility from rural to urban areas (Cai *et al.*, 2008). Specifically, every individual leaving his permanent place of residence for more than three months was required to provide justification to the government and receive authorization to migrate by both the origin and destination local governments (Xu, 2008).

1.1.2 Urban-rural dualism at the dawn of the reform era: legacy of the Mao era

The urban-biased policies implemented during the Mao era have erected "invisible walls" between cities and the countryside. Cities, where heavy industry was concentrated, were considered by the government as "upper-class places" (Ma, 2005) while agriculture and the countryside were sacrificed to support the urban-centered industrialization, which led to a very strong increase in urban-rural inequalities in the pre-reform period, both in terms of individual earnings and productivity (Yang, 1999). Peasants remained poor, were deprived of state-sponsored benefits available to urban residents and were stuck in the agricultural sector. In the countryside, agricultural productivity remained low as the collective production system and the price scissors gave peasants very few incentives to produce foods and primary products (Fan, 1997). Moreover, capital and agricultural surpluses were directed to industrial investments, which prevented the agricultural sector from modernizing.

[2]At the beginning, the *hukou* was established as a tool to register the Chinese population. There are two features in the *hukou*: the registration according to the location (the household's "permanent" place of residence) and the registration nature or type (agricultural or non-agricultural). Moreover, every individual inherits the household status of his mother (Xu, 2008). Since 1958, the *hukou* has been used to strictly control migration, especially from rural to urban areas and from smallest to largest cities (Chan *et al.*, 2008).

1.2 Reform era

1.2.1 Rural reforms at the beginning of transition (1978-mid 1980s)

At the beginning of the economic transition, the government implemented a set of rural reforms, leading to an increase in rural income.

From 1978 to 1983, the household responsibility system was implemented in the countryside. This reform consisted in replacing the former agricultural collective system with a new system, in which households were the main decisional unit and the residual claimant of profits, raising farmers' incentives as well as their decision making authority (de Brauw *et al.*, 2004). Moreover, in 1979 and in 1983, the government significantly increased procurement prices for major crops: in 1979 the average procurement prices of major crops increased by 22.1% (Lin, 1992). Both of these agricultural reforms strongly incited farmers to provide labor efforts and thus, resulted in a substantial increase in agricultural productivity (Lin, 1992)[3]. In addition to agricultural reforms, from 1985 to 1992, rural areas benefited from rural industrialization with the rapid development of township and village enterprises (Cai *et al.*, 2008). Thus, beginning in the early 1980s, rural residents were allowed to "leave the land without leaving the village", which enabled them to engage in local non-agricultural activities. Finally, rural laborers benefited from a certain relaxation of constraints on labor mobility. Indeed, the household registration system was also progressively liberalized, allowing an increasing number of workers to work in cities.

As a consequence of these reforms, rural income increased significantly at the beginning of the economic transition, resulting in a decrease in the urban-rural gap: the income ratio of urban residents to rural residents decreased from 2.9 in 1978, to 2.2 in 1985 (Yang, 1999). However, this trend was very short-lasting. Indeed, after the mid-1980s, rural income growth stopped and the urban-rural gap began to increase again because additional urban-biased policies were implemented (Riskin, 1997; Christiansen and Zhang, 2009).

[3] More precisely, agricultural reforms have been implemented in two broad phases. From 1978 to 1984, reforms increased farmers' incentives as well as their decision-making power, especially through the implementation of the household responsibility system. From 1985 to 1995, a significant market liberalization was implemented, leading to an increased number in market exchanges (de Brauw *et al.*, 2004).

1.2.2 Development strategy in the reform era and increase in the urban-rural divide (mid 1980s-1990s)

The reform era did not break with the urban-bias policies implemented in the 1950s, quite the contrary. First of all, the government stood by its intention to rapidly industrialize the country[4]. Thus, it continued to extract the maximum resources possible from agriculture and the countryside in order to invest these resources in industry and cities. Second, the reform era has marked an ideological turning point, which has resulted in the implementation of additional policies favoring cities. From the early 1980s, the government has considered that efficiency and comparative advantages should be the cornerstones of the reforms[5]. The government officially stated that it would carry out an uneven economic strategy by implementing reforms selectively and gradually, *i.e.* by implementing reforms first in locations endowed with a comparative advantage. Quite naturally, cities, and especially coastal cities, benefited from favorable policies contrary to rural areas, which were not endowed with a comparative advantage (Lin, 2002).

To legitimize this uneven development strategy, party leaders relied on the concept of the "primary stage of socialism" and on the "ladder-step theory" (Fan, 1997). In 1987, the Chinese communist party officially recognized the concept of the "primary stage of socialism", established in 1979 by Su and Feng[6]. According to this concept, the classical Marxist theory was established for more mature and developed economies than China. Thus, as China was at a "primary stage of socialism", it was necessary for the country to go through a transitional period and to develop a "socialism with Chinese characteristics". According to party leaders, this transitional period had to be carried out following the precept of the "ladder-step theory" (*tidu lilun*) (Wei, 1999). This Chinese theory has been deeply influenced by Western development theories as it closely revisits the growth pole theory of Perroux (1950; 1970), the spread/backwash or trickle-down/polarization concepts of Myrdal (1957) and Hirschman (1958), and the inverted-U theory of Williamson (1965). According to the ladder-step theory, for China, which has only limited resources, the only way to achieve rapid economic growth consists in exclusively focusing on the

[4]China has continued its rapid industrialization during the reform period. Thus, the industrial production has increased from 174,520 to 23,531,860 million yuan from 1978 to 2012. Over the period, the share of the secondary industry has remained stable (45%) while the share of the primary industry has decreased from 28% to 10% of GDP (data is from the China Data Online website).

[5]This ideological shift can be attributed to the observation that the Maoist policies were unable to generate rapid growth, as well as to the increasing influence of Western theories, as China has progressively opened up (Fan, 1997).

[6]Su and Feng's (1979) paper is only available in Chinese. Fan (1997) provides a comprehensive description of the concept of the "primary stage of socialism".

development of locations endowed with a comparative advantage. Once these locations have been developed, it is expected that they will spread economic growth to the less developed parts of the country, thus removing inequalities. Any state intervention to limit inequalities, would only squander the few resources the country possesses, and would result in undermining economic growth. According to the ladder-step theory, the increase in inequalities is thus more of a necessary stage along the path of development than a problem; this theory clearly enabled party leaders to legitimize the increase in inequalities (Fan, 1997). The uneven development strategy is perfectly summarized in the famous words pronounced by Deng Xiaoping in 1980, when he advocated to "use our comparative advantages, avoid using our disadvantages and accept the fact of economic disparities. (...) Some people and some regions should be allowed to get rich first and in the end everyone will get rich" (Lin et Liu, 2006).

Since the 1990s, one of the major strategies of the government has consisted in promoting Coastal provinces and cities as growth poles expected to lead national and regional development. To achieve this, the government began implementing a wide range of preferential policies in these locations. To summarize, as we have already stated, in the reform era the government has pursued the urban-bias policy initiated during the Mao period, which has reinforced the urban-rural divide[7].

1.2.3 Urban-biased policies

First of all, the transition has not destroyed the "invisible walls" separating urban areas from rural areas erected in the pre-reform period. As before the economic reforms, the government has continued to pursue its "extractive practices" to develop the urban-centered industrial sector by sacrificing both agriculture and the countryside. The "price scissor" between agricultural and industrial products has remained. Moreover, in spite of several changes in the grain procurement policy, especially in 1985 (Lin, 1992), procurement contracts have remained. In addition, while the *hukou* system has been liberalized, rural migration to cities still remains constrainted[8].

[7]The present chapter focuses on rural-urban relationships and thus, on urban-biased policies. However, the government has also implemented favorable policies in Coastal provinces. It was assumed that once Coastal provinces achieved a sufficient level of economic development, they would produce spillover effects on Interior provinces. See Brun *et al.* (2002) and Renard (2002).

[8]Since the 1990s, although the liberalization of the *hukou* system has made it much easier for rural migrants to work in cities without the local urban *hukou*, it has not made the obtention of an urban *hukou* much easier in practice (Naughton, 2007). Moreover, in 2005 the central government officially announced that migrant workers should be allowed to live and work in cities and should benefit from social services. However, in spite of this official announcement, most rural migrants are still denied urban *hukou* and thus access to education and health

Because of the *hukou* system, rural migrants can only engage in low-paid, often informal jobs in cities where they are perceived as highly exploitable laborers (Naughton, 2007; Christiansen and Zhang, 2009).

In addition to these already existing urban-biased policies, additional extractive practices have added up, still with the aim of promoting the development of urban-centered industry. The requisitioning of rural farmland by authorities constitutes a meaningful example of new extractive practices. Since the 1990s, with the rapid industrial and urban development, local governments have increasingly requisitioned rural lands, even if farmlands are under leases[9]. While these practices generate huge financial gains for local authorities, farmers are usually informed with short notice, obtain unfair compensation and have a high probability of falling into poverty after losing their farmland. In 2009, it was estimated that between 40 and 50 million people had lost their farmland due to urban expansion and about 10 million of them became unemployed (Christiansen and Zhang, 2009).

In addition to these extractive practices, the government has implemented a range of preferential policies to spur the development of cities, and especially of coastal cities endowed with a comparative advantage. In 1984 the government opened several cities for trade by establishing 14 open coastal cities. These preferential policies are in practice deregulation policies as they enable firms to operate in a free-market environment (Démurger *et al.*, 2002). In 1992, the Open Door Policy was further extended to inland China with the creation of new open economic zones in major cities along the Yangtze River as well as in all capital cities of provinces and autonomous regions in inland China. In addition, cities have benefited from many more financial resources than rural areas. The tax sharing reform of 1994 has led richer regions, with highly developed nonfarming sectors, to obtain significantly more tax revenues than agricultural regions. Indeed, local government revenues mainly depend on some major taxes, such as the value-added tax and the personal income tax, which are considerably higher, the higher the development level of the secondary and tertiary sectors (Tsui, 2005). In addition, the tax sharing

services, as well as eligibility for several types of employment, in cities (Chan and Buckingham, 2008). In 2012 China established new rules for migrants to apply for an urban *hukou* (except in the 40 largest cities). In spite of that, most migrants remain tolerated in cities but are unable to acquire an urban registration. See Kam Wing Chan, "China's *Hukou* System Stands in the Way of its Dream of Prosperity", *South China Morning Post*, January 19, 2013.

[9] Even if farmers have leases which give them the right to use their land (often for a period extending up to 50 years), the land ownership remains collective. As a result, in practice the local authorities decide what to do with the farmland even if it is under lease. Thus, local authorities often requisition farmland to convert it for more lucrative non-agricultural uses (Naughton, 2007).

reform has hampered the development of the non-agricultural sector in rural regions (Zhang, 2006). Indeed, regions with a low industrial base that cannot obtain much tax revenues, must impose a much higher tax rate on firms in order to pay for the expenses of the local administration. Moreover, once the expenses of the local administration have been paid, these regions have no additional resources to finance local public goods, such as infrastructure. As a result, rural regions impose a high fiscal burden on firms and offer poor quality infrastructure, which creates a very unattractive environment for potential investors. On the contrary, cities, thanks to their highly developed industrial sector, manage to get enough tax revenues to finance local public goods and to pay for local administration, even by imposing a low tax burden on firms. In addition, the government's financial transfer program has been biased in favor of cities. Differences in the financing of infrastructure is a striking example. While urban infrastructure was mainly financed by the state budget, there was almost no state investment in rural infrastructure until the 2000s (Shen *et al.*, 2012). As a result, the provision of infrastructure was mainly financed by towns, villages, communities and even by farmers, leading to huge disparities between urban and rural areas in infrastructure networks. Last but not least, rural areas face much more difficulty obtaining financial resources and thus, often impose a high tax rate on local dwellers to finance local expenses; this has lead to a huge increase in the "peasant burden". According to a survey carried out in Hubei in 1997, Li (2003) estimates that the annual charges paid by peasants to their village and local authorities accounted for as much as 20% of the net income of rural households.

Finally, not only have cities as locations benefited from policies favoring their development, their inhabitants and officials have also benefited from numerous perks. Urban residents have benefited from huge welfare privileges, especially in terms of housing, health insurance, pension and education. On the contrary, rural residents have suffered from under-developed and poor quality welfare services which, in addition, are unaffordable for most rural dwellers[10]. Finally, local officials in cities also benefit from several advantages such as a larger government, higher official rank and higher salary (Li, 2011).

[10]Indeed, the dismantling of the collective in 1978 (see Section 1.2.1) has led to the collapse of the communal social provision system. After that, the quality and availability of welfare services in rural China has continuously been degraded until the 2000s (Naughton, 2007).

1.2.4 Urban biased *administrative* system: making cities the new actor in local development

To promote the development of cities and to allow them to become engines of growth for the rest of the country, the government has undertaken two types of policies. First, as described in Section 1.2.3, it has implemented a range of preferential economic policies in cities. Second, it has carried out a number of administrative measures to empower cities. The restructuring of the administrative organization during the economic transition, is thus a direct consequence of the aim of the government to turn cities into growth poles (Ma, 2005; Li and Wu, 2012).

Before the economic reforms, provinces and counties were the two major players at the local level[11]. During the economic transition, a profound administrative restructuring has occurred in order to turn cities into integral players in the administrative system. Specifically, three measures have been implemented: "turning prefectures into cities" (*di gai shi*)[12], "turning counties into cities" (*xian gai shi*)[13], and "turning cities and counties into urban districts" (*xian shi gai qu*)[14] (Chung and Lam, 2004). These measures, which we will describe in more detail in Chapter 2, have had several major implications. First, they have led to a sharp increase in the number of designated cities and to an enlargement of the urban administrative area of cities. Second, the *administrative* area of cities (and thus their power) has been expanded well beyond the urban core as a result of allowing cities to administer nearby rural counties. On the whole, during the economic transition, cities have appeared as an integral level in the Chinese administrative system and, in addition, as the main players in local development. Cities have been given much more autonomy to manage local development, for example in terms of setting tax rates and formulating local development strategy and economic plans (Li and Wu, 2012). Cities have thus benefited from increased administrative powers and financial resources, favorable to their own local development and aimed at enhancing the diffusion of development at the regional

[11]Chapter 2 describes the Chinese administrative divisions system.

[12]Also known as "city administering counties", this measure has allowed cities to administer neighboring rural counties. It has thus led to the appearance of city-centered regions, in which the central city has under its jurisdiction several administered rural counties. This measure was expected to enhance interactions between urban and rural areas by reducing administrative barriers and to facilitate planning at the regional level (Ma, 2005).

[13]Also known as "converting entire counties to cities", this measure upgraded entire rural counties to the rank of county-level cities in the expectation that once counties converted to cities, they would benefit from a more prestigious reputation, leading to more investment (Chung and Lam, 2004).

[14]Also known as "annexation of suburban counties by cities", this measure has consisted in administratively converting one or several counties (or county-level city) into urban districts of prefecture or provincial-level cities with the goal of enabling cities to more easily expand and to facilitate the decentralization of industry.

level.

However, in practice such administrative measures have led to empowering cities at the expense of rural areas, thus enhancing the urban bias. The "turning prefectures into cities" measure has generated new conflicts between the central cities and the newly administered rural counties. Indeed, decisions within the entire administrative area are taken by city officials and thus, tend to favor the city core at the expense of administered counties. As a result, financial resources are usually disproportionately allocated to the city. The measure has also enabled cities to obtain low-priced resources from their administered counties, especially in terms of food grains and raw materials (Vogel *et al.*, 2010), leading many to call the "turning prefectures into cities" measure the "city extorting counties", "city squeezing counties" or "city blocking counties" measure (Ma, 2005). The other two measures have also led to negative effects for agriculture and the countryside. For example, the "turning counties into cities" has led officials to focus on the development of the more remunerative nonfarming sector and to neglect agriculture once city status has been obtained. The "turning cities and counties into urban districts" has also led to a loss of administrative autonomy for suburban counties and to significant loss of farmland.

1.2.5 Urban-rural inequalities since the mid-1980s: increase and multidimensionality

There is a large consensus that urban-rural disparities are very high and have soared since the mid-1980s[15]. While the inequality level commonly increases during the economic development process of a country (Kuznets effect), the widening in the urban-rural gap in China has resulted to a large extent from the urban-biased development strategy (Ye, 2009).

The literature provides various estimates of the urban-rural income gap. To our knowledge, Sicular *et al.* (2007) provide the most reliable estimate of the gap by: (i) using a full measure of income (housing-related components of urban income are included), (ii) adjusting the urban-rural income ratio for differences in cost of living between urban and rural areas and (iii) including rural-to-urban migrants in their sample. In this way, the authors take into account the factors which are regularly omitted and which may underestimate (omission of the housing-related components of urban income) or overestimate (omission of controls for spatial differences in living costs; exclusion of migrants) the urban-rural income gap. Although the au-

[15] Kanbur and Zhang (1999) is a notable exception. According to the authors, urban-rural inequality accounts for a very large share of total regional inequality but has remained relatively constant over time.

thors highlight that the urban-rural gap is often over-estimated in other studies, they conclude that it remains large in China even when controlling for usually omitted factors. According to their calculations, the income ratio of urban residents to rural residents was 2.12 in 2002, accounting for about 25% of overall inequality[16]. Since the beginning of the 2000s, the income ratio of urban residents to rural residents has continued to increase and was about 3.20-3.33 in 2007[17] (Christiansen and Zhang, 2009; Liu *et al.*, 2009).

In addition, urban-rural disparities go beyond income inequality. Rural residents also suffer from lower education and health conditions as highlighted in the 2005 *Human Development Report* of the United Nations: in 2003 while the Human Development Index for China as a whole was 0.755, the index for urban China was 0.814 but only 0.673 for rural China (UNDP, 2005).

Finally, to some extent rural households have become increasingly vulnerable because they currently face new risks in addition to the traditional problem of potential crop failure (Christiansen and Zhang, 2009). For example, migrants are typically engaged in jobs that individuals with urban *hukou* do not want. Thus, they are confined to low remunerated jobs, mainly in the informal sector, and that usually take place in dangerous or toxic environments. As a result, a large number of migrants return to their home village hurt or sick, which represents an additional financial burden for rural households. According to Christiansen and Zhang (2009), since the economic transition, rural households have suffered from new forms of impoverishment, especially due to additional health problems and increased land requisitioning.

At the end of the 1990s, the huge increase in the urban-rural and industry-agriculture gaps, the ever increasing number of land requisitioning and the worsening of environmental degradation has led to widespread criticism and major social tensions. Researchers, in particular the Professor Wen Tiejun, began warning about the three rural issues (*sannong wenti*): problems regarding agriculture (*nongye*), rural areas (*nongcun*) and farmers (*nongmin*).

[16]The ratio is equal to 3.18 when the authors do not control for living costs differences and do not include migrant workers.

[17]Obviously, this ratio is much higher than the 2.12 obtained by Sicular *et al.* (2007) partly because inequality has increased but also because the authors do not control for all the necessary factors as in Sicular *et al.* (2007).

1.3 Rural areas: a new target of the government since the 2000s

1.3.1 Coordinating urban and rural development

Since the early 2000s, policy makers have increasingly recognized the ever increasing problems facing rural areas and have started rethinking the national development strategy, until then strongly biased in favor of urban areas and industry. The early 2000s marks a turning point in the Chinese economic transition, with the appearance of new notions in the official discourse, such as "coordinating urban and rural development", "urban-rural integration" or "balanced urban-rural development", which means tackling urban-rural dualism (Christiansen and Zhang, 2009). As a result, the national development strategy is being re-oriented, from the single-minded pursuit of efficiency and economic growth, to the aim of achieving more equity by supporting less developed areas.

In 2002, it was officially announced at the 16^{th} National Congress of the Chinese Communist Party that prosperity could not be achieved without developing rural areas. It was also stated that economic and social development must incorporate both urban and rural areas (Ye, 2009). The aim of developing rural areas has become more concrete since 2004, as the annual Number One Policy Document of the central government has constantly been devoted to rural issues. This is particularly meaningful as this document establishes the government's priorities for the year to come. Every year since 2004, this document has defined a series of measures to enhance rural and agricultural development as well as urban-rural integration (Ye, 2009)[18]. Specifically, a number of measures increase public spending in rural areas in order to develop infrastructure, to give "equal access to basic urban and rural public services" and to ensure that the "social insurance system will cover both urban and rural areas". In addition, the government has explicitly indicated that the urban-biased policy will progressively be re-oriented, promising to "give more and take less" and announcing that the new policy implemented will consist of "getting industry to support agriculture and cities to support the countryside".

1.3.2 Break or continuity with Deng Xiaoping?

It is interesting to ponder whether these new policies truly mark a break with Deng Xiaoping's ideology or, on the contrary, whether they fit into the continuity of the policies he initiated.

[18] A detailed summary of the Number One Policy Documents published from 2004 to 2011 is provided in Li and Wu (2012); see their Table 3.

In fact, even if the recent policies emphasize new notions, such as equity, they appear to be much more in line, than in conflict, with Deng Xiaoping's ideology. First, although these new policies prioritize less developed areas, efficiency remains one major criteria in the way policies are implemented (Li and Wu, 2012). Second, for now, the policies implemented do not interfere with the economic management of the most developed areas (Naughton, 2008). That is to say, the new policies have not led to a complete reversal of the urban-biased policy, which would have led the government to extract resources generated by cities and industry in order to increase spending in rural areas and agriculture. As Naughton (2008) highlights, the most developed areas "are left alone to prosper". Finally, it seems in fact that these new policies indicate that in the early 2000s, China entered the "second phase" foreseen by Deng Xiaoping. In other words, while until the 2000s policy makers followed Deng's recommendation to "use our comparative advantages, avoid using our disadvantages and accept the fact of economic disparities", since the early 2000s, the new policies prioritize less developed areas to ensure that "in the end everyone will get rich". As China has reached a relatively high income level and faces huge inequalities, the government both can and must enter into the "second phase" foreseen by Deng, namely to enhance the development of less developed regions.

While Deng Xiaoping very precisely detailed that the initial increase in inequalities was unavoidable, he remained vague on the way according to which "in the end everyone will get rich". Two main options were evoked by Deng Xiaoping in the early 1990s: (i) the diffusion of economic development from developed to less developed areas; (ii) place-based policies (or policies targeting rural areas). First, as described in Section 1.2.2, the government legitimized its policies using the ladder-step theory, which is built on the concepts of growth poles, spread and backwash and the inverted-U theory. Thus, it was assumed that once cities achieved a sufficient level of development (leading to an initial increase in inequality), they would become growth poles and spread economic development to the countryside, for example through industry decentralization (reducing income inequality). Second, in 1993 Deng Xiaoping acknowledged that the state may have to intervene to reduce inequalities once the country had reached a sufficient level of living. Interestingly, Deng Xiaoping situated this period of time at the end of the 20^{th} century (Fan, 1997).

1.3.3 Achieving rural development by relying on cities as growth-poles

So far, it seems that these two strategies evoked by Deng Xiaoping have both been considered by the government in order to drive rural development and achieve coordinated urban and rural development.

First, the government has intervened by boosting spending and improving access to public services in rural areas. Among the most famous policies is the launch of the New Cooperative Medical Scheme in 2002 which gives the rural population access to primary health care. The agricultural tax was also revoked and the minimum living standards guarantee, which was limited to urban areas until 2007, has been extended to rural China (Christiansen and Zhang, 2009). A wide range of policies have been implemented or are currently being implemented. The present dissertation does not study the effects of such policies, each of them would require an entire dissertation[19].

Second, since recently a number of initiatives, especially at the local level, have attempted to promote cities as growth poles for nearby rural areas. The multiplication of "one-hour economic zones", also known as "100 km economic zones", provides a meaningful illustration. Many provincial governments have started creating economic zones, composed by one (several) central city(ies) at the center and by the rural areas located within approximately one hour by bus (Ke, 2010; Ke and Feser, 2010). The idea is to create a large region, in which the core urban area will spread economic development to rural areas located within the economic zone. The recent regional division of Chongqing into "One Circle and Two Wings" reveals particularly well the government's desire to turn cities into growth poles, driving the regional economic development (Chongju and Lifen, 2009). The size of Chongqing municipality is relatively similar to that of the smallest Chinese provinces, such as Ningxia province[20]. Chongqing municipality's administrative area is divided into several urban districts (the urban core) and twenty-nine rural counties. In the early 2000s, to orient the economic development and planning of Chongqing, the municipality was divided into three distinct economic zones: the "Developed Municipal Economic Circle", which included the urban core, the "Western Chongqing Economic Circle" and the "Three Gorges Ecological Economic Zone". However, in the mid-2000s, it was decided to re-arrange Chongqing into "One Circle and Two Wings" so that urban districts within Chongqing

[19]See for example Pélissier (2012) on the New Cooperative Medical Scheme.
[20]A map of Chinese provinces is given in Appendix 1.4

Figure 1.1: Chongqing: "One Circle and Two Wings"

municipality could enhance economic development in nearby rural counties. Specifically, the "Developed Municipal Economic Circle" and the "Western Chongqing Economic Circle" were merged into "One Circle". The rest of the territory was re-arranged into "Two Wings", namely the "Northeastern Three Gorges Reservoir Area" and the "Southeastern Folk Area". Figure 1.1 presents the division of Chongqing municipality into one-circle (districts and counties colored in red) and two wings (purple and green area)[21]. The areas encompassed by the "Two Wings" are areas suffering from poor ecological environments that face very specific challenges in terms of environmental protection. On the other hand, the "One Circle" is an example of one of the numerous "one-hour economic circles" recently established in China. The circle is composed of several urban districts (the city core) at the center and by the rural counties located within one-hour's driving distance from the city center. The creation of the economic circle has been accompanied by huge investments in rural infrastructure in order to enhance linkages between urban and rural areas within the circle.

[21] The map is from the website: http://en.investincq.com/index.html [as seen on 02.04.2013].

1.4 Aim of the thesis

1.4.1 Understanding the role of cities in rural development

The aim of this thesis is to study whether rural areas can benefit from urban proximity. In other words, can "cities support the countryside" by producing positive effects on nearby rural areas, or can rural development only be achieved by redistributive policies targeted at rural development? In the current context of China, where rural development and coordinated urban-rural development are listed high on the policy agenda, it is of primary importance to understand whether or not cities support rural areas. This issue is even more important given that the government has reaffirmed simultaneously that urbanization continues to be one of its priorities[22].

It is worth noting that our goal is to understand whether promoting linkages between urban and rural areas can be a means to achieve rural development and coordinated urban-rural development. Under any circumstances, the present thesis aims at demonstrating the existence of positive urban effects on rural areas in order to justify the implementation/continuation of urban-biased policies. According to several studies carried out in other countries (Solé-Ollé and Viladecans-Marsal, 2004; Barkley *et al.*, 2006), as cities are growth poles, it may be rational to implement policies favoring cities. However, such a recommendation cannot be suggested for the case of China, where rural areas have already been far too sacrificed. In contrast, this thesis aims at understanding the role of cities in rural development because this may have direct implications for the design of rural development policies. If cities foster rural and agricultural development, an optimal policy could consist of generalizing the implementation of "one-hour economic zones" and reducing restrictions between rural and urban areas. Moreover, if rural areas close to cities benefit from positive urban effects, then public spending should focus on remote rural areas. On the contrary, if cities produce insignificant or backwash effects on rural areas, this would clearly demonstrate that enhancing urban-rural linkages cannot achieve rural development and inequality reduction, considered as priority issues by the Chinese government in its project to build a "harmonious society". In this case, rural development, as well as urban and rural coordinated development, would be more likely achieved by relying on rural-based policies, rather than on regional-level policies, and by protecting rural areas from nearby extractive cities. In addition, providing evidence of urban effects on nearby rural areas could

[22] As stated in the 12^{th} Five Year Plan, the government foresees to increase the urbanization rate from 47.5% to 51.5% over the period 2011-2015 (Casey and Koleski, 2011).

shed additional light on intra-rural inequalities in China.

1.4.2 Do cities enhance rural development in China? First insights

Cities seem to have played an increasingly important role on the economic development of nearby rural areas during the economic transition. In the pre-reform period, rural areas were quite homogeneous across the country: they remained poorly developed agrarian economies with a collectivized agricultural sector. However, since the beginning of the economic reforms a new picture of rural China has emerged, featuring two main characteristics (Mohapatra *et al.*, 2006; Long *et al.*, 2009; Liu *et al.*, 2009). First, different rural development models have appeared so that rural China has become very heterogeneous both in terms of earning levels and economic structure. Thus, across rural China different models of development currently co-exist: subsistence farming, commercial farming, rural industry, private micro-enterprises and amenities-based development types. Second, the development path taken by a given rural area strongly depends on external forces and especially on urban proximity. For example, rural areas close to cities benefit from locational advantages and thus, are much more likely to engage in an industrial-based development type.

The literature on rural inequalities and rural poverty gives some interesting insight on the role played by cities on rural development. On the whole, the literature agrees that intra-rural inequality has soared since the mid-1980s and has attained a very high level (Rozelle, 1994; Wan and Zhou, 2005; Ye and Wei, 2005; Liu, 2006; World Bank, 2009). For instance, according to the data issued by the State Statistical Bureau, the Gini coefficient for rural areas raised from 0.21 in 1978 to 0.36 in 2002 (Fan and Chan-Kang, 2008).

In addition, it seems that location, and especially urban proximity, plays a very significant role in explaining the level of rural development. According to the nationally representative 2002 survey of the Chinese Household Income Project, per capita net income was 43% higher in rural areas located in the vicinity of cities than in other rural areas in 2002. Consistently, in spite of China's huge performance in reducing poverty since 1978, many rural people remain poor and a striking fact is that remote rural areas suffer the most from poverty (World Bank, 1992; Knight and Song, 1993; Jalan and Ravallion, 2002; Long *et al.*, 2009). Similarly, Glauben *et al.* (2012) have recently estimated that rural households in villages close to cities have a lower probability of suffering from persistent poverty. Moreover, according to some estimates, village location (which captures the effect of urban proximity but also that of natural endowments) is one major determinant of intra-rural inequality, accounting for about 30-40% of intra-rural inequality in the early 2000s (Wan and Zhou, 2005; Benjamin *et al.*, 2008). Consistently, relative to the rural population as a whole, the rural poor are more likely to live in mountainous areas and in villages far away from the nearest county town[23] (World Bank, 2009). On the whole, it seems that the spatial pattern of inequality has evolved since the beginning of the economic reforms. While in 1978 the development gap broadly favored developed cities over poor rural counties, the spatial pattern of inequalities has become more complex with the transition. Indeed, some rural counties, especially those benefiting from locational advantages, have benefited from significant economic development. As a result, the current development gap not only exists between cities and rural counties but also between some city-regions (including cities and nearby counties) and more peripherical areas (see Ye and Wei (2005) for the case of Zhejiang province). Thus, cities may have become growth poles for nearby rural areas during the economic transition.

According to some authors, however, even if location remains one major determinant of intra-rural inequality and rural poverty, it has played a decreasing role in explaining them since the beginning of the economic reforms (Riskin, 1997; Wan and Zhou, 2005; Benjamin *et al.*, 2008). Thus, while rural poverty remains concentrated in remote areas, it is no longer *exclusively* confined to remote areas (World Bank, 2009).

Figure 1.2 and Figure 1.3 provide additional insight on the role of cities on rural development in China. Both maps represent China's county-level divisions, which correspond to the third level of administrative divisions in China, under the central government and the provinces. There are three different types of county-level divisions: (i) urban districts under prefecture and provincial-level cities, (ii) county-level cities and (iii) counties. While urban districts under prefecture and provincial-level cities as well as county-level cities are considered as urban areas, counties are classified as rural areas (even if they have towns under their administrative jurisdiction)[24]. In both maps, cities are represented in grey, and city size, measured by city GDP, is represented by blue circles.

[23]Based on the 2003 Rural Household Survey, the World Bank estimates that while 26% of the total rural population lived in mountainous areas, as much as 51% of the rural poor lived in mountainous areas. Similarly, while 39% of the total rural population lived more than 10 km from the nearest county town, about 50% of rural poor were located more than 10 km from the nearest county town.

[24]Chapter 2 describes in more detail the administrative division systems of China and discusses the definition of urban and rural areas.

Figure 1.2 represents the county-level divisions officially designated as "poverty county" at the national level[25]. Several observations arise from the map. First of all, urbanization demonstrates a strong regional pattern: most (large) cities are concentrated in Eastern China. As pointed out by Zhu *et al.* (2012), the difference in urbanization is the largest between Eastern and Interior China[26]. Second, poverty also demonstrates a strong regional pattern: most poor counties are located in inland provinces whereas very few counties are designated as poor in the richest eastern provinces. Third, on the whole (large) cities are mainly surrounded by counties not designated as poor counties. However, the pattern is less clear in several cases. For example, in spite of the proximity to Beijing and Tianjin, many counties in Hebei are designated as poor counties. However, this should not be a surprise given that Hebei is highly populated and suffers from land scarcity and land degradation[27] (especially due to pollution). Consequently, many farmers in Hebei lack farmland and are unable to generate agricultural income. Moreover, we can also ask whether this is the result of Beijing and Tianjin's backwash effects on rural counties in Hebei provinces. The relationship between urban proximity and poverty designation is also less straightforward in Xinjiang and in Inner Mongolia, where in spite of the small number of cities, relatively few counties are designated as "poverty counties". As for Hebei, this particular pattern may arise from land availability and quality, which heavily determine rural incomes. For example, most poverty counties in Xinjiang are located in the South, which is an arid area (Taklamakan Desert). On the contrary, other counties in Xinjiang and Inner Mongolia may not be designated as poor as they benefit from large amounts of farmland and usually specialize in livestock farming and wool production, which are much more remunerative than ordinary crop production.

Even if the geographical repartition of poor-designated counties provides interesting insights, there are two main shortcomings. First, counties with a large population from ethnic minorities or located in old revolutionary bases are more likely to be designated as poor counties (de la

[25]Since 1986, the State Council's Leading Group Office of Poverty Alleviation and Development has issued a list of designated "poverty counties". To date, on the 2,853 total county-level divisions in China, 592 are designated as poverty counties, which entitles them to receive alleviation funds. Officially, counties are designated as poor according to their level of rural net income per capita (in 1986, every county with a rural net income per capita below 150 yuan was designated as poor). The list of "poverty counties" is available at http://www.cpad.gov.cn/publicfiles/business/htmlfiles/FPB/fpyw/201203/175445.html [as seen on 31.03.2013].

[26]According to the authors' calculations, in 2000, while the urbanization rate was 54.2% in Eastern China, it was only 36.4% and 28% respectively in Central and Western China.

[27]As estimated by the World Bank (2009), owning low productivity land significantly increases the probability of being poor. Indeed, while 25% of the whole rural population have low productivity land, as much as 56% of the rural poor have low productivity land.

Rupelle and Li, 2012). Moreover, as nearly no Eastern counties are designated as poor, it does not enable us to discuss the potential role of cities on rural development in Eastern China.

Figure 1.3 may provide a better illustration of the role of cities on rural development. The map provides information on the annual per capita net income level of rural households for rural counties[28]. The richest fourth rural counties (annual per capita net income level of rural households higher than the third quartile) are represented in red. On the contrary, the poorest fourth rural counties (annual per capita net income level of rural households lower than the first quartile) are represented in dark green. In addition, to erase differences in development between Eastern, Central and Western China, quartiles have been calculated for these three macro regions respectively[29]. Thus, for example in Eastern China, red counties represent the richest rural counties *among Eastern* rural counties.

In Eastern China, the richest counties are exclusively located close to (large) cities. On the contrary, the poorest counties are located in more remote places, especially in Hainan and Guangxi provinces. As was the case in Figure 1.2, many rural counties in Hebei are among the poorest counties of Eastern China in spite of the proximity to Beijing municipality, which probably arises from land scarcity and land degradation.

Regarding Central China, the relationship between urban proximity and rural development is less straightforward. On the one hand, in Henan, Hubei, Hunan and Anhui provinces, the richest counties are mainly concentrated around cities, and especially around the provincial capitals[30] (Zhengzhou, Wuhan, Changsha and Hefei). On the other hand, in Northeastern provinces (Jilin and Heilongjiang), the pattern is less clear as both the richest and poorest counties are located close to cities. Finally, when comparing Inner Mongolia and Shanxi provinces, it appears once again that land availability and quality play a very significant role in driving rural income. These two neighbor provinces are both characterized by relatively few cities. However, Inner Mongolia benefits from large areas of farmland enabling farmers to breed cashmere goats whereas Shanxi suffers from the same land scarcity and land degradation problems as Hebei province. This may explain why many counties in Inner Mongolia are among the richest counties of Central China whereas Shanxi contains many of the poorest counties of Central China[31].

[28]Data is from the China data center website (University of Michigan).

[29]This is more relevant to capture the effect of cities on rural counties. Otherwise, the most developed counties are concentrated in Eastern China. A map representing the four quartiles of annual per capita net income of rural households is given in Appendix 1.5.

[30]A map of the provincial capital cities is given in Appendix 1.6.

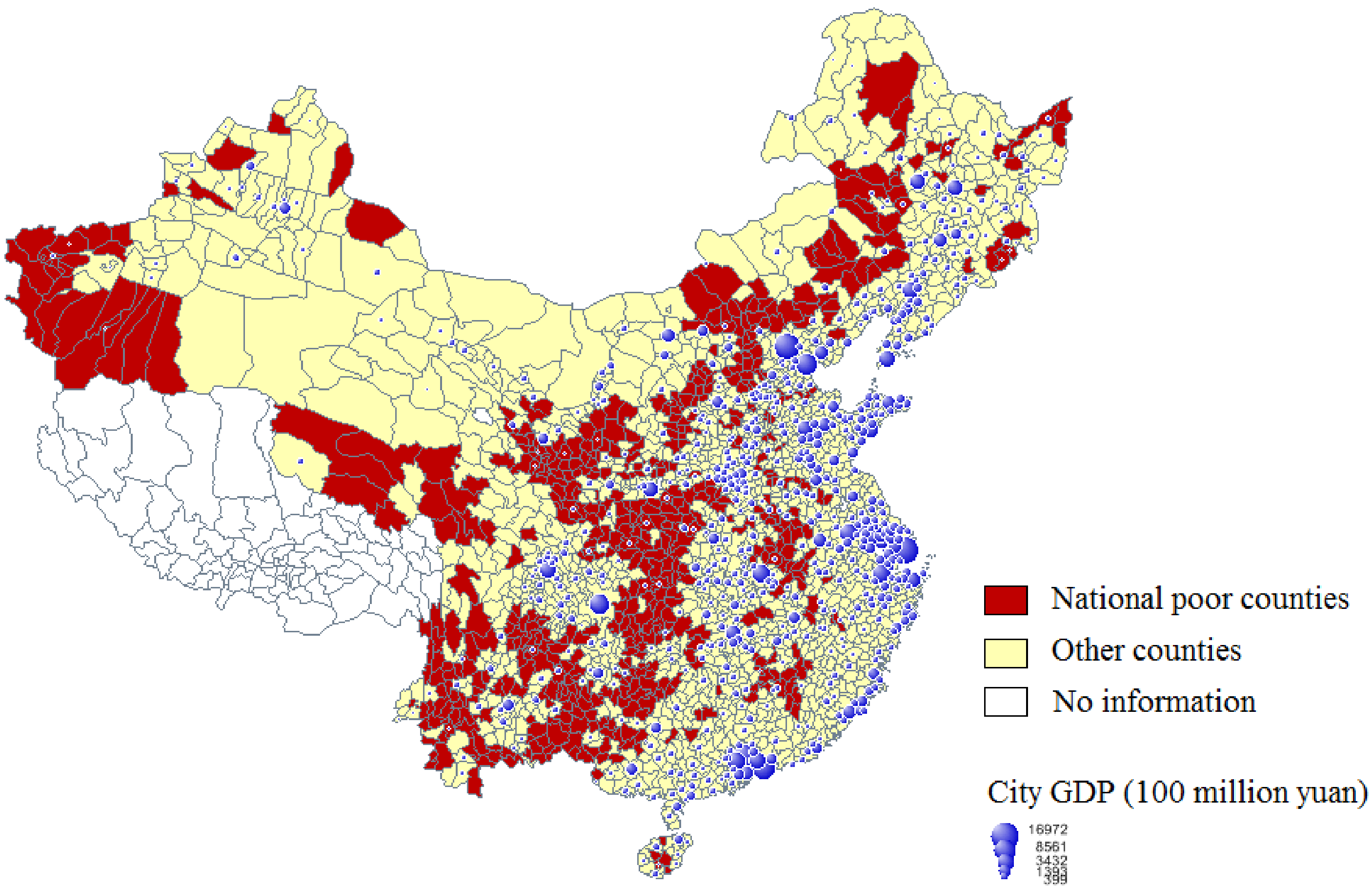
[31]Consistently, the World Bank (2009) has highlighted that land scarcity in Central China is one major deter-

In Western China, the largest cities are often surrounded by the richest rural counties. This is particularly striking in the case of Chengdu (the capital of Sichuan province) and Chongqing cities. The same pattern is also observed in the vicinity of other provincial capitals, such as Xi'an in Shaanxi province and Kunming in Yunnan. Once again the pattern is less clear in Xinjiang province, even if the capital city, Ürümqi, appears to play a role. Consistently, the poorest counties in Western China are often located in the more remote areas, such as in the west of Sichuan province.

To summarize, these two maps have provided some interesting insights on the relationship between urban proximity and rural development. On the whole, the richest rural counties are more likely to be located in the vicinity of cities. However, the relationship seems to vary both across city size and regions. Indeed, the richest counties are more likely to be concentrated around the largest cities. In addition, the relationship appears much stronger in Eastern China. Interestingly, cities in Eastern China, which are more developed and already face several congestion effects such as high factor prices, may be more likely to generate spread effects on nearby rural counties (for example through firm relocation) than inland cities. The existence of stronger urban spread effects in Eastern China could help to explain several results obtained in previous studies and to our knowledge until now not explained. First, stronger urban spread effects in Eastern China could explain why the urban-rural gap is lower in Eastern China than in other regions. Indeed, according to Sicular *et al.* (2007), the urban-rural income ratio in Eastern, Central and Western China was 1.89, 2.23 and 3.49, respectively, in the year 2002. Second, stronger urban spread effects in Eastern China could explain why the determinants of rural poverty vary across Chinese regions. Indeed, while the distance to the nearest county town is one of the three most important determinants of rural poverty in Coastal and Northeastern China, it has a much lower impact on rural poverty in Western China (World Bank, 2009). Finally, while it appears that cities may play a positive role on rural income, we certainly cannot infer from these maps any causal relationship. The rest of the thesis tries to provide a thorough analysis of the effects of urban areas on rural development in China.

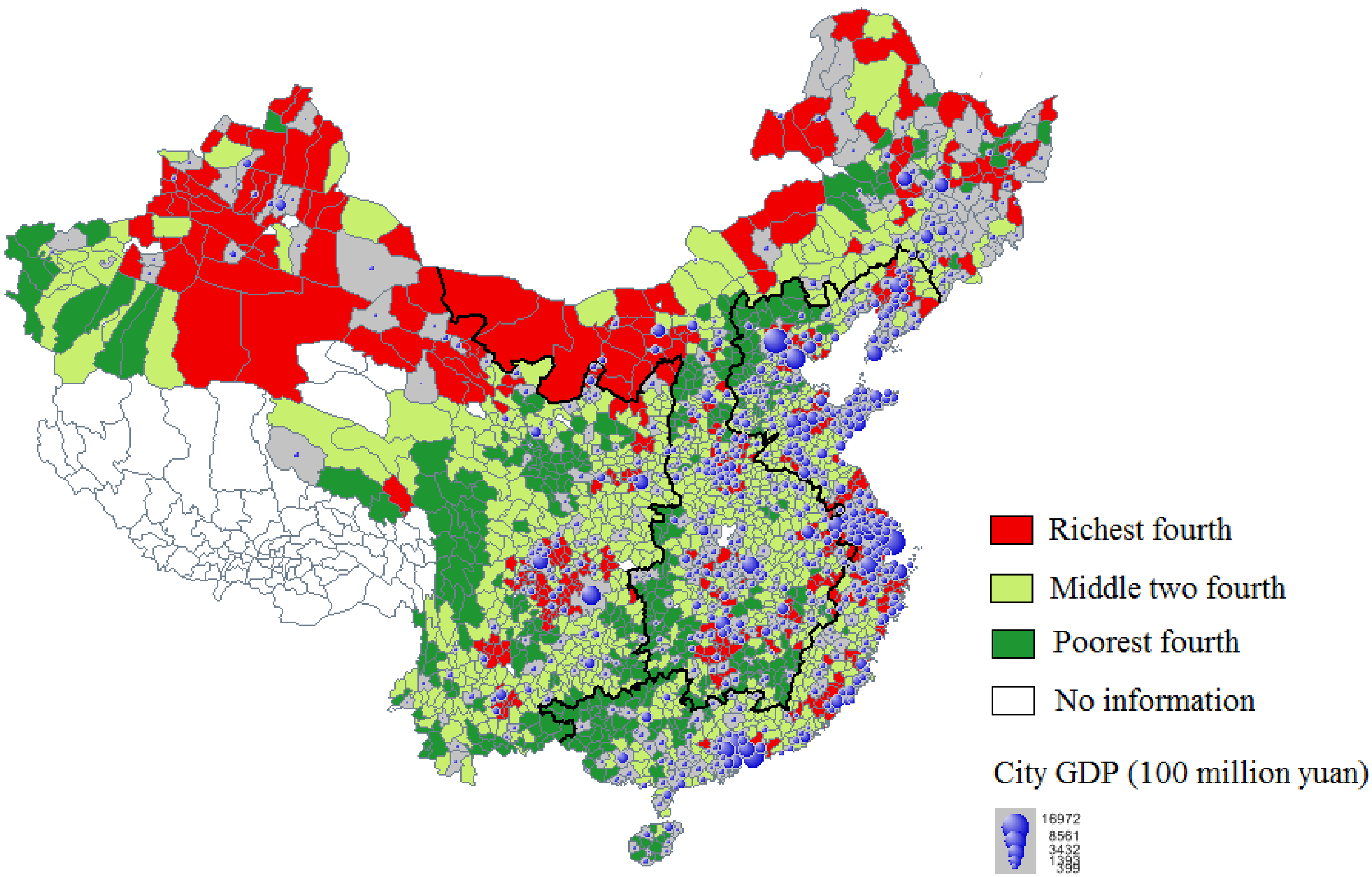
minant of rural poverty.

Figure 1.2: National poverty counties



Source: author (using Phildigit and Philcarto)

Figure 1.3: Annual per capita net income of rural households: richest fourth, poorest fourth (by region)



Source: author (using Phildigit and Philcarto)

1.4.3 Overview of the dissertation

The present thesis aims at answering a number of fundamental questions in order to thoroughly understand the effect of urban areas on rural development.

1. What is the effect of urban areas on the different economic sectors of nearby rural areas (agricultural and non-agricultural sectors)?
2. Beyond the economic impact of urban areas, do cities enhance rural development?
3. Are urban effects on rural areas homogeneous across Chinese regions?
4. Do different cities produce different effects on rural areas?

To answer these questions, the thesis is organized into the following six chapters.

First of all, investigating whether urban areas affect rural development requires us to begin by clearly defining what we mean by "urban" and "rural" areas. That is why **Chapter 2** presents in detail the very complex Chinese administrative divisions system as well as the definition of urban and rural areas. We also describe how some administrative changes implemented during the economic transition have progressively blurred the definition of urban and rural areas. Finally, in the light of the issues raised in the chapter, we discuss the relevant scale of analysis to empirically investigate whether urban areas affect rural development in China.

Chapter 3 provides a critical analysis of the literature regarding urban effects on rural areas. First, we present the general transmission channels by which cities can affect economic development in nearby rural areas and describe the results obtained by empirical analyses. Second, as the literature has mainly been conceived to study urban effects in the context of developed countries, we discuss the compatibility of these western theories with the Chinese realities. This discussion will help us to highlight some key elements to be taken into account when empirically investigating urban effects on rural areas in the specific context of China.

The first two chapters constitute a solid base, which enables us to carefully implement in the rest of the thesis three successive empirical analyses to investigate the effects of urban areas on the countryside in China.

As agriculture remains a major component of the rural economy, the first empirical analysis test the role of urban areas on the agricultural sector of nearby rural areas (**Chapter 4**).

First, we highlight that improving technical efficiency constitutes one of the major challenges currently facing China's agriculture. That is why the rest of the chapter provides a comprehensive analysis of how cities can affect agricultural technical efficiency in the hinterland.

After discussing the potential mechanisms by which cities can affect agricultural efficiency, I empirically assess the role of cities on agricultural efficiency by using Chinese county-level agricultural data for 19 provinces over the period of 2005-2009. The empirical analysis provides important insights on urban spillover effects on agricultural efficiency. First, cities are found to produce very significant positive effects in the most developed Eastern provinces but have no significant effects in the least developed Western provinces, which confirms the first insights that we observed with Figures 1.2 and 1.3. Second, urban effects not only vary across regions but also across the urban hierarchy. Indeed, we estimate that provincial-level cities have a deteriorating impact on technical efficiency, while lower-level cities enhance technical efficiency in most regions. This highlights that the current policies that favor provincial-level cities is much less able to enhance rural development than a policy favoring the development of a network of medium-sized cities scattered across the territory.

After having investigated the effect of cities on the agricultural sector of nearby rural areas, we analyze the effect of urban areas on the rural non-agricultural sector (**Chapter 5**). Specifically, we assess the effect of cities on rural non-agricultural employment, which is of primary importance because it is widely recognized that rural non-agricultural employment helps rural households in developing countries to get out of poverty.

While the existing literature has focused on the effect of urban proximity on the *access* to rural non-agricultural employment, the chapter investigates whether urban proximity also enhances rural non-agricultural wages. The goal of the chapter is thus to investigate whether rural workers close to cities manage to get better remunerated non-agricultural employment.

Using micro-level data, we find robust evidence that rural workers in the vicinity of cities and towns benefit both from higher employment opportunities and from higher wages in the non-agricultural sector. Consistent with Chapter 4, we also find evidence that different types of cities produce different effects on rural areas by highlighting that workers close to the largest cities benefit from the highest wage premium (urban hierarchy effects). In addition, we investigate why workers are paid higher wages in villages close to cities. We conclude that workers close to cities are paid higher wages for two reasons. First, they are more likely to commute to the city, where they engage in better paid jobs. Second, villages located close to urban areas benefit from higher market potential and from some localization economies leading to higher productivity and thus, to higher wages in these villages. To our knowledge, we are the first to highlight that Chinese villages surrounding urban areas benefit from significant agglomeration effects. In this context, we emphasize that it may be difficult for rural policies to attract new industries or relocate existing ones to peripheral rural areas. This issue is extremely serious given that non-agricultural employment strongly determines rural earnings and welfare. Finally, this chapter provides some evidence on the geographical reach of urban spillover effects. Specifically, we find that most agglomeration effects occur in the close vicinity of the county seat. As urban effects seem to disappear quite rapidly over space, we can wonder whether relying on cities as growth pole is an efficient strategy for enhancing rural development. Would it be preferable to concentrate on the implementation of policies targeting rural areas? Would it be desirable to reduce barriers between urban and rural areas in order to increase the geographical reach of urban effects?

After having dedicated two chapters to the study of the *economic* impact of cities on nearby rural areas, the last analysis focuses on the effect of cities on rural *development* (**Chapter 6**). Specifically, if on average rural areas close to cities may benefit from economic advantages (more efficient agricultural sector, access to better remunerated non-agricultural employment), do not they suffer from other disadvantages such as higher pollution, insecurity, land requisitioning and even from cultural destruction? Thus, if urban proximity may enhance economic performance in nearby rural areas, it may also increase rural vulnerability. This issue is crucial because harmonious and coordinated urban and rural development cannot be achieved without dealing with developmental issues. Given the dramatic environmental degradation that has accompanied China's spectacular economic performance, and the significant increase of pollution in rural areas over the recent period, we have decided to focus on the link between urban proximity and pollution.

In this last chapter, we investigate which Chinese counties suffer the most from pollution. To do this, we empirically study the location choices of polluting firms within Hebei province. Our estimation results suggest that being close to a prefecture-level city significantly increases the probability of attracting polluting firms. Interestingly, this effect arises both from a "pure urban market effect" and from the deliberate intention on the part of polluting firms to avoid more stringent urban environmental regulations. Thus, if urban proximity may have positive impact on the economic performance in nearby rural places, its impact on rural development and quality of life is much more uncertain.

The general conclusion draws on the different analyses carried out in the thesis and asks whether, or under which circumstances, relying on cities to enhance rural development could be an effective strategy (**Chapter 7**).

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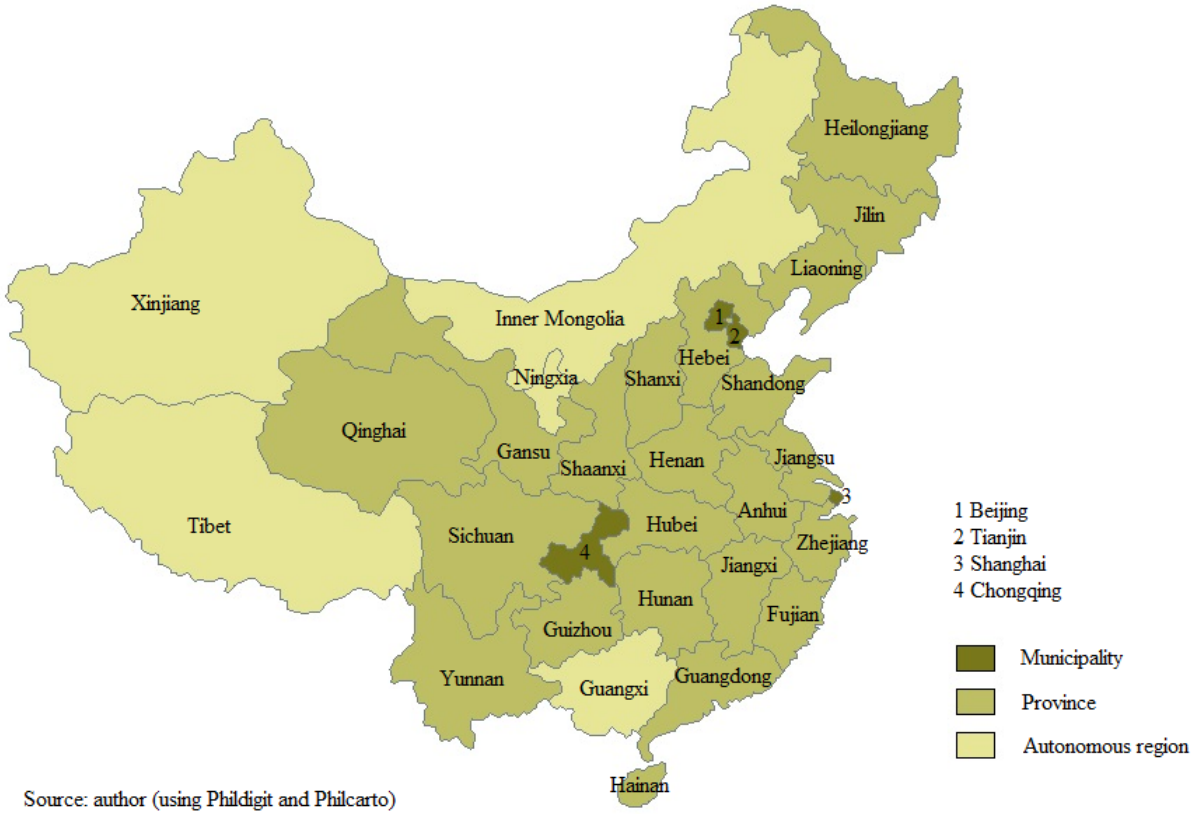
Appendix to Chapter 1

1.A Provincial-level divisions

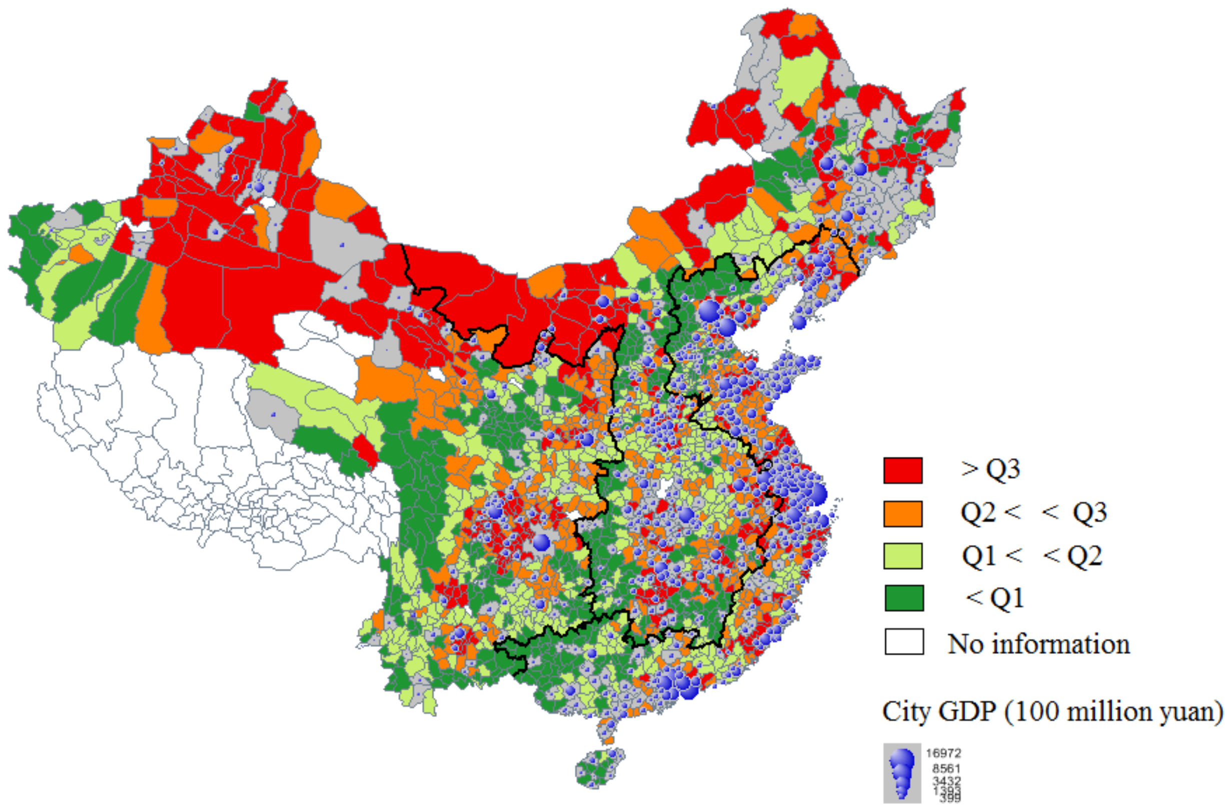
Figure 1.4: Provincial-level divisions



Source: author (using Phildigit and Philcarto)

1.B Annual per capita net income of rural households (by region)

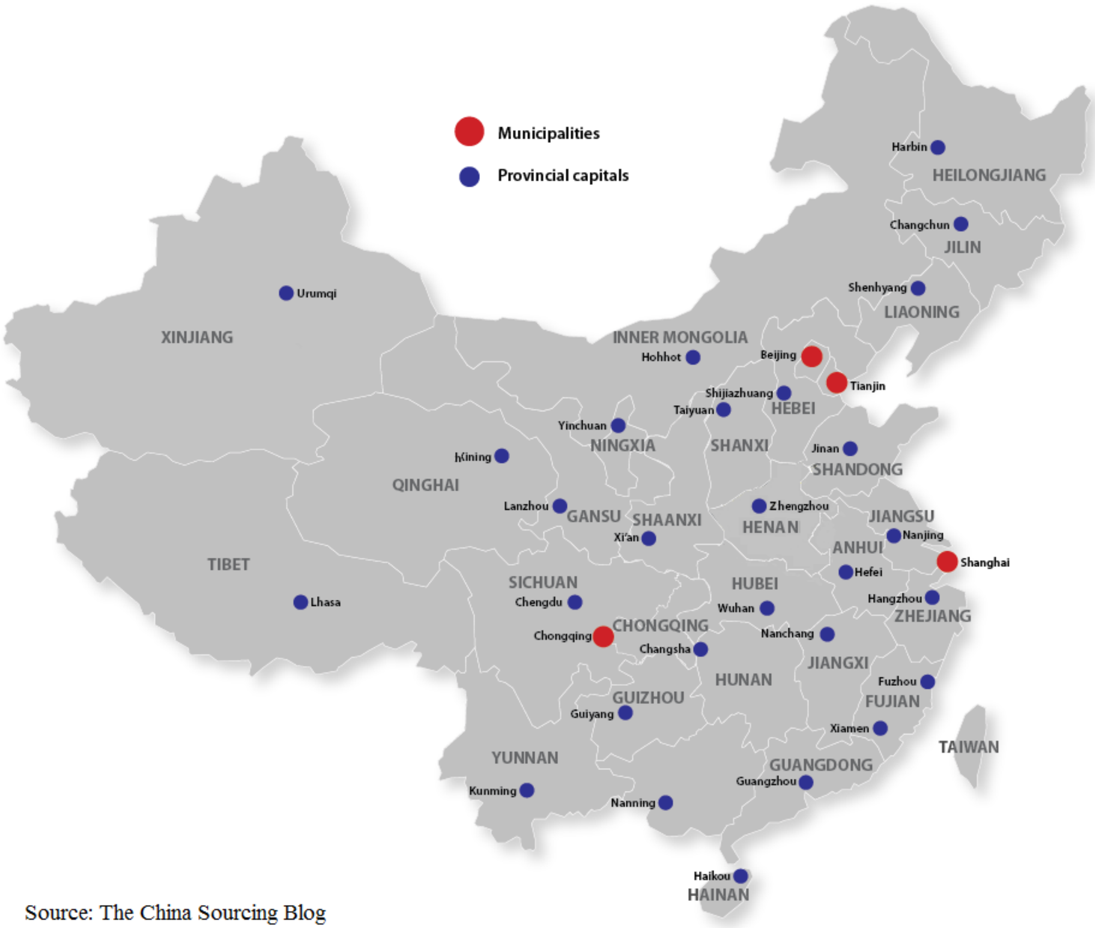
Figure 1.5: Annual per capita net income of rural households (by region)



Source: author (using Phildigit and Philcarto)

1.C Provincial capital cities

Figure 1.6: Provincial capital cities



Source: The China Sourcing Blog

Chapter 2

The Chinese Spatial System

Administrative Divisions,
Urban and Rural Areas
& Scale of Analysis

2.1 Introduction

Investigating whether urban areas affect rural development first requires to clearly defining what we mean by "urban" and "rural" areas. This task is not straightforward in the case of China where the concept of urban areas has evolved over the reform era as a result of three administrative measures: "turning prefectures into cities", "turning counties into cities" and "turning cities and counties into urban districts" (Chung and Lam, 2004).

First, by "turning prefectures into cities", the central government has significantly affected the administrative boundaries of cities. In the pre-reform era, "cities" corresponded to built-up areas with high population density and relatively developed industries (functional concept of cities or "city proper" concept). In the reform era, in an attempt to empower cities, the government has allowed them to place rural counties under their administrative jurisdiction. Thus, the concept of cities has progressively changed from a functional to an administrative concept. Nowadays, there is a mismatch between the current designation of cities, which refers to their entire administrative area, and the functional concept of cities, which includes only the city proper (namely the urban administrative area).

Second, in the reform era the central government has weakened the criteria for designating a settlement as urban by implementing additional administrative measures ("turning counties into cities" and "turning cities and counties into urban districts"). As a result, the number of cities has increased, but these newly created cities remain in large part genuinely rural. Moreover, the urban area of large cities has grown and is increasingly composed of large areas with rural economic structures and landscapes. Thus, the Urban Administrative Area of cities is increasingly composed of genuinely rural areas and therefore, corresponds less accurately to the "city proper" concept than at the beginning of the economic reforms.

The present chapter has four main objectives, each corresponding to the successive subsections of the chapter. The first objective is to present the complex administrative structure of China and to understand the hierarchical relationships between the different administrative levels (Section 2.2). Second, we will attempt to make a clear distinction between the administrative and functional concepts of cities (Section 2.3). Third, we will discuss how the weakening of the criteria for designating a settlement as urban has progressively eroded the relevancy of the urban administrative area of cities and thus, of city-level data (Section 2.4). Finally, in the light of the previously raised issues, we will discuss the relevant scale of analysis to investigate whether urban areas affect rural development in China (Section 2.5).

2.2 Current administrative divisions structure

2.2.1 A hierarchical structure

As stated by Article 30 of the Constitution of the People's Republic of China (1982), there are three *de jure* levels of administrative divisions in China below the central government, which are from top to bottom: (1) province, (2) county and (3) township levels. However, *de facto* five levels of administrative divisions are commonly distinguished: (1) province, (2) prefecture, (3) county, (4) township and (5) village levels.

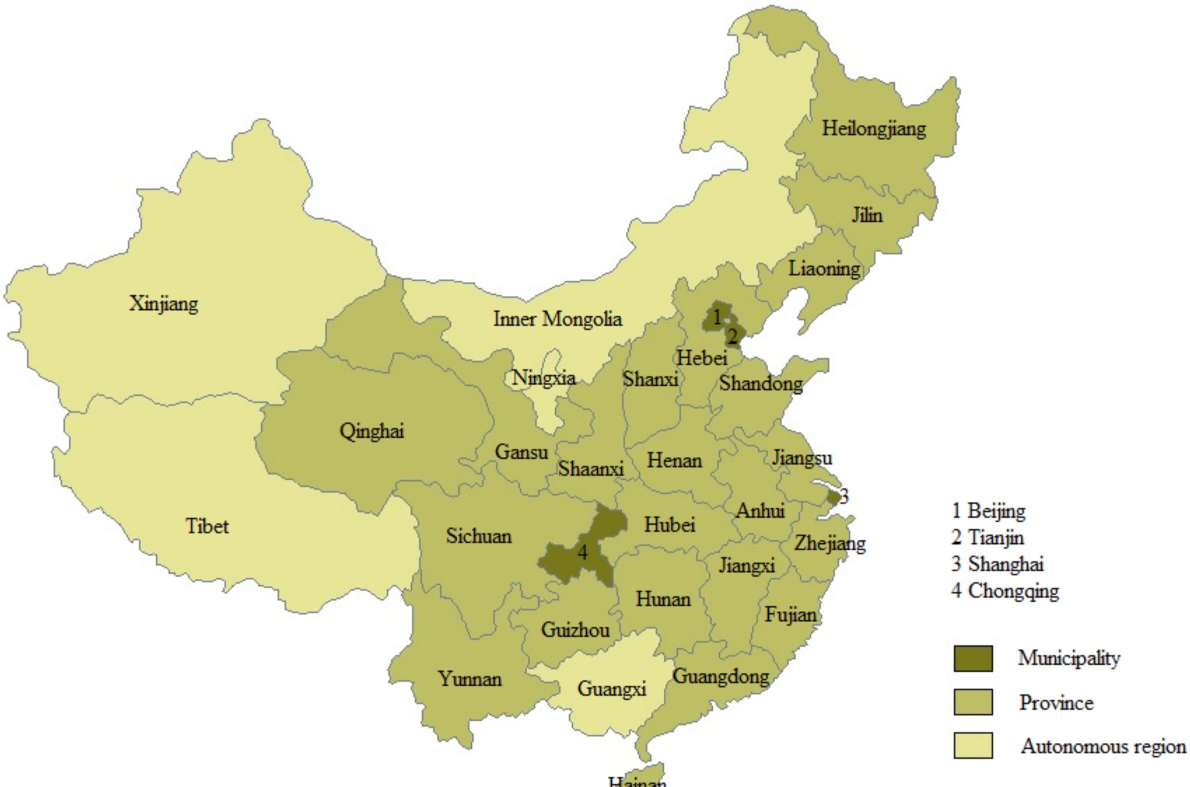
In this administrative system, higher-level units have jurisdiction over the lower-level units located within their administrative area. Officially, a given administrative unit can only directly interact with the units immediately below and above it in the administrative hierarchy. For example, a township-level unit cannot directly interact with the central government but must deal with the county-level unit to which it belongs (Ma, 2005). In addition, the higher in the hierarchy the administrative rank, the higher the political and administrative powers. In fact, even if since the 1980s' lower-level governments have been given substantial powers to develop their local economies, the political power remains strongly hierarchically structured from top to bottom as higher-level governments still play a very significant role in appointing lower-level governors in their jurisdictions (Chan, 2010). Moreover, higher administrative units have a higher number of government offices and higher-ranking officials. They are also allocated more fiscal resources and public investment, and more easily acquire or convert land for housing and industrial development. As a result, the level of economic development is significantly and positively correlated with the administrative rank (Ma, 2005). In this context, lower-level administrative units have strong incentives to climb the administrative ladder, *i.e.* to be upgraded to higher administrative level units (Chan *et al.*, 2008).

2.2.2 Administrative divisions

Directly under the central government are provincial-level units. There are 33 divisions including 22 provinces, 5 autonomous regions, 4 municipalities and two special administrative regions (Hongkong and Macao). Figure 2.1 below represents the provincial-level units in China

(Hongkong and Macao are not represented).

Figure 2.1: Provincial-level divisions



Source: author (using Phildigit and Philcarto)

Figure 2.2 represents the whole administrative hierarchical structure in China. As indicated, provincial-level units, with the exception of municipalities, are in turn divided into prefectures[1] and prefecture-level cities. Prefectures are themselves composed of counties[2] and county-level cities while prefecture-level cities are composed of counties, county-level cities and urban districts. As prefecture-level cities, provincial-level cities are composed of both urban districts[3] and counties. However, contrary to prefecture-level cities, there are no county-level cities under the jurisdiction of provincial cities as the Constitution of the People's Republic of China forbids provincial cities from administering other cities. Finally, all county-level divisions are divided

[1]Includes autonomous prefectures and leagues.
[2]Includes autonomous counties as well as the banners and autonomous banners of Inner Mongolia.
[3]City-administered districts under provincial cities are in practice prefecture-level units (Ma, 2005).

into three potential township-level divisions: urban subdistrict (*jiedao*), town (*zhen*) and township (*xiang*). Counties are only divided into towns and townships whereas county-level cities and urban districts can be divided into urban subdistricts, towns and townships.

Appendix 2.A provides data on the number of administrative units at the prefecture, county and township-level for China as a whole and by province in 2011. At the end of the year 2011, in China there were:

- 332 prefecture-level divisions, of which 284 are prefecture-level cities
- 2,853 county-level divisions, of which 857 are urban districts, 369 are county-level cities and 1,573 are counties
- 40,466 township-level divisions

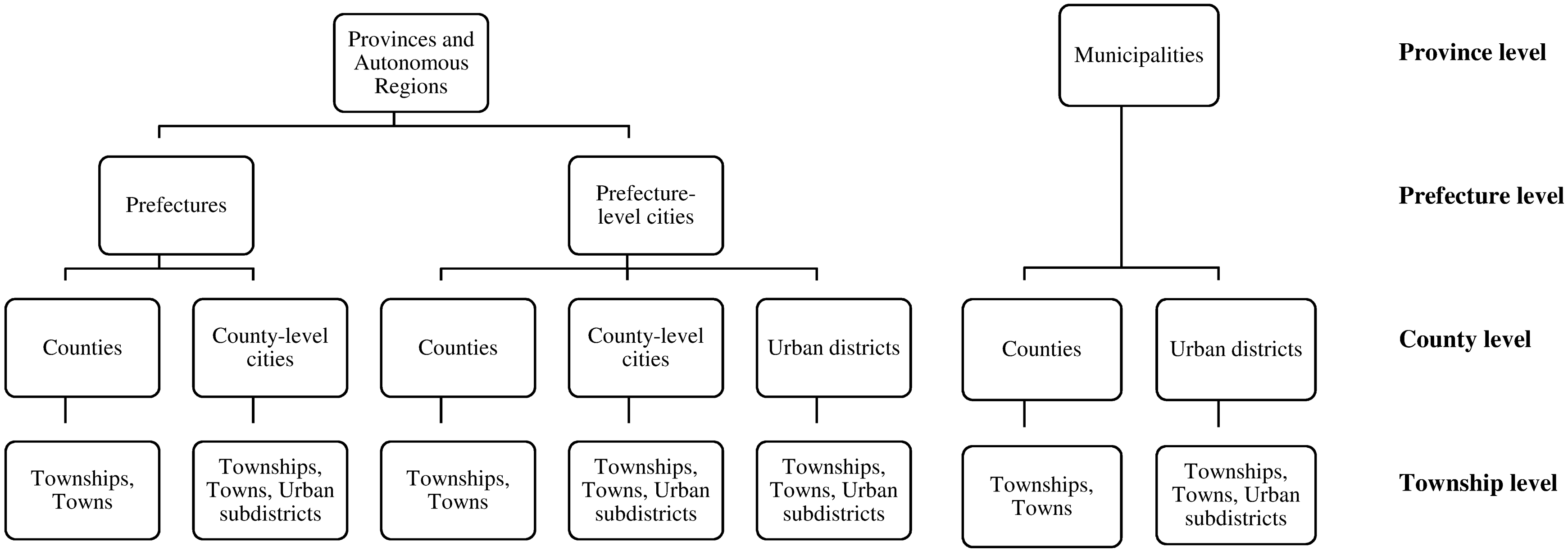
2.2.3 Urban areas within the administrative structure

According to the National Bureau of Statistics, there are two officially designated urban units in China: the city (*shi*) and the town (*zhen*)[4]. First, cities are found at three levels of the administrative hierarchy: at the provincial-level, at the prefecture-level and at the county-level (see Figure 2.2)[5]. The higher the administrative rank of the city, the larger the extent of its administrative jurisdiction and the wider its sphere of influence (Fan, 1999). Second, the town is a township-level unit under the jurisdiction of cities or counties. Therefore, cities are larger in size and at a higher-level in the administrative hierarchy than towns. In practice, a town is a small place in which most of the county' non-agricultural activities are located. Among cities and towns, cities are the main urban unit in China.

[4]It was in 1955 when for the first time the State Council released the criteria to classify areas as urban (Kojima, 1995). An area was then granted city status if: (1) it had a permanent population of more than 100,000 inhabitants or (2) if it had a population of more than 20,000 inhabitants and was the county-seat. Moreover, every area with (1) more than 2,000 inhabitants and at least 50% of its population classified as non-agricultural or (2) between 1,000 and 2,000 inhabitants and at least 75% of its population classified as non-agricultural, was granted the town status. These criteria have been readjusted several times, first in a more stringent way (in 1963) and later in a more permissive way (in 1984). Xu (2008) provides a very comprehensive description of the criteria a community must meet to be granted the administrative statute of city or town (see Xu (2008) on pages 41-43).

[5]In practice there are two additional types of cities between provincial and prefecture-level cities, namely deputy-provincial cities and provincial capitals. According to the *de jure* classification, these cities are considered as prefecture cities.

Figure 2.2: China's administrative system



Source: Based on Ma (2005) and Xu (2008).

2.3 Appearance of a city-centered system during the economic reforms

Section 2.2.2 presents the current administrative divisions system, which differs from that of the pre-reform period. Indeed, while the economic reforms have not removed the hierarchical administrative structure, they have led to a *restructuring* of the administrative units. The main feature is the emergence of cities as new independent administrative units within the hierarchy, a direct consequence of the "turning prefectures into cities" measure implemented at the beginning of the 1980s[6].

2.3.1 Turning prefectures into cities (*di gai shi*)

In the pre-reform era, cities did not constitute a proper administrative unit. At this period of time, there were only the four following government levels: provinces, prefectures, counties and townships. If a given prefecture was composed of one prefecture-level city and several rural counties, there were then two governments in the same prefecture (the prefecture-level city, which administered the urban areas, and the prefecture government, which administered the rural counties). Thus, urban and rural areas were separately governed and duplicate (rural and urban) governments existed at every ladder of the administrative hierarchy (Chung and Lam, 2004). This system was then characterized by very few horizontal linkages among rural and urban areas within the same prefecture. Many administrative roadblocks prevented urban-rural interaction. For example, as highlighted by Ma (2005), it was not possible for a city to directly interact with a nearby village. Instead, the city had to interact with the village's county government.

To facilitate urban-rural interactions and to empower cities, the state began implementing the "turning prefectures into cities" measure in the early 1980s (Ma, 2005). Specifically, cities were authorized to administer their neighboring counties and they became an independent administrative unit in the administrative hierarchy. In other words, rural counties, which had previously been under the jurisdiction of the provinces[7], were placed under the jurisdiction of the nearby prefecture or provincial-level city, and thus provincial and prefecture-level *divisions*

[6] This policy is also known as the "city administering counties" or as the "city-leading-county" system (Ma, 2005).

[7] Indeed, the prefecture does not represent a formal level in the administrative hierarchy.

were restructured into provincial and prefecture-level *cities*. The “turning prefectures into cities” policy has led to the appearance of city-centered regions, in which the central city has under its jurisdiction several administered counties. It was expected that the reform would facilitate urban-rural interactions as city leaders could now take decisions for the whole integrated administrative area. By increasing the administrative and economic powers of central cities, as well as their area of influence, the central government aimed at allowing large cities to enhance regional economic development within their new administrative area[8].

The “turning prefectures into cities” measure was implemented in three different ways, according to the situation prevailing before the reform. First, if there was already a prefecture-level city in the prefecture, the prefecture-level city was simply merged with the prefecture. In this case, the counties located in a given prefecture (and thus, formerly administered by the province) were placed under the jurisdiction of the prefecture-level city. This method, which was predominant in the first years of the policy’s implementation, resulted in a significant drop in the number of prefectures, from 170 in 1982 to 66 in 1998. Consistently, the number of prefecture-level cities increased and in 2000, prefecture-levels cities accounted for 78% of Chinese prefecture-level entities (Chung and Lam, 2004). Second, if there were no prefecture-level cities but rather county-level cities, the prefecture was abolished and one of the prefecture’s county-level cities was upgraded to the rank of prefecture level-city. Naturally, the counties which were located in the prefecture were then placed under the jurisdiction of the newly established prefecture-level city. Third, in the cases where the prefecture was only composed of counties, one of them was directly upgraded to the rank of prefecture-level city and the remaining counties of the prefecture were placed under the jurisdiction of the newly established prefecture-level city[9]. Finally, some prefectures have not been turned into prefecture-level cities. At this time, there are still 48 prefectures in China.

[8]If the policy was widespread implemented during the reform era, some counties were already administered by large cities in the 1950s to provide the urban population stable supplies of foodstuff.

[9]As stated in the general introduction of this thesis, the city-leading-county system has often led central cities to sacrifice counties. To solve this problem, in 2005 the government suggested reorganizing the city-leading-county administrative system into a province-leading-county administrative system (Li and Wu, 2012). In 2009, the “Directive on Promoting the Province-Leading-County Fiscal Reform” was issued by the Fiscal Ministry in order to give more power back to counties and county-level cities, especially in terms of taxation and fiscal distribution, as well as regarding the elaboration of budgetary schemes and the reception of provincial subsidies. This new administrative system, which is currently still under experimentation, is an attempt to separate the fiscal system of counties from that of prefecture and provincial-level cities as counties would have to directly report to the province and no longer to the city. In other words, in this new system counties and county-level cities would be upgraded to the same administrative rank as prefecture-level cities.

2.3.2 Consequence for the concept of cities: entire administrative area vs urban administrative area

As shown in Figure 2.2, in the current administrative hierarchy, prefecture and provincial-level cities not only have urban districts under their administrative jurisdiction but also rural counties (as well as county-level cities in the case of prefecture-level cities). This is a direct consequence of the reform era's "turning prefectures into cities" measure, which has changed the concept of cities from a functional concept (as cities before the reform era consisted of built-up areas) to an administrative concept. As a result, it is of primary importance to make a clear distinction between the "city" as an entire administrative area and the "city" as an urban administrative area. Administratively speaking, provincial and prefecture cities refer to every area administrated by the city, which includes both urban districts and counties (as well as county-level cities in the case of prefecture-level cities). In practice, this corresponds to a region and not to a city. Strictly speaking, the Urban Administrative Area (hereafter UAA) of prefecture and provincial-level cities is only composed of their urban districts[10] (Chan *et al.*, 2008). In turn, urban districts are composed of a built-up area (*chengqu*) and suburban area (*jiaoqu*).

Confusion between the administrative jurisdiction of cities and their UAA abound, leading to sometimes inaccurate claims. Thus, as Chan (2007) observed, in 2005 *Time* magazine issued an article claiming that "Chongqing has become the largest city not only in China but in the world"[11]. Although Chongqing accommodates the highest number of residents within its administrative jurisdiction, strictly speaking Shanghai city remains the largest city in China. In addition, when using the most accurate measure of urban population, Chongqing is only the seventh largest city in China according to the 2000 Census (Chan, 2007). The author provides numerous additional examples of confusion between a city's administrative area and a city's UAA created by the media, scientific researchers and governmental and international organizations, including the US Government's trade website and the United Nations.

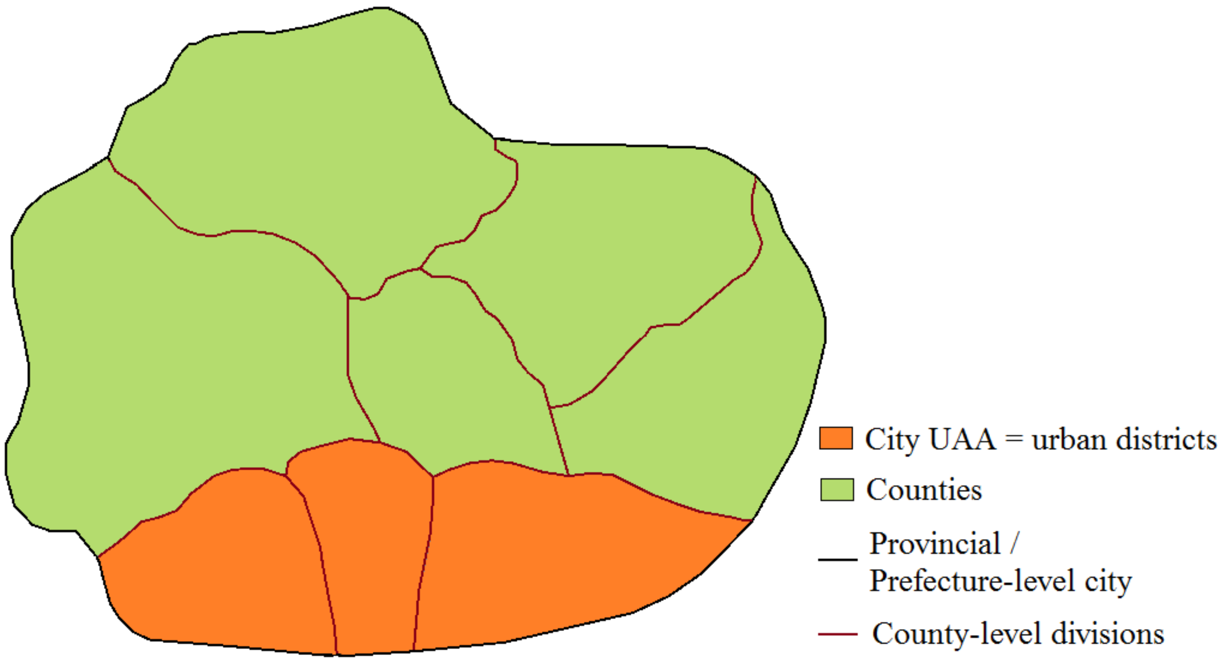
Figure 2.3 provides an illustration of the mismatch between "city as the entire administrative

[10]Prefecture and provincial-level cities are large cities and thus, their urban area is subdivided into urban districts. Therefore, the UAA of such large cities is composed of all of the different urban districts under the jurisdiction of the city. On the contrary, county-level cities are smaller and thus, their urban area is not further divided into urban districts. As a result, a given county-level city's UAA is composed of its entire administrative circumscription.

[11]Spencer Davidson "The World's Largest City", *Time*, April 18, 2005.

area" and "city as UAA" in the case of a typical provincial or prefecture-level city. In this figure, we assume that a given provincial or prefecture-level city administers three urban districts and five counties[12]. Administratively speaking, the city corresponds to the whole area colored in green and orange. However, strictly speaking, the city refers to its Urban Administrative Area which only includes the three urban districts (orange part). In the rest of the dissertation, by city we refer to the UAA of the city and not to the entire administrative area under its jurisdiction.

Figure 2.3: Typical large city in China: *entire* vs *urban* administrative area



Source: author (using Phildigit and Philcarto)

[12]To simplify, we assume that there is no county-level city under the jurisdiction of this city.

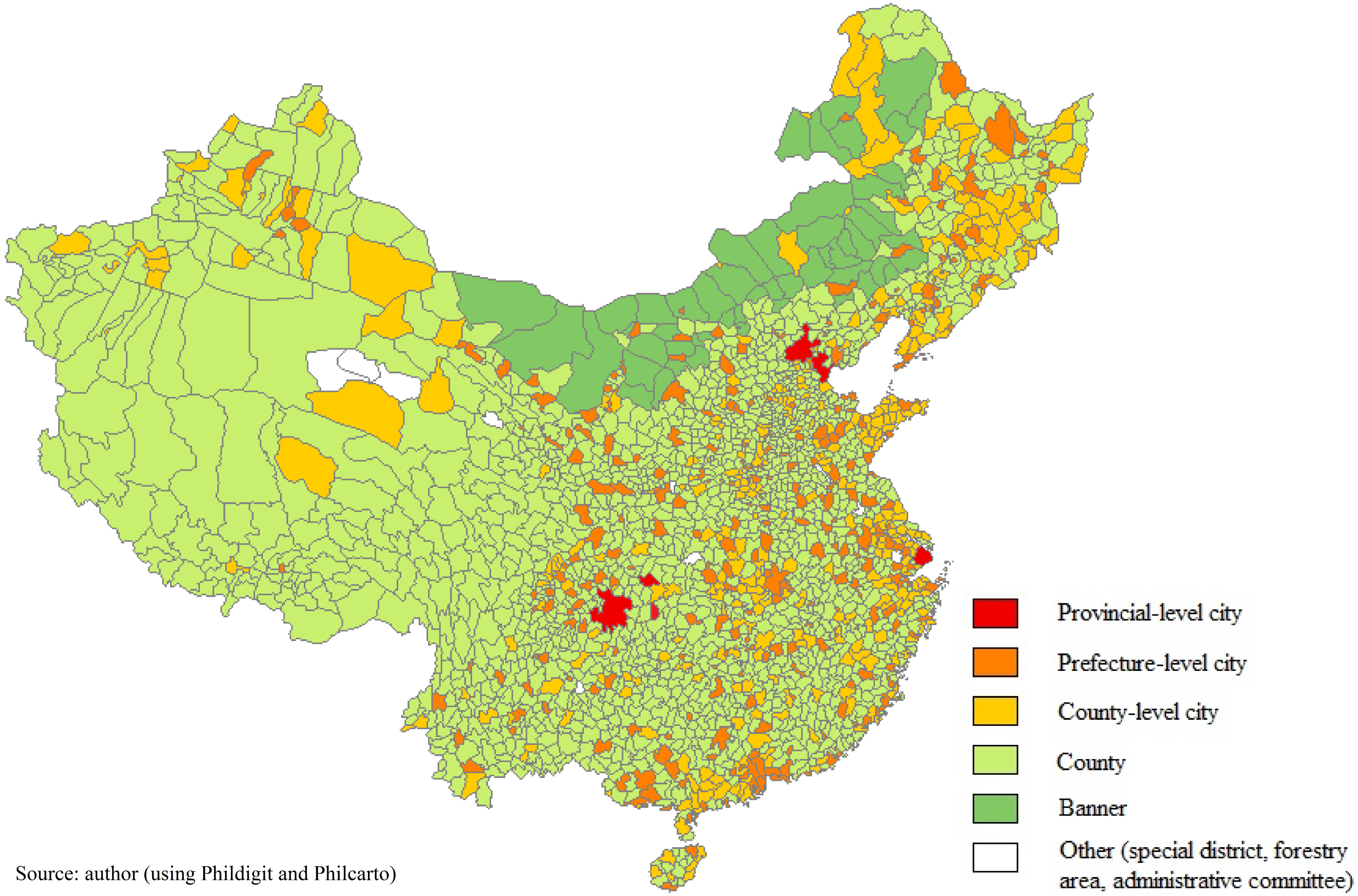
To summarize, the following areas are administratively classified as urban in China:

- The UAA of cities (county-level divisions):
  - the urban districts under the provincial cities
  - the urban districts under the prefecture cities
  - the entire administrative circumscription for county-level cities
- The designated towns (*zhen*) under the jurisdiction of counties (township-level divisions)

Most official data on Chinese urban areas are published in the City Statistical Yearbooks, which provide indicators based on the UAA of both provincial, prefecture and county-level cities (Chan *et al.*, 2008). Although urban districts are composed of a built-up area (*chengqu*) and of a suburban area (*jiaoqu*), the City Statistical Yearbooks do not provide desegregated data for these areas (Fan, 1999). Figure 2.4 below represents the Urban Administrative Areas of cities and rural areas in China[13]. As presented in Appendix 2.A, there are 4 provincial cities (Beijing, Tianjin, Shanghai and Chongqing), 284 prefecture cities and 369 county-level cities. In addition to the UAA of the different cities, counties and their equivalent (banners) constitute the rural division at the county-level in China (colored in green in Figure 2.4). Counties and banners are primarily rural areas and thus, at the county-level, it is considered that they are rural areas, even if they have towns (*zhen*) under their administrative jurisdiction.

[13]Due to the difficulty in finding an accurate map with current administrative divisions, I have digitalized the map presented according to the 2010 administrative divisions (which corresponds to the last release of county-level statistics). Moreover, as statistics for most provincial and prefecture-level cities are given at the aggregated level (*i.e.* for the whole urban districts under each city), I have aggregated the urban districts belonging to each provincial or prefecture city together (*i.e.* belonging to the same UAA).

Figure 2.4: Urban and rural areas in China (2010 county-level division)



Source: author (using Phildigit and Philcarto)

2.4 Additional administrative conversions and relevance of city data based on the UAA criteria

Strictly speaking, cities are made up of their UAA and not by their entire administrative jurisdiction. As explained in the previous section, the UAA of prefecture and provincial-level cities is made by their urban districts while the UAA of county-level cities corresponds to their entire administrative circumscription.

While the UAA may have fit the "city proper" concept well at the dawn of the economic transition, since then the UAA of cities has increasingly covered non-genuine urban areas for the following two reasons. First, due to the "turning counties into cities" measure, most county-level cities created during the 1980s-1990s are not genuinely urban. Second, due to the "turning cities and counties into urban districts" measure, the UAA of prefecture and provincial-level cities increasingly encompasses large areas with rural landscapes and economic structures.

As city-level data is provided by the City Statistical Yearbooks and as these yearbooks release data based on the UAA criteria, the loss of relevance of the UAA raises problems for obtaining accurate city-level data.

2.4.1 Turning counties into cities (*xian gai shi*)

In the pre-reform era, county-level cities were created by designating a developed and urbanized part of a county as city. In other words, only the most urbanized portion of a county was upgraded to the rank of county-level city. However, such an administrative arrangement generated conflicts as counties were strongly opposed to being deprived of their most urbanized and developed territories. Moreover, this led to an increase in the number of county-level units and thus, increased bureaucracy.

From 1983, to spur urbanization and to solve the previously mentioned problems, the state promoted the growth of small cities by upgrading *entire* rural counties to the rank of county-level cities. Turning entire counties into county-level cities was achieved through a loosening of the criteria for the designation of cities[14].

Official criteria to turn counties into cities first appeared in 1983 but were officially announced by the State Council in 1986 (Ma, 2005). Although more stringent requirements were

[14]This measure is also known as "converting entire counties to cities".

issued in 1993, the requirements remained very low and many counties were then eligible to be turned into county-level cities. Specifically, to be granted county-level city status, a rural county had to meet three weak requirements in terms of industrialization level, urbanization level and fiscal strength. Moreover, contrary to the usual rule for obtaining city designation, low population density counties had to meet lower requirements. The precise 1993 requirements are given in Appendix 2.B.

In addition to these weak requirements, the city designation system suffers from two additional problems. First, counties applied for city designation using inaccurate data regarding their industrialization and urbanization levels. Specifically, as counties had strong incentives to be upgraded to the rank of county-level city, data were largely inflated[15] (Ma, 2005). Second, not only the requirements were weak but also, in practice, many rural counties which did not meet the requirements still managed to gain county-level city status. Indeed, in practice a county's economic performance proved to be the main determinant explaining how a county was reclassified as a county-level city (Li, 2011). This "turning counties into cities" policy has then enabled a very large number of growing rural counties to be entirely turned into county-level cities, even if they remained fundamentally rural economies.

Due to the weak requirements and their poor enforcement, the number of county-level cities surged over the 1980s and in the first half of the 1990s. The number of county-level cities increased from 144 in 1983 to 430 in 1999 (Ma, 2005). However, on the whole, the newly created cities were quite different from the cities already established prior to the 1980s. Thus, the "turning counties into cities" measure has led to the emergence of a new type of area, officially designated as a county-level city but which may include large areas whose landscape and functions remain fundamentally rural (Ma, 2005). Because of the difficulties raised by this policy in terms of measurement of the urban population, the "county-to-city upgrading" policy was stopped in 1997[16]. As turning counties into cities is the only way to create new county-level cities in China, since then only prefecture-level cities have been created, especially by upgrading

[15]When counties are reclassified as county-level cities, they remain at the same ladder of the hierarchical structure. However, the term "upgrading" is often used to highlight that reclassification from a rural to an urban area increases political and administrative powers, as well as fiscal autonomy, accessibility to resources, and ability to attract investment (Fan, 1999). A list of such benefits is given in Table 2 in Li (2011) and explains why rural areas have strong incentives to be granted an urban designation.

[16]Similar to the idea that cities lead the development of counties was the idea that towns lead the development of the countryside. Thus, in 1984 the State Council also relaxed the requirements of designating a community as a town. This, associated with the rural industrialization of the countryside, resulted in a very large number of conversions of townships (*xiang*) into towns (*zhen*) and the number of towns increased from 2,781 in 1983 to about 9,000 in 1987 (Chan, 1994).

a county-level city to the rank of prefecture-level city (Fan *et al.*, 2009).

2.4.2 Turning cities and counties into urban districts (*xian shi gai qu*)

The last administrative measure implemented to empower cities in the reform era consists in "turning county-level cities and counties into urban districts"[17]. While this administrative measure has been implemented throughout the reform era, it has been increasingly used since the mid-1990s, in particular to provide a solution to increased demand for land in large cities (Chung and Lam, 2004).

This measure consists in administratively converting one or several counties (or county-level cities) into urban districts. As the UAA of cities is composed of urban districts, this administrative measure has led to an increase in the urban scale of cities. Note that this measure has only increased the urban scale of prefecture and provincial-level cities, which have urban districts under their jurisdiction, but not the urban scale of county-level cities, which do not.

This administrative measure has been used in some large prefecture-level cities, leading to the re-designation of both counties and county-level cities as urban districts. In provincial-levels cities, this administrative measure has been largely used and has always consisted in re-designating counties into urban districts. For example, while Beijing administered 9 counties in 1982, it only administers 2 counties nowadays (Ma, 2005). A similar trend has been observed in the three other municipalities, and administrative conversions have led to a huge increase in the urban area of the municipality. Chongqing municipality constitutes an extreme example. Due to the administrative conversion of several counties into urban districts, the UAA of the municipality currently expands over more than 150km. Thus, Shuangqiao district is located about 160 km away from other districts[18] (Chung and Lam, 2004).

On the whole, this administrative measure has led to a significant increase both in the number of urban districts and in the urban area of cities. However, there have been no official requirements set to convert counties into urban districts. As a result, many counties have been administratively re-designated as urban districts, even though they remain genuinely rural in

[17] This measure is also known as "annexation of suburban counties by cities" or as "abolishing county and establishing [city-administered] districts".

[18] Shuangqiao district no longer exists as it was merged with Dazu county in 2011 to form Dazu district. Nevertheless, the same observation remains: Dazu district is located very far away from other urban districts of the municipality, indicating that Chongqing's UAA expands over a very large area.

terms of landscape and economic structure. Thus, similarly to the "turning counties into cities" measure, the re-designation of counties into urban districts has led to inflated urbanization.

Finally, in practice, this measure has enabled cities to secure land resources for its expansion, resulting in an increase in the rate of conversion of farmland and in the number of landless farmers. This has led the government to reduce the number of conversions of counties into suburban districts since the year 2004.

2.4.3 Consequence for the relevance of city-level data based on the UAA criteria

Both the "turning counties into cities" and the "turning counties into urban districts" measures have led to administratively converting rural counties into urban areas, even though some counties were anything but urban. First, the "turning counties into cities" has led to converting *entire* rural counties into county-level cities by applying weak requirements. This administrative arrangement has led to the creation of new county-level cities, which are not genuinely urban areas, but which are administratively and statistically considered as entirely urban based on the UAA-criteria. Second, the "turning counties into urban districts" has led to converting counties (and cities) into urban districts of large cities, even if some of them remain genuinely rural. This administrative arrangement has led to "artificially" increasing the UAA of large cities, as a result of embracing rural areas.

Because of these administrative measures, while the UAA of a city very relevantly covered the city proper in the pre-reform period, it has progressively lost relevancy over the reform-period. Nowadays, the UAA is likely to over-bound cities because recent increases in UAA reflect not only the urbanization process but also administrative arrangements (Chan, 1994).

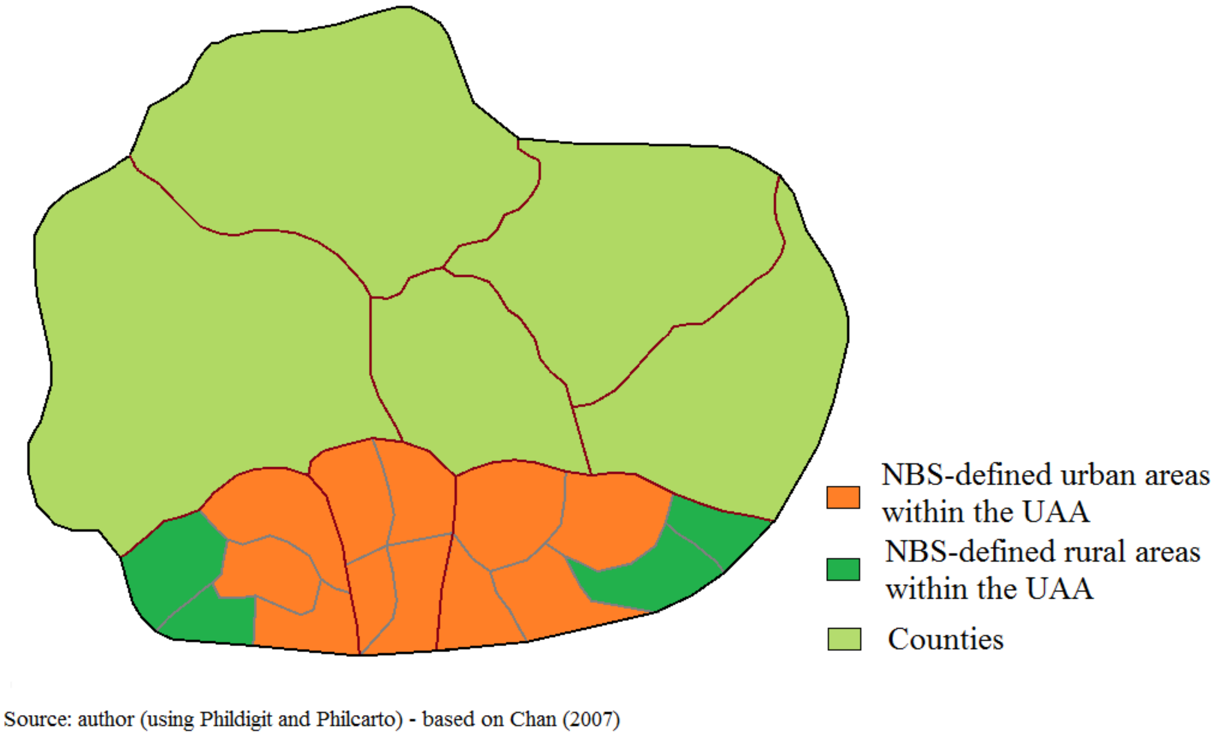
The problem of over-bounded UAA has raised major problems, especially for measuring the urban population and thus, for providing relevant data on urbanization in China. As a result, since the 1990 Census new criteria have been introduced to measure the Chinese urban population and to better define urban areas. Specifically, smaller settlements (residents' committees and villagers' committees, which are under township-level divisions) are used to provide more accurate data on urban population. In this way, it is possible to exclude from the city's UAA areas which remain genuinely rural. Thus, according to the 2000 Census, the following are considered as rural: (1) villagers' committees in county-level cities and towns;

(2) villagers' committees in prefecture-level cities and above, if the district has an average population density of less than 1,500 persons per sq.km. Moreover, a "contiguous built-up area" criterion has also been added to consider as urban the nearby townships if the built-up area to nearby urban centers is contiguous (see Chan and Hu (2003) for a detailed presentation of the criteria of the 1990 and 2000 censuses). These new criteria rely more on urban physical characteristics than on administrative boundaries and thus, more precisely differentiate between urban and rural areas than the UAA (Chan, 2007). On the whole, researchers consider that these criteria are reasonable for defining urban areas since NBS-defined urban areas fit the city proper concept quite well. In the rest of this dissertation, the urban areas defined according to the 2000 Census criteria are designated as "NBS-defined urban areas".

Comparing Figure 2.3 and Figure 2.5 provides an illustration of the difference between the city's UAA and the NBS-defined urban areas within the UAA. According to the UAA, the city's urban area is composed of its urban districts (Figure 2.3). The criteria used in the 2000 Census are more restrictive and thus, urban districts may include several areas considered as rural according to the NBS-defined urban areas (Figure 2.5).

The new criteria implemented since the 1990 Census enable us to provide accurate data on the urban population. However, most indicators at the city-level (such as GDP) provided by the City Statistical Yearbooks are based on the likely "over-bounded" UAA-criteria (Chan, 2007).

Figure 2.5: NBS-defined urban area within urban districts



2.5 Unit of analysis in the present dissertation

As the Chinese spatial structure has been presented, we can now discuss the relevant scale of analysis to empirically investigate whether urban areas stimulate rural economic development. In our view, there are two interesting options: county-level and village-level analyses.

2.5.1 County-level analysis

A first option to investigate whether urban areas enhance rural development is to test the effect of cities on counties by using county-level data. As shown in Figure 2.6, in this case urban areas refer to cities' UAA whereas rural areas correspond to counties.

Carrying out a county-level analysis is the most obvious option because this scale of analysis is consistent with the scale of growth poles as specified in theory (Ke and Feser, 2010). That is why most empirical studies on urban spillover effects on rural areas have been carried out at the county level. In addition, carrying out a county-level analysis seems particularly relevant given that inequality between counties accounts for most of rural inequality in China (Knight and Song, 1993; Gustafsson and Li, 2002). Finally, this will enable us to benefit from annual data for quite a large part of the Chinese territory.

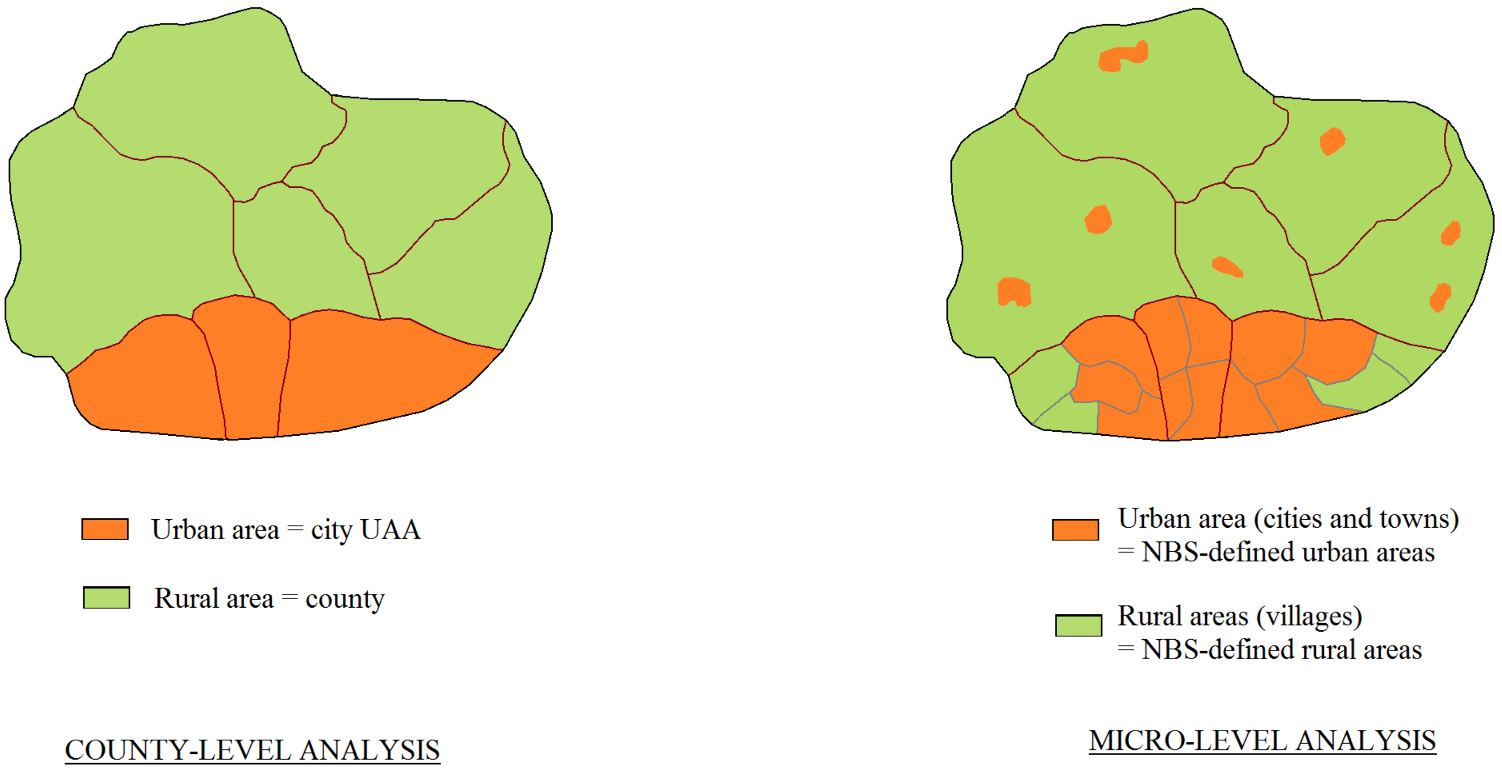
However, there are also several inherent drawbacks to county-level analyses. First, as raised in the present chapter, the UAA tends to over-bound cities, which raises concerns about the accuracy of city-level data. More importantly perhaps, using city-level data based on the UAA can lead to over-estimation of the size of *some* cities. Indeed, although there is a difference between the UAA and the NBS-defined urban area for most cities, the difference is much larger for some cities than for others. For example, as shown in Table 2.1, using population data based on UAA leads to over-estimating the size of Chongqing by a much higher proportion than that of Shanghai or Shenzhen. Second, as the UAA includes some NBS-defined rural areas we are not able to assess the effect of urban areas on their closest rural areas with county-level data (these rural areas are represented in dark green in Figure 2.5). Finally, one may also wonder about the quality of official Chinese data (Rawski, 2001).

Table 2.1: *De Facto* Population (in million) of Selected Large Cities in China (2000 Census)

	UAA	NBS-defined urban area	Difference†
Shanghai	14.35	13.46	1.07
Beijing	11.51	9.88	1.16
Chongqing	9.69	6.17	1.57
Guangzhou	8.52	7.55	1.13
Shenzhen	7.01	6.48	1.08

Note: *De facto* population includes temporary migrants.
† Difference calculated by dividing population within the UAA by population within the NBS-defined urban area.
Source: based on Chan (2007).

Figure 2.6: Urban and rural areas in county-level vs micro-level analysis



Source: author (using Phildigit and Philcarto) - based on Chan (2007)

2.5.2 Village-level analysis

Given the previously mentioned drawbacks that may tarnish county-level studies, it can be interesting to carry-out a village-level analysis in addition to a county-level analysis. Indeed, using micro-level data overcomes the main drawbacks inherent in county-level analysis as the micro-level survey we will use follows the 2000 Census classification of urban/rural areas[19]. First, by using survey data we are thus able to consider as rural every village that belongs to a city's UAA but which genuinely remains rural (represented in dark green in Figure 2.5). This is more relevant because it enables us to investigate the effect of cities on their most nearby villages. Second, as stated in Section 2.3.2, there are two urban units in China: cities (the main urban entity) and towns. The NBS-defined urban areas encompass towns within rural counties whereas in county-level analysis, counties are entirely considered as rural (see Figure 2.6). In other words, while using county-level data enables us to investigate whether cities enhance the development level of counties, using village-level data enables us to asses the effect of both cities and towns on the rural economy. Investigating the impact of proximity to towns seems particularly relevant. Indeed, rural non-agricultural activities as well as new technologies and ideas are concentrated in towns; thus, towns are likely to play a very significant role on nearby rural areas, by reducing agricultural labor surplus and by modernizing the countryside (Lin, 2002).

On the whole, it seems that county-level and village-level analyses constitute interesting and complementary scales of analysis to empirically investigate whether urban areas drive rural development in China. Thus, I will provide both county-level and village-level analyses in the present dissertation in order to provide the most thorough analysis possible. Specifically, Chapters 4 and 6 provide county-level studies (cities correspond to their UAA) while Chapter 5 provide a micro-level analysis (urban areas correspond to NBS-defined urban areas).

2.6 Conclusion

While the central government did not remove the hierarchical administrative structure during the economic transition, it has implemented three main administrative measures to empower cities and to spur urbanization.

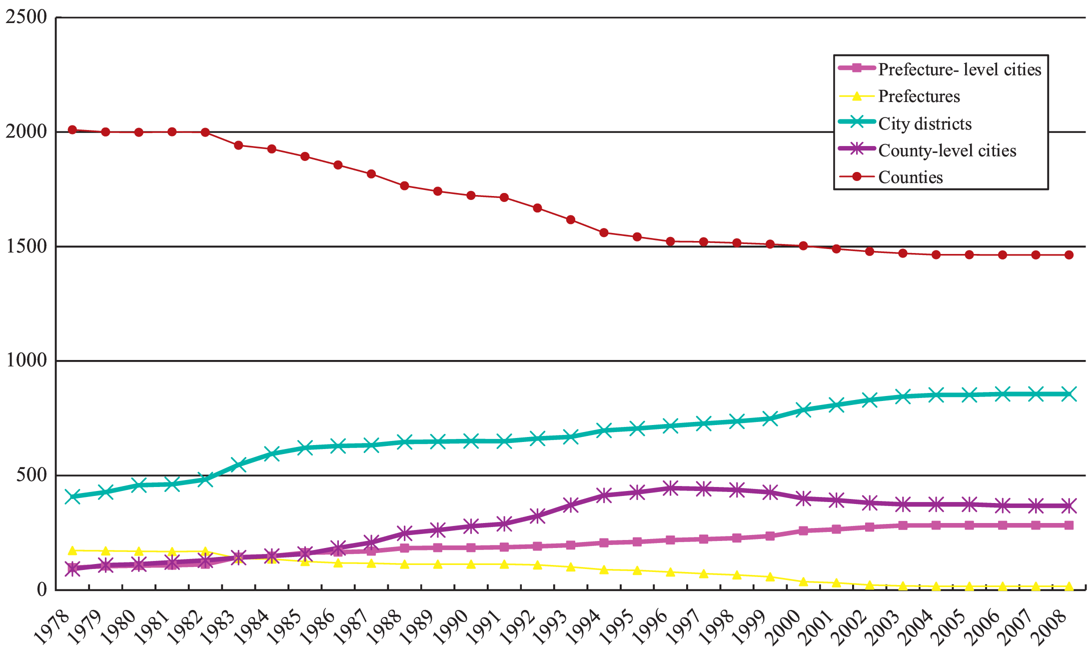
[19]As described in Chapter 5, we use the 2000 rural survey of the Chinese Household Income Project.

First, in the early 1980s, the central government authorized cities to administer counties. This administrative measure, which led to an increase in the administrative jurisdiction of cities, has had direct implications for the concept of cities. While in the pre-reform era cities refer to built-up areas (functional concept of cities), nowadays cities have become an administrative concept as they include urban districts (the UAA) as well as counties and lower-level cities. We have highlighted in this chapter the necessity of clearly understanding the difference between the city as an entire administrative area and the city as an urban administrative area. In the rest of the dissertation, we will refer to cities as Urban Administrative Areas.

In addition, during the reform era the criteria to designate a settlement as urban were weakened. First, this led to the conversion of entire rural counties into county-level cities during the 1980s and the mid-1990s. However, counties have been upgraded to the rank of county-level cities more as a consequence of a loosening in criteria to designate a settlement as urban than because of a genuine urbanization of counties. Second, many counties and county-level cities were converted into urban districts throughout the transition. As a result, the UAA of prefecture-level and above cities has increased but the new urban districts remain in large part rural entities. Thus, the UAA of prefecture-level and above cities has been changed from a genuine urban area to a hybrid entity, including both strongly urbanized areas and portions of rural areas. On the whole, the weakening of the criteria to classify entities as urban has progressively eroded the relevancy of the UAA to cover the city proper. This is a serious issue that must be kept in mind given that city-level data, which are provided by the City Statistical Yearbooks, are based on the UAA criteria.

Figure 2.7 summarizes the impact of the three previously described administrative measures on the number of administrative divisions. Consistently, the "turning prefecture into cities" measure led both to an increase in the number of prefecture-level cities and to a decrease in the number of prefectures in the two first decades of the reforms. Moreover, the "turning counties into cities" measure led to a sharp increase in the number of county-level cities until 1997, when the policy ended. Since then, the number of county-level cities has declined because some of them have been converted into urban districts. The "turning counties and cities into urban districts" has also led to an increase in the number of urban districts since the reforms began. Consistently, as counties were turned into county-level cities and urban districts, their number decreased during the whole reform era. On the whole, most administrative changes occurred during the 1980s-1990s and despite the increase in the number of urban districts until 2004, administrative divisions have remained essentially unchanged since 2000.

Figure 2.7: Administrative changes thorough the reform era



Source: Li and Wu (2012)

Finally, in light of the previously discussed issues, we have wondered about the relevant scale of analysis to empirically assess urban influence on rural economic development. The obvious answer is to carry out county-level studies as this approach is directly derived from the theory and as it is the most widely used scale in empirical works on urban spillover effects on rural areas. However, we believe that it is interesting to complement county-level studies with a micro-level analysis to overcome some drawbacks inherent to county-level analyses carried out in the Chinese context. The present dissertation will thus provide both county-level and micro-level studies to empirically assess the effects of urban areas on the hinterland in China.

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Appendix to Chapter 2

2.A Administrative divisions of China (end of 2011)

Table 2.2: Administrative divisions of China (end of 2011)

Provincial level		Prefecture level		County level				Township level
Type	Name	Nb. regions	Of which: Prefecture cities	Nb. regions	Of which: Urban districts	County-level cities	Counties†	Nb. regions
Municipality	Beijing			16	14		2	322
Municipality	Tianjin			16	13		3	244
Province	Hebei	11	11	172	36	22	114	2233
Province	Shanxi	11	11	119	23	11	85	1397
Autonomous region	Inner Mongolia	12	9	101	21	11	17	909
Province	Liaoning	14	14	100	56	17	27	1508
Province	Jilin	9	8	60	20	20	20	898
Province	Heilongjiang	13	12	128	64	18	46	1278
Municipality	Shanghai			17	16		1	209
Province	Jiangsu	13	13	104	55	25	24	1300
Province	Zhejiang	11	11	90	32	22	36	1346
Province	Anhui	16	16	105	43	6	56	1522
Province	Fujian	9	9	85	26	14	45	1102
Province	Jiangxi	11	11	100	19	11	70	1539
Province	Shandong	17	17	140	49	31	60	1857
Province	Henan	17	17	159	50	21	88	2381
Province	Hubei	13	12	103	38	24	40	1233
Province	Hunan	14	13	122	35	16	71	2426
Province	Guangdong	21	21	121	54	23	44	1585
Autonomous region	Guangxi	14	14	109	34	7	68	1235
Province	Hainan	2	2	20	4	6	10	222
Municipality	Chongqing			38	19		19	1012
Province	Sichuan	21	18	181	44	14	123	4672
Province	Guizhou	9	6	88	13	7	67	1558
Province	Yunnan	16	8	129	13	11	105	1362
Autonomous region	Tibet	7	1	73	1	1	71	692
Province	Shaanxi	10	10	107	24	3	80	1418
Province	Gansu	14	12	86	17	4	65	1353
Province	Qinghai	8	1	43	4	2	37	396
Autonomous region	Ningxia	5	5	22	9	2	11	237
Autonomous region	Xinjiang	14	2	99	11	20	68	1020
National level		332	284	2853	857	369	1573	40466

Note: †Includes autonomous counties.
Table constructed using data from the 2012 China Statistical Yearbook.

2.B Minimum requirements for county-to-city upgrading

Table 2.3: Minimum requirements for county-to-city upgrading

Population density (person/km2)		> 400	100-400	< 100
Industrialization level	Industrial output value (yuan)	1.5 billion	1.2 billion	0.8 billion
	Share of industrial output value in gross output value	80%	70%	60%
Urbanization level	Urban population (engaged in non-agricultural production)	150 k	120 k	100 k
	Share of urban population	30%	25%	20%
Fiscal strength	Fiscal revenue (yuan)	60 million	50 million	40 million
	Per capita fiscal revenue (yuan)	100	80	60

Source: Li (2011) (based on "The Report on Adjusting the Criteria for the Designation of New Cities" by the Ministry of Civil Affairs in 1993)

Chapter 3

Literature Review

Literature Review and Chinese Specificities

3.1 Introduction

Since the beginning of China's economic reforms, more than 500 million people have got out of poverty (World Bank, 2009). However, as stated in the general introduction of this thesis, many rural people remain poor and the fact that remote rural areas suffer the most from poverty (Jalan and Ravallion, 2002; Glauben *et al.*, 2012) is a striking one. Studies on other developing countries (Bird and Shepherd, 2003) and on the United States (Partridge and Rickman, 2008; Kilkenny, 2010) also highlight that poverty increases with remoteness from urban centers. As noted by Wu and Gopinath (2008), as a result, there are significant spatial disparities not only between urban and rural areas but also *within* rural areas. Moreover, according to the authors, remoteness from urban centers is the primary cause of spatial disparities across US counties.

One primary explanation for such a phenomenon may be that, contrary to rural areas surrounding cities, remote areas do not enjoy agglomeration externalities and urban spread effects (Partridge and Rickman, 2008).

As emphasized by the New Economic Geography (NEG), firms tend to concentrate in destinations with good market and supplier access in order to save on transport costs. That is why rural areas close to cities are much more attractive destinations for profit-maximizing firms than remote areas (pecuniary externalities). Moreover, firms are also more likely to set up in areas close to cities where they can also benefit from production externalities (Wu and Gopinath, 2008). For example, producers close to large and diversified urban areas can more easily access a wide range of complementary services, such as maintenance. Thus, rural firms close to cities can specialize their production, leading to productivity gains (through learning-by-doing) and to a reduction in costs (as workers do not have to switch tasks) (Duranton and Puga, 2004). Firms close to cities can also benefit from knowledge spillovers and may more easily access information about demand conditions, thus increasing their productivity level.

As pecuniary and production externalities decrease with distance from the urban center, a higher *distance* to the urban center is expected to be associated with a lower level of rural development. Distance to urban centers, for any given city size and city's growth rate, would thus have a negative impact on rural development; this is known as the "pure distance effect" (Polèse and Shearmur, 2004) or as the "Urban Distance Discount" (Partridge *et al.*, 2007a). It is worth noting that in general *larger* urban centers provide higher orders of services (Central

Place Theory) and higher market opportunities so that pecuniary and production externalities are likely to be higher close to larger urban centers; this is known as "urban hierarchy effects".

In addition to the effects of distance and city size, the growth pole theory has emphasized that *growth* in the center also matters for development in the periphery (Perroux, 1950). For example, due to inter-industry linkages, growth in the center can lead to an increase in the demand for natural-resource-based commodities produced in the nearby periphery. In this case, urban growth stimulates rural growth; this phenomenon is known as "spread effects" (Myrdal, 1957) or "trickling-down effects" (Hirschman, 1958)[1]. However, urban growth can also reduce rural growth. For example, growing cities may lure scarce resources such as workers and capital from nearby rural areas, resulting in "backwash effects" (Myrdal, 1957). Similarly, while urban growth will generate "trickling-down effects" through inter-industry linkages when the center and the periphery are complementary, urban growth will lead to "polarization effects" when the center and the periphery are not (Hirschman, 1958)[2].

Given the existence of agglomeration externalities and urban spillover effects, understanding rural development requires taking into account surrounding urban areas (Barkley *et al.*, 1996; Partridge *et al.*, 2007a; Kilkenny, 2010).

The present chapter provides an overview of the literature on urban effects on the hinterland. Following this introduction, in Section 3.2 we highlight the general mechanisms mentioned in the literature to explain how cities can affect the level of economic development in the periphery. In Section 3.3, we will review the empirical results obtained in the literature on urban effects on the hinterland. As most studies have focused on developed countries, in Section 3.4 we will provide a critical analysis of the existing framework to assess the applicability of Western theories in the Chinese context. We will also present the few empirical studies on urban effects in China and investigate the relevant measure of urban influence in the Chinese context. Finally, in Section 3.5, we will conclude by highlighting how this chapter enables us to guide the empirical analyses carried out in the last three chapters of the thesis.

[1]The notions of spread and backwash effects first appeared in the international trade theory (Myrdal, 1957) and have been subsequently used to describe how urban growth affects growth in rural areas (Gaile, 1980).

[2]Usually urban growth generates both spread and backwash effects on the hinterland so that spread and backwash effects usually refer to the *net* effects of urban growth on the periphery.

3.2 How can cities affect the economic performance of the hinterland?

Studies on urban effects on the hinterland have overwhelmingly focused on the effect of cities on rural employment and rural population. As Renkow (2003) underlines, given the decline of traditional enterprises in rural areas, it is of primary importance to understand the determinants of rural employment, which is the key to revitalizing the rural economy. Moreover, rural population (employment) growth results from household location choices (firm location decisions) and thus, is an indicator of the relative well-being (profit) obtained in a given area. The present section discusses how urban proximity (including distance alone, city size and city growth) can enhance rural employment (Section 3.2.1) and population (Section 3.2.2). Next, we will describe how cities can, on the contrary, hinder rural development in nearby rural areas (Section 3.2.3) and in remote areas (Section 3.2.4).

3.2.1 Positive impact on rural employment

Rural areas close to cities are likely to benefit from a higher demand for rural labor. First, rural workers benefit from more job opportunities because they can commute to the nearby urban area. Second, rural workers usually benefit from a higher number of job opportunities directly in their *own* rural community because: (i) of inter-industry linkages between cities and nearby rural areas; (ii) pecuniary and production externalities attract new firms in rural areas close to cities; and, (iii) as cities grow, urban firms that flee high production costs in cities relocate to rural areas close to cities.

3.2.1.1 Commuting opportunities

Thanks to the development of road infrastructures and transportation systems, it has become possible to dissociate one's place of work from one's place of residence. Nowadays cities provide numerous job opportunities to residents of neighboring rural places and a high number of them hold jobs in the nearby city. For example, in North-Carolina as much as 20% of workers living in rural counties commute every day to work in the adjacent metropolitan county (Renkow, 2003). Obviously, residents of rural areas far way from cities do not benefit from such job opportunities as the distance is too large to be traveled daily.

Given that cities provide jobs to a very significant share of neighboring rural residents, urban growth may spread to nearby rural economies by providing to their residents additional job opportunities. This is expected to benefit rural areas close to cities in two ways: by reducing unemployment of current residents and by attracting new residents (in-migrants), resulting in an increase in the county population. Such a phenomenon is far from being negligible. In the U.S., it is estimated that when the number of available jobs increases in metropolitan counties, as much as 50% of the new jobs are filled by in-commuters who reside in nearby rural places (Renkow, 2003).

Khan *et al.* (2001) provide evidence on the geographical reach of this phenomenon in the U.S.[3] They estimate that a county's economic growth not only provides new employment opportunities to the residents of the own county but, because of commuting flows, also provides new jobs to residents of the adjacent county and to those two counties away. As a result, economic expansion in a county raises employment opportunities and population (through in-migration) within a three-county radius. Finally, it is worth noting that urban proximity, by making commuting possible, enhances both rural labor demand and the level of wages earned by rural residents. Indeed, commuting not only enables rural residents to benefit from more employment opportunities but also enables them to get access to better remunerated jobs, as the level of wages is higher in urban areas than in rural areas (Hanson, 2000)[4].

While rural workers close to cities may commute to nearby urban areas, they also usually benefit from a higher number of job opportunities directly in their *own* rural community.

3.2.1.2 Inter-industry linkages

Urban and rural economic activities are usually connected through inter-industry linkages. Rural industries, producing primary products and natural-based-commodities, are often input suppliers of urban industries (forward linkages). Thus, rural areas close to cities benefit from higher urban demand, which encourages the development of the local economy. Moreover, growth in the center can lead to an increase in the demand for natural resource-based commodities produced in the nearby periphery, and thus, to an increase in rural employment (Hugues and

[3]The authors do not exactly consider the effect of economic growth in the city on population growth in rural counties. Instead, they look at the effect of economic growth in one county on population growth in nearby counties.

[4]This issue will be empirically addressed in Chapter 5 of the thesis.

Holland, 1994). On the other hand, even when remote areas are well-endowed with natural resources, transport costs are so high that urban growth usually does not entail an increase in demand in remote areas.

3.2.1.3 Productive advantages and firms' location choices

There is extensive evidence that the number of firms locating in a given region (and thus demand for labor) is an increasing function of urban proximity (Arauzo-Carod *et al.*, 2010). One major explanation is that production and pecuniary externalities are much higher close to cities, which make rural areas close to cities much more attractive destinations for profit-maximizing firms, compared with remote areas (Wu and Gopinath, 2008).

By setting up close to cities, firms can benefit from productive advantages through a number of mechanisms. First, for example, firms close to cities may more easily access the complementary services (such as maintenance) offered in large and diversified urban areas. This may enable firms to specialize their production without providing all required services. And, as known since Adam Smith, increase in specialization leads to productivity gains. Second, rural areas close to cities usually benefit from a much more developed infrastructure and input supplier network than remote ones. Thus, by locating in these areas, firms can share some indivisible goods and facilities, such as physical infrastructure (Duranton and Puga, 2004; Tveteras and Battese, 2006). In this way, urban proximity enables firms to save on investments in indivisible inputs that are necessary for production but usually not fully utilized. Diversified urban environments also enhance the generation of knowledge (Jacobs, 1969) so that rural areas close to cities may benefit from diffusion of knowledge. Given that this requires face-to-face interaction, knowledge diffusion from cities to neighboring rural areas is expected to be reinforced particularly through commuting. In addition, by locating in rural areas close to cities, firms enjoy lower transport costs to reach their suppliers and consumers, compared with firms in remote areas.

A number of studies have estimated the geographical reach of these productive advantages, usually referred to as "agglomeration economies"[5]. Most works in urban economics find that

[5] Agglomeration economies (or external economies) refers to the productive benefits that firms obtain when locating close to each other. Traditionally, a distinction is made between localization and urbanization economies. Localization economies refers to the benefits that a firm accrues when locating near other firms in the same industry (Marshall, 1890). Urbanization economies refers to the benefits that a firm accrues when locating near firms in different industries, typically in a large and diversified city (Jacobs, 1969). In other words, localization economies stress the importance of intra-industrial externalities (and thus, of specialization) whereas urbanization

agglomeration economies die out quickly with distance. For example, Baldwin *et al.* (2010) estimate that the productivity level of a firm significantly increases with the number of firms in the same industry located within 5 km of the firm. On the contrary, firms located beyond 5 km of the firm do not significantly affect its productivity level. Rosenthal and Strange (2003) reach a similar conclusion regarding the geographic scope of agglomeration economies.

However, it is well-known that the extent of spatial externalities strongly depends on the type of externalities considered (Rosenthal and Strange, 2001). Typically, while localization economies, and especially knowledge spillovers, occur in very limited areas (such as within a zip code), urbanization economies occur at a wider level (such as within the city), whereas transport costs (or NEG effects) occur at an even broader level, such as within the region (Nakamura, 2012). As a result, and as pointed out by Mion (2004), studies which focus on localization economies (Rosenthal and Strange, 2003; Baldwin *et al.*, 2010) conclude that agglomeration economies have a very limited geographic scope.

In the regional science literature, a number of studies emphasize that agglomeration economies have an extended geographic scope. These studies highlight that even if agglomeration economies decrease with distance, they extend *beyond* the city boundaries. As a result, firms in rural areas close to cities benefit from some agglomeration economies, contrary to firms in areas farther away from urban centers, where all agglomeration effects have disappeared. Deckle and Eaton (1999) estimate that in Japan, agglomeration effects in the manufacturing sector spread nation-wide. Even in the case of financial services, where agglomeration economies are more localized, the authors find that agglomeration economies spread beyond the prefecture boundaries. More recently, Broersma and Oosterhaven (2009) also find that the regional labor productivity is significantly affected by job density in surrounding regions in The Netherlands. In addition, Lopez-Bazo *et al.* (2004) estimate that even knowledge externalities can have an extended geographic scope. Using a sample of European regions, the authors estimate that knowledge spillovers do not entirely disappear until about 600 km, even if most spillovers occur within the regions belonging to the same country. Finally, several papers specifically investigate the geographic scope of NEG type externalities (or cost and demand linkages) and find that such

economies highlight the importance of inter-industrial externalities (and thus, of diversification). See Duranton and Puga (2004) for a presentation of the theoretical micro-foundations of agglomeration economies and Rosenthal and Strange (2004) for a review of the empirical literature. Puga (2010) offers a more recent overview of this issue. Finally, while localization and urbanization economies highlight production externalities, the New Economic Geography literature stresses the importance of pecuniary externalities: a firm benefits from the proximity to suppliers and consumers because proximity leads to a reduction in transport costs.

externalities extend over hundreds of kilometers (Mion, 2004; Hanson, 2005).

By setting up in rural areas close to cities, firms are thus likely to benefit from pecuniary and production externalities, which enables them to raise their productivity level. Looking at the spatial patterns in wages and land rents provides evidence of these productive differences[6] (Puga, 2010). For the U.S., Partridge *et al.* (2009) estimate that productive disadvantages are the primary explanation for the lower wage levels and housing costs in remote rural counties. In addition, remoteness would not only lead to productive disadvantages, but also to *increasing* productive disadvantages over time (Partridge *et al.*, 2010).

3.2.1.4 Relocation of urban firms

As cities grow, congestion costs appear; typically land prices and wages increase (Glaeser, 1998). Such congestion costs lead cost-sensitive industries to relocate to nearby rural areas, where they benefit from cheaper production costs while still retaining advantage of the urban market access and of some external economies granted by urban proximity. Thus, as cities grow, rural areas close to cities benefit from progressive industrialization, which enhances rural employment growth. It is worth noting that such spread effects are expected to be at work only in the surrounding areas of large urban centers. Indeed, in small urban areas, land and labor costs are quite similar to production costs in nearby rural areas so that urban firms have no interest in relocating there (Schmitt and Henry, 2000).

While rural areas close to cities are likely to benefit from a higher demand for labor, they are also likely to benefit from a larger and more rapidly growing population.

3.2.2 Positive impact on rural population

Rural areas close to cities usually benefit from a higher population growth rate than remote areas for at least two reasons: (i) people are attracted to regions close to cities because they offer more job opportunities; (ii) there is a decentralization of urban population to nearby rural areas.

[6] Indeed, firms in remote areas, which have to pay higher transport costs and which do not benefit from agglomeration economies, are expected to pay lower wages and land rents in order to compensate for the costs of distance.

As described in Section 3.2.1, rural areas close to cities benefit from a higher and more rapidly growing demand for rural labor. As a result, a number of migrants, especially from remote areas, may be encouraged to set up in areas close to cities, leading to an increase in population close to cities[7]. For example, Renkow (2003) estimates that employment growth in metropolitan counties significantly increases labor force (*i.e.* both in-migration and participation rate) in nearby rural counties. Thus, rural counties close to urban centers might in fact "be net recipients of migrants" (Jordan *et al.* 2011).

Rural areas close to cities also have a higher population growth rate because of the decentralization of urban populations. For example, Barkley *et al.* (1996) highlight that in certain U.S. states, urban families leave the urban core to relocate to suburban and nearby rural areas, where they benefit from lower housing costs and natural amenities, while still retaining access to urban amenities and jobs. As indicated by Henry *et al.* (1997), the decentralization of urban populations not only depends on urban growth but also on the characteristics of rural areas. For example, as urban families decide to move to nearby rural areas to benefit from a better quality of life, rural areas offering stronger amenities (e.g. green spaces) should benefit from larger spread effects (Deller *et al.*, 2001).

3.2.3 Negative effects of cities on nearby rural areas

While cities can enhance rural growth and development in nearby rural areas, firms in nearby rural areas can also suffer from the competition with urban firms. On the urban market, a high number of firms are concentrated; as a result, urban firms, which face a high level of competition, are usually particularly competitive. In this context, rural populations close to cities may prefer buying goods and services from urban firms, which usually produce more competitive and diversified products than rural firms. This would both threaten the viability of rural firms and lead to a leakage of spending from rural to urban areas (Barkley *et al.*, 1996).

While rural firms may suffer from competition close to cities, on the contrary, firms in remote areas may benefit from a "distance-protection" effect (Polèse and Shearmur, 2004). In this case, distance to urban areas is likely to have a positive impact on rural development as it "protects" rural firms from destructive urban competition.

[7]There is a debate in the literature on whether "jobs follow people" or "people follow jobs". On the whole, the results differ from one study to another and there is support for both hypotheses. However, Hoogstra *et al.* (2005), who perform a meta-analysis of Carlino-Mills' studies, point out that there is a little more support in favor of the "jobs follow people" hypothesis.

As a consequence, rural areas close to cities may both benefit and suffer from urban proximity. However, as we will see in more detail in Section 3.3, most empirical studies have estimated that the positive effects of urban proximity exceed its negative effects (Barkley *et al.*, 1996; 2006; Henry *et al.*, 1997; Henry *et al.*, 1999; Schmitt and Henry, 2000; Partridge *et al.*, 2007a; 2007b; Ganning *et al.*, forthcoming). In other words, the closer the urban areas, the higher rural development and/or rural growth.

Two broad reasons can explain why rural areas remote from urban centers are less developed. First, the greater the distance to urban areas, the lower the benefits in terms of employment and population, as highlighted in Sections 3.2.1 and 3.2.2. For example, a higher distance to urban areas significantly reduces commuting opportunities, agglomeration benefits and inter-industry linkages between urban and rural areas. Second, as we will explain in the following section, it seems that urban backwash effects are much more prevalent in remote areas, especially beyond the distance that makes commuting impossible and/or exchange with the urban market too costly (Partridge *et al.*, 2007a).

3.2.4 Negative effects of cities on remote rural areas

3.2.4.1 Luring capital

As previously noted, agglomeration economies induce firms to locate close to each other. Thus, the appeal of productivity gains can induce rural capital holders to move to cities in order to invest their capital where they will benefit from productive advantages and from the growing urban market (Barkley *et al.*, 1996). This backwash effect is expected to be stronger in remote areas than in rural areas close to cities. Indeed, capital holders close to cities can benefit from some productive advantages and can easily exchange inputs and/or final goods with the urban market. In remote areas, where transport costs are very high so that exchange with the urban market is non-existent, the incentive to relocate is much higher.

This issue is all the more problematic when local governments have to finance local public goods, such as infrastructure. As firms often constitute a very large share of the local tax base, the departure of capital holders leads to the departure of major tax payers (Renkow, 2003). This is likely to result in both an increased burden for remaining residents and a lower provision of local public goods.

3.2.4.2 Luring workers

Not only may cities lure capital from remote areas but they may also lure workers for two main reasons: cities offer (i) consumption amenities and (ii) job opportunities. Contrary to residents in areas close to cities, remote residents cannot access consumption amenities and job opportunities without migrating, which may result in a desertification problem in remote areas.

Cities not only offer productive advantages but also consumption amenities (such as restaurants and theaters) that are only available in urban areas (Glaeser *et al.*, 2001). Thus, while urban productive advantages may lure rural capital, urban consumption amenities may lure rural residents and workers. Once again, the backwash effect is expected to be less severe close to cities where residents can remain living in their rural community while accessing urban consumption amenities. In areas close to cities, the appeal for urban amenities can lead in some cases to "reverse commuting"[8]. In this case, the central city may lure residents from nearby rural areas but not workers. On the contrary, in remote areas the only way for rural residents to benefit from urban consumption amenities is to migrate to a city, which induces both a decrease in rural population and employment.

In addition, urban employment growth is likely to lure workers from remote areas by generating new employment opportunities (backwash effect). As explained in Section 3.2.1, urban employment growth generates new employment opportunities for nearby rural areas, since commuting is possible. On the contrary, when a rural commune is located too far away from the city, commuting is not possible. In this case, rural workers will have to migrate to the city if they want to benefit from its economic expansion, thus leading to a decrease in rural population. According to Khan *et al.* (2001), while a county's growth increases population for counties located within the daily maximum commuting distance (estimated to be a three county-radius), it reduces population in counties located too far away (outside the three county-radius). In other words, while urban growth produces spread effects on nearby rural areas, it generates backwash effects once the maximum daily commuting distance has been reached. Similarly, Polèse and Shearmur (2006) highlight that in Canada, out-migration from peripheral regions increases during periods of national economic expansion.

[8]Reverse commuters refer to people who reside in the central city but who work in the suburbs or in nearby rural areas. As shown by Glaeser *et al.* (2001), the number of reverse commuters increased by 4.7% per year from 1980 to 1990 in the U.S., providing evidence of the increasing role played by urban amenities on the location choices of households.

According to Polèse and Shearmur (2006), in Canada, and more generally in countries characterized by a core-periphery structure and having completed their demographic transition[9], "peripheral regions are destined to decline" (*i.e.* to lose jobs and population). Indeed, while employment in the traditional resource sector is decreasing[10], other industries do not locate to peripheral areas because of the continued impact of distance on firms' location choices and because the "intrusive rentier syndrome" may discourage the emergence of new sectors[11]. In other words, peripheral regions are suffering from a decline in the traditional resource sector but are not managing to diversify in other industries, leading to a decline in employment, which, in turn, leads workers to move to central regions with higher employment opportunities.

As a consequence, the propensity for workers to migrate is usually much higher in remote areas. For example, in the United States, individuals in remote non-metropolitan areas are two to three times more likely to migrate than those in non-metropolitan areas close to urban centers (Jordan *et al.*, 2011). Over the last 50 years, remote communities have thus been slowly declining and many of them have even disappeared. As Kilkenny (2010) points out, nowadays in the U.S., remote areas have become both smaller and more dispersed geographically.

The higher emigration rate in remote areas is likely to be particularly harmful for their economic development (Kilkenny, 2010). Indeed, out-migration leads to a reduction in the local tax base, which increases the fiscal burden of the remaining individuals and can reduce the provisions for local public goods. Moreover, as is well-known, migration is selective (Greenwood, 1997). The departure of the most educated and skilled workers is likely to reduce productivity and innovation and thus, long-term economic growth in remote areas. Finally, out-migration further reduces the size of the local market and thus, makes it even more difficult to attract new industries to remote rural areas.

[9] In countries that have completed their demographic transition, natural growth rates are close to zero. As a result, the growth (decline) of the local population is almost entirely determined by net out-migration.

[10] Technological change and new production methods have led the primary sector to increasingly concentrate in urban areas. In addition, and more importantly, the availability of natural resources has decreased and thus, the exploitation of a number of natural resources is no longer profitable.

[11] This syndrome, which was first described in Polèse and Shearmur (2002), refers to a Dutch disease phenomenon at the regional level. Specifically, when resource-based industries are highly capital intensive, the local economy is usually dominated by a handful of companies. As these industries are highly capitalized, labor costs are only a very small component of total costs so that industries are able to pay high wages to their laborers. However, high wages paid by large companies make it difficult for smaller businesses to start up and discourage them from investing in workers. This discourages the emergence of sectors other than natural resource-based industry sectors.

3.2.5 Heterogeneity of urban effects

Urban effects on nearby rural areas are likely to be heterogeneous. For example, in the U.S. during the 1980s, while 25% of non-metropolitan counties adjacent to a metropolitan area grew faster than the national average, as much as 40% lost population (Barkley *et al.*, 1996).

The literature has shown that urban effects varied according to the characteristics of both cities and rural communities. First, urban effects are likely to vary according to a number of characteristics of the rural communities, such as tax rates, amenities, size and industrial composition of the rural community (Khan *et al.*, 2001; Partridge *et al.*, 2007a). For example, rural areas providing a number of basic public services are much more attractive for households and thus, are more likely to benefit from the decentralization of urban population (Henry *et al.*, 1997). Second, urban effects are likely to vary according to a number of characteristics of a given city, such as city' size, growth rate or industrial structure (Barkley *et al.*, 1996). For example, cities with a more developed and faster growing service sector are more likely to generate positive effects on nearby rural areas through the relocation of industry from the downtown area to the close periphery.

Perhaps the most important issue when dealing with heterogeneity consists in investigating whether or not different cities (usually in terms of size) have different impacts. Indeed, in terms of urban-planning, it is of primary importance to understand whether the optimal policy consists in promoting the development of a few huge cities or in focusing on the development of a network of medium-sized cities scattered across the territory. While the New Economic Geography only considers the role of the aggregate market potential effects, Mark Partridge has been pointing out for several years that NEG representation is "too blunt" for providing relevant policy recommendations regarding the role of cities in rural development. According to Partridge, the city type significantly determines the magnitude (or even the sign) of urban effects on rural areas and thus, empirical observations would be more consistent with the Central Place Theory (Christaller, 1933) than with NEG models. According to the Central Place Theory (CPT), higher-order services are only available in higher-tier cities so that there would be additional benefits to being close to a large city. Thus, contrary to NEG models, which consider the aggregate market potential, the CPT emphasizes that different tiers within the urban hierarchy generate various effects. Considering elements from the CPT would thus enable researchers to provide more nuanced policy recommendations by highlighting the role played by different cities in rural development. We will further discuss this issue when presenting empirical findings (Section 3.3) and when discussing the measure of urban proximity to use in this dissertation (Section 3.4.3).

Summary

In this section, we have reviewed the mechanisms by which cities may enhance, or impede, the economic development of the hinterland. There is no doubt that rural economic development significantly depends on urban proximity. Rural areas close to cities benefit from a locational advantage, which may lead them to benefit from higher employment opportunities and population arrivals. Even if they may suffer from some backwash effects, overall spread effects are likely to prevail as we will see in the next section. On the contrary, the distant periphery has very few assets and thus, struggles to develop economic activities. In addition, the difficulties of remote areas are compounded by the fact that capital and their most efficient workers are induced to move to cities so that such areas are threatened by diversification. As a consequence, one major reason for the heterogeneous development of rural areas would be differences in urban proximity.

3.3 Empirical evidence for developed countries

The previous section has presented the different mechanisms by which urban proximity (including proximity to cities, city' size and city' growth rate) can enhance, or on the contrary reduce, employment and population in nearby rural areas. As cities may produce at the same time positive and negative effects on nearby rural areas, a number of empirical analyses have estimated the *net* effect of cities on rural areas.

On the whole, empirical studies have estimated that growing cities may produce significant net spread effects on their closest rural neighbors[12]. For example, Barkley *et al.* (1996) observe that in the U.S., urban growth leads to a decentralization of the population in the central city, leading in turn to an increase in population for rural areas located within 30-40 miles

[12]Hugues and Holland (1994) is a notable exception. Using input-output models, the authors find that growth in the core produces very few spread effects on the periphery in the State of Washington. According to the authors, as industries in the core have weak backward linkages to industries in the periphery, shocks in the major industries in the core have very little impact on industries in the periphery.

from the center[13]. Henry *et al.* (1997) provide additional evidence on urban spillover effects in the U.S. Interestingly, the authors highlight that rural areas where governments provide basic public services are much more attractive for households and firms. More recently, Barkley *et al.* (2006) have confirmed that in the U.S., urban growth significantly enhances both population and employment growth (and to some extent growth of earnings per worker) in adjacent non-metropolitan counties. While all the previously quoted studies were carried out for the U.S., Henry *et al.* (1999) and Schmitt and Henry (2000) provide evidence for other developed countries. Henry *et al.* (1999) estimate that urban growth generally enhances rural employment and population growth in Denmark, France and in the U.S. Moreover, using data on six French regions, Schmitt and Henry (2000) find that urban employment growth strongly stimulates rural population growth. On the other hand, however, urban population growth appears to have little effect on rural employment growth.

One potential drawback of the previously mentioned studies is that they only consider the impact of cities on their "closest" rural areas, assuming that cities have no effect on rural areas beyond a given distance. For example, Barkley *et al.* (1996), Henry *et al.* (1997), Henry *et al.* (1999) and Schmitt and Henry (2000) have focused on the effect of urban areas on rural communes located within the commuting distance. Moreover, Barkley *et al.* (2006) have investigated the impact of metropolitan counties on non-metropolitan counties sharing a common border. Interestingly, some recent studies have estimated the geographic scope of urban spillover effects without *a priori* limiting urban effects to the commuting distance. Thus, using nationwide data on Canada, Partridge *et al.* (2007a) estimate that cities produce significant effects on rural areas over several hundreds of kilometers, *i.e.*, well beyond what is generally assumed. Specifically, while urban spread effects dominate over about 175 km, urban growth would generate backwash effects on rural communities located beyond 175 km from the urban center. Similarly, using nationwide data on the U.S., Ganning *et al.* (forthcoming) have estimated that large urban centers may produce spread effects over about 140 miles.

In addition, several studies have emphasized that urban effects are heterogeneous according

[13]However, the authors show that urban spread effects disappear quickly over space as urban growth has no effect, or even negative effects, on population in rural areas located beyond 30-40 miles from the urban center. However, as noted by the authors, this probably arises from the fact that they use a sample of counties that contains relatively small cities. As a result, few diseconomies of scale (in terms of housing costs, input costs, criminality) are likely to occur in their sample and thus, the relocation of the urban population to nearby rural areas is likely to be limited.

to city size. Partridge *et al.* (2007a) have provided a very comprehensive study on urban effects by disentangling the effects of (i) distance from urban areas, (ii) city size and, (iii) urban growth. According to them, both distance to city, city size and city growth rate matter for rural areas. Indeed, they estimate that greater distance to the nearest urban center and to mega-urban centers (over 500,000 inhabitants) significantly reduces rural population growth[14]. Moreover, urban population growth would produce significant spread effects on rural population growth. Similar results can be found in Partridge *et al.* (2007b). Finally, Ganning *et al.* (forthcoming) show that larger cities not only produce higher spread effects, but also that the spread effects they generate extend over a broader distance.

Finally, we may wonder whether the appearance of new communication technologies and the decline in transport costs have reduced the disadvantages of remoteness over time. However, recent empirical works have estimated that distance still significantly determines firm location. Thus, in spite of the appearance of new communication technologies and the decline in transport costs, very few industries are locating to peripheral regions. For example, Polèse and Shearmur (2004) have shown that location patterns of different industrial sectors in Canada remained heavily sensitive to both distance to metropolitan areas and city size between 1971 and 1996. Moreover, the location pattern of some industrial sectors, especially the service sector, became even more sensitive to distance and urban hierarchy effects over the period. According to the authors, while recent technological change has reduced transport costs, the production process of most activities still heavily depends on the characteristics of locations. For example, producing knowledge-based service activities requires locating in areas with a large pool of educated workers. Similarly, Partridge *et al.* (2008) show that while proximity to higher-tiered urban centers and market potential significantly stimulated rural growth over the period 1950-2000, the effect has become larger since the 1970s. According to the authors, the increasing cost of remoteness may arise from the fact that higher-end services, which are only available in large urban centers, are increasingly important for production, leading firms to more heavily agglomerate close to cities. Moreover, innovative technologies are almost exclusively available in large urban centers, which makes remote counties increasingly disadvantaged. A similar observation is made by Barkley *et al.* (1996), who point out that new productions (such as

[14] The authors also find that the negative effect of distance on rural population growth diminishes when one moves further away from the urban area.

business services) and new production methods (such as vertical disintegration or just-in-time inventory replacement) have led firms to increasingly set up in areas with a good supplier and market access. According to Kilkenny (2010), remote areas also remain disadvantaged because, in spite of the decline in transport costs, the use of transport has increased and commodities are increasingly carried by high-cost transport (such as truck transport) instead of low-cost transport (such as railway). In addition, while transport costs of goods have declined, the cost of moving people remains high.

3.4 Urban proximity and rural development in China

The present section begins by discussing whether the transmission channels previously presented may be relevant to understand urban effects on the hinterland in China. After that, we will present the few empirical studies investigating whether cities affect rural development in China. This will help us to discuss how to measure urban proximity in the Chinese context.

3.4.1 Relevancy of the analytical framework in the Chinese context

Section 3.2 has presented the transmission channels by which cities may affect the hinterland. As most studies have been carried out in the context of developed countries, and especially of North America, it is necessary to discuss whether or not these transmission channels seem relevant in the Chinese context. To our knowledge, there is no study which explicitly discusses whether or not Western theories on urban effects are relevant in the Chinese context.

3.4.1.1 Urban proximity and rural employment

Studies on urban effects in developed countries have emphasized that rural areas close to cities are likely to benefit from a higher demand for rural labor. As explained in Section 3.2.1, this can be due to several mechanisms: (i) commuting, (ii) inter-industry linkages, (iii) pecuniary and production externalities and, (iv) relocation of urban firms to rural areas close to cities.

In our view, all four of these mechanisms may also be at work in China. First of all, one may wonder whether rural workers in China, where transportation is much less developed, manage to commute to nearby urban areas. Indeed, because of poor transportation, even rural workers close to cities could be unable to access urban jobs without migrating (Partridge *et al.*, 2007a). However, as Xu (2001) highlights, commuting of rural workers to nearby urban areas is far from being a marginal phenomenon in China. According to a nationwide survey, 42% of town workers are composed of commuters. Moreover, commuting is even more significant in Eastern China: as much as 64% of town workers were commuters in the Yangtze River delta. According to Xu, the very specific land tenure system[15], the restricted access of migrants to urban benefits[16] and the improvements in transportation explain the high number of commuters from rural to nearby urban areas in China. Thus, it appears that rural workers close to cities manage to get access to urban jobs, contrary to remote workers who have no choice but to migrate to work in urban areas.

In addition, in China rural workers usually also benefit from a higher number of job opportunities directly in their *own* rural community, compared with remote workers. As in developed countries, in China rural areas close to cities have a more developed industrial sector thanks to inter-industry linkages, the presence of pecuniary and production externalities and the relocation of urban firms. First, the rural non-agricultural sector (Township and Village Enterprises) has mainly developed close to cities because: (i) a large proportion of rural industries has been engaged in subcontracting with urban firms and (ii) areas close to cities benefit from location advantages (Naughton, 2007). Second, an increasing number of urban firms have been relocating to nearby rural areas. Indeed, congestion costs have appeared in some large cities over the last few years, leading cost-sensitive industries to relocate to the nearby periphery. Moreover, as the service sector develops in urban China, industry is relocating to nearby smaller cities and counties (Chan *et al.*, 2008).

As a consequence, rural workers close to cities are very likely to benefit from a much higher

[15]In China, households receive a quantity of land which is proportional to the number of members in the household. Moreover, land remains collectively owned and is periodically reallocated among households in the village, especially because of demographic changes. In this context, households with migrant workers run the risk of being deprived of part of their land (de la Rupelle *et al.*, 2010) and thus, rural workers usually prefer commuting to migrating.

[16]Rural migrants in cities suffer from bad living conditions, are often separated from their family and are poorly look upon by urban dwellers. For these reasons migration is “2nd best” work: workers only decide to migrate when they have no possibilities to work locally or to commute (Zhao, 1999; Guang and Zheng, 2005).

number of job opportunities, particularly in the non-agricultural sector, than remote workers. In our opinion, cities are likely to play a crucial role on rural development by enhancing the number of job opportunities given that labor surplus remains considerable in Chinese rural areas[17] (Golley and Meng, 2011).

3.4.1.2 Urban proximity and rural population

Studies on developed countries have emphasized that rural areas close to cities usually benefit from a positive population growth rate whereas remote areas are declining (Kilkenny, 2010). One major explanation of such a phenomenon is that urban households increasingly relocate to nearby rural areas, where housing costs are lower and where they can enjoy natural amenities, while retaining access to urban consumption amenities.

Obviously, this transmission channel is not relevant in China, where population flows are still from rural to urban areas, as was the case for developed countries until the end of the 1960s and early 1970s (Saraceno, 1994). In China, the rural population is currently looking for (better paid) jobs and for a higher standard of living in urban areas and there is no migration flow from urban to rural areas.

In spite of that, however, in China rural areas close to large cities may have a higher population growth rate than remote rural areas. Indeed, as many migrants cannot afford to rent accommodation in cities, an increasing number of them is forced to settle in what is known as "urban villages" (Henderson, 2010). Urban villages, which are located in rural areas close to cities, are very similar to slums in other developing countries. Thus, while urban proximity may increase population in areas close to cities in China, this cannot be considered as a spread effect but much more as a backwash effect as it leads to the development of slums.

3.4.1.3 Negative effects of cities on nearby rural areas

Studies on developed countries have emphasized that urban proximity may generate negative effects on nearby rural areas. Specifically, we explained that urban proximity could threaten

[17] The rising trend in real wages in urban areas could lead one to conclude that China has reached the Lewisian turning point and is no longer a surplus labor economy (Zhang *et al.*, 2011). However, because of the very specific institutional context in China (*hukou*), the country is actually in a situation where a huge rural labor surplus coexists with rising wages in rural areas (Knight *et al.*, 2011).

the viability of rural firms by increasing competition. However, empirical studies on developed countries have estimated that on average, spread effects prevail over backwash effects.

In our opinion, cities may be more likely to generate negative impacts on nearby rural areas in China because the country is at a lower stage of economic development. Indeed, as some Chinese cities (especially county-level cities) have a very similar economic structure to rural areas, they are very likely to compete with and thus, to lure resources from rural areas. As we will see, Ke and Feser (2010) have estimated that in China, the least developed cities produce net backwash effects on nearby rural areas in the non-agricultural sector.

In addition, cities may generate additional negative effects on rural development in China because of the specific "city administering county" system. As described in Chapter 2 of this dissertation, prefecture and provincial-level cities administer rural counties. While this administrative arrangement was implemented in order to facilitate urban-rural interactions, it has in fact created opportunities for cities to exploit their administered rural counties. For example, cities are used to paying depressed prices to obtain resources from their administered counties (Ma, 2005). Moreover, while city leaders receive funds for the whole administrative area, they often retain most of the funds for the city. This administrative arrangement has also enabled cities to more easily requisition farmland, which has disastrous consequences for rural workers, as already highlighted in the general introduction.

3.4.1.4 Negative effects of cities on remote rural areas

Studies on developed countries have pointed out that urban backwash effects are much more prevalent in remote areas, especially beyond the distance that makes commuting impossible and/or exchange with the urban market too costly (Partridge *et al.* 2007a). As previously explained, remote rural areas may suffer in particular from the departure of their most efficient workers.

This channel is also very likely to be at work in China. Indeed, as stated in Section 3.4.1.1, rural areas close to cities benefit from a much more developed non-agricultural sector. Thus, rural workers close to cities benefit from a higher number of job opportunities and can access more stable and income-generating activities[18]. By contrast, in remote areas, workers suffer

[18]Indeed, non-agricultural activities are on average significantly more remunerated and generate more stable income than agriculture.

from underemployment and very few opportunities exist to generate income. As a result, remote workers have no other solution but to migrate to cities (Knight and Song, 2003). Out-migration from rural areas is a widespread phenomenon in China: over the last 10 years, out-migration has led to the disappearance of about 900,000 villages across China[19].

To summarize, studies on developed countries have highlighted a number of mechanisms by which cities may affect rural development. The majority of these mechanisms could also be at work in the Chinese context. However, cities may generate additional negative effects on nearby rural areas in China, in particular because of the similarity between the economic structure of some cities and counties and because of the "city administering county" system.

3.4.2 Empirical evidence on urban effects on rural areas in China

A few recent studies have investigated whether cities enhance growth in nearby rural counties in China (Ke, 2010; Ke and Fesert 2010; Chen and Partridge, 2011). One major finding of these works is that urban effects vary a great deal according to the city type. For example, Ke and Fesert (2010) estimate that in Central China, non-agricultural growth in large cities (prefecture and higher-level cities) enhance non-agricultural growth in nearby rural counties whereas county-level cities produce backwash effects on nearby counties. According to the authors, because of their similar economic structure, county-level cities and rural counties are competing. Thus, counties close to county-level cities suffer from backwash effects because rural non-agricultural activities relocate to the nearby growing urban center in order to benefit from agglomeration economies. On the contrary, counties close to large cities may benefit from the relocation of industries due to tertiarization and to the increase in factor prices. Similarly, while Chen and Partridge (2011) find that on the whole, cities significantly increase GDP per capita growth in nearby rural counties, the authors estimate that different cities produce very different impacts. Specifically, while prefecture-level cities produce significant spread effects on rural GDP growth, mega-cities produce backwash effects. Combining the results from these two studies, it appears that both cities at the bottom (county-level cities) and at the top (provincial cities) of the hierarchy generate backwash effects on nearby rural counties whereas prefecture-level cities produce spread effects on nearby rural areas.

[19]Information available on the website of the Embassy of France at: http://www.ambafrance-cn.org/900-000-villages-disparus-en-dix-ans.html [as seen on 04.05.2013].

In our opinion, if empirical studies on both developed countries and China have demonstrated that urban effects vary according to the city type, there is a stark contrast between these studies. On the one hand, most studies on developed countries have demonstrated that the *magnitude of spread* effects varies according to city type. In other words, on the whole it seems that urban proximity is almost always good for rural development in developed countries. By contrast, studies on China have shown that the *type of spillovers* (spread vs backwash) varies with city type. In other words, in developed countries some cities generate larger spread effects than others while on the contrary, in China, some cities produce spread effects while other cities generate backwash effects on nearby rural places. As a result, it seems that urban spread effects are much less predominant in China than in developed countries. This is consistent with Hirschman (1958), who assumes that at the first stages of development, core areas may lure resources, generating backwash effects on peripheral areas. However, in the long-run, once cities develop, they may generate spread effects on peripheral areas.

Regarding the spatial reach of spillover effects, both Ke (2010) and Ke and Feser (2010) estimate that most urban spillover effects occur within 100 km from the urban center. Thus, the geographical reach of urban effects is much more limited in China than that estimated for the U.S., which is not surprising given differences in the development of communication and transportation networks. Administrative and institutional constraints on the circulation of goods, materials and people, as well as greater cultural differences, are also likely to reduce the geographic scope of urban effects in China.

3.4.3 Measuring urban proximity in China

3.4.3.1 Distance to city, city size and/or city growth rate

Previous studies have emphasized that distance to city, city type and/or city growth may significantly determine rural development. On the whole, there are two broad types of studies, and thus two different ways to measure urban influence on the hinterland, depending on the framework the studies are based on.

A first category of works is based on the growth pole theory. Following this theory, urban influence is measured by the growth rate of nearby cities (see Ke (2010) and Ke and Feser (2010) for China). Specifically, a spatial lag variable, measuring growth in nearby cities, is constructed to estimate whether this growth significantly affects the growth rate of rural counties. Urban influence is then measured as:

$$UrbanProx_i = \sum_{j=1}^{J} \frac{Growth_j}{DIST_{ij}} \tag{3.1}$$

where i refers to the rural county and j to the city. $DIST_{ij}$ is the number of kilometers[20] from county i to city j and $Growth_j$ is the population or employment growth rate of city j. By introducing this spatial lag variable in a growth function for rural counties, these studies intend to estimate whether urban employment and population growth stimulate or slow employment and population growth in rural areas.

A second category of works is based on the NEG and agglomeration economies theory. In this case, urban influence is measured by the size of nearby cities, also referred to as "market potential" (see Chen and Partridge (2011) for China). The most common way to test for market potential effects is to use the measure proposed by Harris (1954). Urban influence is then measured as:

$$UrbanProx_i = \sum_{j=1}^{J} \frac{Size_j}{DIST_{ij}} \tag{3.2}$$

where i refers to the rural county and j to the city. $DIST_{ij}$ is the number of kilometers from county i to city j and $Size_j$ is the size of city j. With this approach, the market potential variable does not intend to capture spread or backwash effects but rather inter-industry linkages and production and pecuniary externalities.

In the present dissertation, we will follow Chen and Partridge (2011) by constructing market potential variables to measure how urban proximity affects the level of agricultural efficiency (Chapter 4), the level of non-agricultural wages (Chapter 5) and the location choices of polluting firms (Chapter 6)[21]. Indeed, as we will highlight in the next three chapters, agricultural

[20]Remoteness is a function of both physical distance, *i.e.* the number of kilometers, and frictional distance, *i.e.* distance due to lack of infrastructure (Bird and Sheperd, 2003). As a result, the more relevant consists in taking into account both the number of kilometers from urban centers and transport facilities. Luo (2004) has proposed an indicator of "peripheral degree" to measure the effective remoteness of Western provinces from Coastal provinces, by adjusting physical distance by the level of infrastructure. Interestingly, Luo *et al.* (2014) have used this indicator to assess the role of remoteness on regional economic growth in Western China and to estimate the effect of transportation infrastructure investments on regional and national growth. Unfortunately, data on infrastructure is not available for rural counties.

[21]While in Chapter 4 we will exclusively use market potential variables, we will use additional indicators to measure urban influence in Chapters 5 and 6 due to greater data availability (Chapter 5) or to test for transmission channels (Chapters 5 and 6).

efficiency, non-agricultural wages and the location choices of polluting firms are more likely to be affected by inter-industry linkages and production and pecuniary externalities than by urban growth, which justifies our choice for measuring urban proximity.

3.4.3.2 How to measure city size?

As shown in Equation 3.2, to measure urban influence we must use information on city size. City size may alternatively be measured by the population or by the GDP of the city. In this subsection, we explain why the increase in the "floating population" has raised concerns about the accuracy of city population data provided in the City Statistical Yearbooks. Specifically, the population of a number of cities may be seriously underestimated in the City Statistical Yearbooks and thus, it seems much more relevant to use the city's GDP to measure city size.

Since the 1980s, the household registration system has been liberalized (Naughton, 2007). First, while it remains difficult to obtain *hukou* in large cities, it has became quite easy to obtain an urban *hukou* in towns and small cities. Second, for recently graduated students from good colleges and for wealthy individuals, it is now quite easy to obtain an urban *hukou*. In spite of this, however, for most rural migrants the liberalization of the *hukou* system has not made the obtention of an urban *hukou* easier in practice. In fact, the main change which has occurred since the 1990s is that it has become much easier for rural migrants to work in cities without the local urban *hukou*.

Due to the household registration system, there are two different kinds of migration in China: "hukou migration" and "non-hukou migration". Hukou migration refers to migrants who have obtained the *hukou* of their destination community and thus, are officially registered as residents in their destination community. As the liberalization of the *hukou* has not made the obtention of the urban *hukou* much easier, hukou migration has remained relatively stable in the last decades (Brandt *et al.*, 2008). Non-hukou migration (or temporary or floating migration) refers to migrants who are living in a given destination community without having acquired the local *hukou*. In practice, most non-hukou migration is made up of rural migrants who work and live in urban areas without an urban *hukou*. While the floating population was very low before the 1990s due to the very stringent implementation of the household registration system, it has significantly increased since the late 1990s. According to Census data, it increased from

11.44 million in 1982 to 29.73 million in 1990 and to 54 million in 1995. According to the 2000 Census, the floating population accounted for 153.19 million people, including 117.5 million in cities, which accounts for 25.6% of the urban population (Xu, 2008)[22]. According to the most recent estimates, as much as 31% of the urban population is composed of temporary migrants[23].

The increase in non-hukou migration has led to a serious underestimation of city population. The problem is particularly severe for cities in coastal provinces (especially in Guangdong, Fujian, Jiangsu and Zhejiang provinces), which receive a very high number of temporary migrants, as well as in municipalities. For example, the floating population in Beijing and in Shenzhen is estimated to account for about 36% and 75% of the city population respectively (Duan, 2011).

To tackle this problem, since 1982, censuses have provided a *de facto* measure of urban population by including temporary migrants who have been living in a given city for at least one year (1982; 1990 Censuses) or six months (2000 Census). However, the annual city-level population data provided in the City Statistical Yearbooks still suffer from inconsistency. Indeed, the City Statistical Yearbooks provide a *de jure* measure of urban population by only accounting for permanent residents, *i.e.* those with local urban *hukou*. Thus, data from the City Statistical Yearbooks may seriously underestimate the actual urban population as it only includes some registered migrants (Chan *et al.*, 2008). As a consequence, and following Chen and Partridge (2011), we will use city GDP to construct our indicators of urban proximity in this dissertation. Thus, urban influence will be measured as:

$$UrbanProx_i = \sum_{j=1}^{J} \frac{GDP_j}{DIST_{ij}} \tag{3.3}$$

where i refers to the rural county and j to the city. $DIST_{ij}$ is the number of kilometers from county i to city j and GDP_j is the Gross Domestic Product of city j.

[22]The definition of non-hukou migrants used in the 2000 Census is less restrictive than the definition used in the previous censuses which considered as temporary migrant every individual who had been living in a given community more than one year without local *hukou*. The 2000 Census has reduced the minimum stay to six months, which automatically increases the number of non-hukou migrants. In spite of this change in definition, the 2000 Census data highlights that there has been a huge increase in temporary migration.

[23]Kam Wing Chan, "Path to Riches is Paved Through Cities", *China Daily*, May 25, 2012.

3.4.3.3 Taking into account city type

As already pointed out, the literature has emphasized that different cities may produced different impacts on nearby rural areas. For Canada and the U.S., it has been shown that more populated cities produce larger benefits on nearby rural areas (Partridge *et al.*, 2007a; Partridge *et al.*, 2009). Indeed, larger cities provide higher-order services and higher production and pecuniary externalities. While studies on China have also highlighted that urban effects vary according to the type of city, the distinction is not based on city *size* but on city *administrative rank* (Ke, 2010; Ke and Fesert 2010; Chen and Partridge, 2011). As already explained in Chapter 2, there are three *de jure* types of cities in China, which are from top to bottom: provincial, prefecture and county-level cities.

We believe that it is indeed much more relevant to classify cities according to their administrative rank to study urban effects on the hinterland in China. First, the administrative rank of cities is well correlated to city size, political and economic powers, and economic development level. Thus, distinguishing urban effects according to city administrative rank makes it possible to capture the fact that larger cities may generate higher production and pecuniary externalities (Ma, 2005; Chan *et al.*, 2008). Second, in terms of policy recommendation, it is much more meaningful to compare the role of higher-ranked versus lower-ranked cities than to compare the role of larger versus smaller cities. Indeed, the Chinese government has been favoring higher-ranked cities for a long time[24]. Thus, in terms of urban-planning, it is crucial to investigate whether favoring the development of a few high-ranked cities is better to enhance rural development than focusing on the development of a network of low-ranked cities.

To empirically assess whether different tiers in the urban hierarchy produce different effects, one must create three different market potential variables to separately estimate the effect of provincial, prefecture and county-level cities:

[24] Since 1978, Chinese urban policy has tried to control the size of large cities and to encourage the growth of small cities. However, in spite of this, the Chinese government has continuously favored higher-ranked cities. For example, higher-ranked cities benefit from more fiscal resources and from more investment, which results in much higher investment in roads than in lower-level cities. Higher-ranked cities also benefit from favorable policies in terms of FDI and land development (Chan *et al.*, 2008). As a consequence, there is a contradiction between the urban policy's stated aim of encouraging the growth of smaller-ranked cities and the actual situation as smaller-ranked cities suffer from policy disadvantages, which slow down their development (Chan and Zhao, 2002).

$$UrbanProxProvincial_i = \sum_{j=1}^{J} \frac{GDP_j}{DIST_{ij}} \tag{3.4}$$

where i refers to the rural county and j to the provincial-level city.

$$UrbanProxPrefecture_i = \sum_{j=1}^{J} \frac{GDP_j}{DIST_{ij}} \tag{3.5}$$

where i refers to the rural county and j to the prefecture-level city.

$$UrbanProxCounty - level_i = \sum_{j=1}^{J} \frac{GDP_j}{DIST_{ij}} \tag{3.6}$$

where i refers to the rural county and j to the county-level city.

3.4.3.4 The specific case of county-level cities

While county-level cities are officially designated as cities, a number of studies do not consider them as *de facto* cities. For example, in their study on inequality in Zhejiang Province, Ye and Wei (2005) have considered both county-level cities and rural counties as rural entities. Similarly, to investigate the determinants of city growth, Zhu *et al.* (2012) have focused on cities at prefecture level and above.

Studies on urban effects on the hinterland also differ in the way they consider county-level cities. On the one hand, Chen and Partridge (2011) have estimated the effects of prefecture and higher-level cities on both rural counties and county-level cities. On the other hand, Ke and Feser (2010) have estimated the effects of both county-level and higher-level cities on rural counties.

There are reasons to consider county-level cities both as cities and as rural entities. On the one hand, as county-level cities are officially designated as cities, they benefit from more favorable policies, such as receiving more government revenue (Fan *et al.*, 2009). For this reason, it may be more relevant to consider county-level cities as cities. On the other hand, as explained in Chapter 2, the "turning counties into cities" policy has led a number of jurisdictions to be designated as county-level cities even if they remain fundamentally rural. Thus, it seems that on the whole, county-level cities are very similar to counties in terms of economic growth, provision of public services, industrial employment and ratio of immigrants to total population (Fan *et al.*, 2009), which may lead one to consider them as *de facto* rural entities.

In our opinion, given that there are reasons to consider county-level cities as both cities and as rural entities, the best option is the following: (i) to take into account the potential role of county-level cities on rural counties, but (ii) to distinguish the effects of county-level cities from those of higher-level cities. Creating three different market potential variables to separately estimate the effects of provincial, prefecture and county-level cities will enable us to do that.

3.5 Conclusion

This chapter has reviewed the literature on the role of cities in rural development. In developed countries, cities significantly increase employment and population in nearby rural areas. Close to cities, rural areas benefit from significant externalities and from urban spread effects. However, these benefits attenuate with distance to the urban center. Moreover, spread effects may turn into backwash effects beyond the distance that make commuting impossible and/or exchange with the urban market too costly. As a result, in developed countries most empirical evidence supports the view that urban proximity is good for rural development.

As most studies have been carried out in the context of developed countries, we have discussed the relevance of this framework in the Chinese context. In our opinion, most of the mechanisms at work in developed countries may also be relevant in China. However, it appears that cities may produce additional negative effects on rural areas in China. Indeed, the country is at a lower stage of development and thus, the least developed cities and rural areas may be competing. Moreover, the "city administering counties" system has enabled cities to exploit their administered rural counties.

A few recent studies have analyzed whether cities may enhance rural development in China and have found more nuanced results than in the case of developed countries. Thus, while some cities seem to produce spread effects on nearby rural areas in China, other cities may produce backwash effects. In addition, we have wondered about the relevant measure of urban proximity to empirically assess the effect of cities on the hinterland in China.

This chapter was a necessary stage to go through before carrying out the empirical analyses in this dissertation. Indeed, it has enabled us to learn about the existing works on urban effects on the hinterland and thus will make it easier to understand the contributions of the following three empirical analyses. In addition, it was necessary to think about the relevant measure of urban influence in the Chinese context. As highlighted, it seems crucial both to assess whether the different tiers in the urban hierarchy produce different effects and to use information on city GDP to measure city size.

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Chapter 4

Urban Proximity and Agricultural Efficiency

This chapter is an adapted version of an article untitled "Does Urban Proximity Enhance Technical Efficiency? Evidence from Chinese Agriculture", accepted for publication in the *Journal of Regional Science*.

4.1 Introduction

Agricultural productivity growth is a real challenge for China today. First, given the increase in food demand and the growing shortage in arable land[1], agricultural productivity growth is the only solution to avoid importing large quantities of food. Second, although non-agricultural activities represent a growing share of rural households' income, agriculture remains a significant source of income for most of them. Then, to reduce rural poverty and inequalities between rural and urban areas, there is a need to raise agricultural productivity (Liu and Zhuang, 2000). Finally, because of intersectoral linkages, agricultural growth has a positive effect on the development of non-agricultural activities (Haggblade *et al.*, 2002). Thus, agricultural productivity is both important in terms of alimentary self-sufficiency, poverty reduction and economic development. That is why, many papers try to disentangle the determinants of agricultural productivity in China. For instance, the effect of agricultural reforms (Fan, 1991; Lin, 1992; Brümmer *et al.*, 2006), infrastructures (Fan and Zhang, 2004), migration (Taylor *et al.*, 2003) and environmental degradations (Rozelle *et al.*, 1997) have been investigated.

An interesting fact in China is that all the components of agricultural productivity have not experienced the same evolution (Kalirajan *et al.*, 1996; Mao and Koo, 1997; Yao and Liu, 1998; Wu *et al.*, 2001; Chen *et al.*, 2008). Changes in total factor productivity can be broken down into technical change and technical efficiency change[2] (Coelli *et al.*, 2005). In China, technical change is the strength of agriculture as it contributes the most to total factor productivity (TFP) growth. On the contrary, technical efficiency would be the weakness of Chinese agriculture as it is both low and decreasing and, therefore, negatively contributing to TFP growth[3]. That is why, we argue that agricultural efficiency is a fundamental outcome in analyzing urban spillover effects on the hinterland. Consistently, many papers study its determinants (Liu and Zhuang, 2000; Chen and Song, 2008; Chen *et al.*, 2009; Monchuck *et al.*, 2010).

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[1] Between 2001 and 2008, although population increased by 4%, cultivated area fell by nearly 6.5%. Moreover, before that, the arable land area in China was already far below the world average as it was only 0.11 hectare per capita in 2000 (Tan *et al.*, 2005)

[2] Technical efficiency measures the ability to produce the maximum output which can be produced given the inputs and the technology. A producer is considered as technically inefficient if its effective production level is lower than the maximum output it could produce. A more detailed definition will be given in Section 4.2.1.

[3] According to Tian and Wan (2000) agricultural efficiency is high in China and so there is little potential to increase output by efficiency improvements. However, other studies consider that efficiency is not so high and above all declining (Yao and Liu, 1998; Chen *et al.*, 2008) so that there is room to further improve efficiency.

Literature review

The literature provides very little evidence on whether or not cities enhance the agricultural efficiency level of nearby rural areas. First, even if the agricultural economics literature has extensively investigated the determinants of agricultural efficiency, very little attention has been dedicated to the specific role of urban proximity. Second, even if the regional science literature has extensively studied whether cities produce spillover effects on rural counties, it has focused on the non-agricultural sector or on the whole economy of counties. In addition, this literature has overwhelmingly focused on the effect of cities either on rural growth or on factor prices (wages, land prices) and provides no evidence on the effect of cities on rural efficiency. Finally, the urban economics literature has provided some evidence on the effect of agglomeration on technical efficiency. However, existing studies do not explicitly test how cities affect nearby rural areas because they focus on the effects of agglomeration *within* the city or the regional boundaries.

Agricultural economics literature on technical efficiency

A few agricultural economics papers have provided some evidence on the role of cities on agricultural efficiency. For the specific case of China, Yao and Liu (1998), Monchuk *et al.*, (2010) and Zhou *et al.*, (2011) find that the higher the share of the rural population, the lower the agricultural efficiency. Moreover, Wang *et al.*, (1996) estimate that farmers living in mountainous areas are less efficient. However, these studies on agricultural efficiency in China investigate all the determinants of inefficiency and thus, urban proximity only constitutes one determinant among many others. In our opinion, the present chapter provides one of the most comprehensive studies of urban effects on rural efficiency, particularly by using a much more precise measure of urban influence and by investigating whether urban effects vary across cities and regions.

Regional economics literature on urban spread and backwash effects

A few recent studies have empirically assessed the role of Chinese cities on the non-agricultural sector (Ke, 2010; Ke and Feser, 2010) or on the whole economy of rural counties (Chen and Partridge, 2011). However, cities are likely to exert very different effects on counties, depending on whether we consider a county's agricultural or non-agricultural sector. According to Peng *et al.* (1997), if urban growth often produces spread effects on a county's non-agricultural sector, it may produce backwash effects on agriculture. For example, urban growth often fosters industrialization in neighboring counties, *i.e.* stimulates non-agricultural growth (Naughton, 2007) which, in turn, produces backwash effects on a county's agriculture. Indeed, industrialization leads to the conversion of agricultural lands and thus, results both in a decrease in farm lands, which reduces agricultural production capacities, and in a fragmentation of farm lands, which increases the costs of production (Gardner, 1994). The regional science literature provides thus very few information on the role of cities on the agricultural sector of counties.

In addition, regional science studies have overwhelmingly focused on the effect of cities either on rural growth or on factor prices (Barkley *et al.*, 1996; 2006; Henry *et al.*, 1997; Schmitt and Henry, 2000; Partridge *et al.*, 2007a; 2007b; 2009; Ganning *et al.*, forthcoming). If we acknowledge that these indicators are crucial, these studies do not provide evidence on the impact of cities on the technical efficiency level of nearby rural areas, which is a key determinant of long-term rural economic growth.

Regional and urban economics economics literature on the role of agglomeration on efficiency

A few papers have highlighted that market potential and/or agglomeration economies stimulate technical efficiency[4] (Beeson and Husted, 1989; Tveteras and Battese, 2006; Larue and Latruffe, 2009; Otsuka *et al.*, 2010; Lakner *et al.*, 2011). However, in some cases the relationship is very weak (Mitra and Sato, 2007) and diseconomies are likely to prevail after a certain level of urbanization (Mitra, 1999). On the whole, the evidence on how agglomeration affects technical efficiency remains scarce, especially for China. In addition, existing studies do not explicitly test how cities affect nearby rural areas because these studies focus on the effects of agglomeration within the urban (Mitra, 1999), the regional (Tveteras and Battese, 2006; Larue and Latruffe, 2009; Lakner *et al.*, 2011) or the State (Beeson and Husted, 1989; Mitra and Sato, 2007; Otsuka *et al.*, 2010) boundary[5]. Yet, understanding how urban areas affect rural development requires investigating the role of agglomeration economies on efficiency *beyond* the city's boundary.

[4]Among these studies, Tveteras and Battese (2006), Larue and Latruffe (2009) and Lakner *et al.* (2011) investigate agglomeration effects on technical efficiency in agriculture.

[5]One partial exception is Larue and Latruffe (2009) who take into account the effect of nearby sub-counties. However, no attempt is made to assess the effect of cities on nearby rural areas.

Contributions of the chapter

We make two contributions to the literature. First, to our knowledge, the present chapter provides the most comprehensive study on the effect of cities on the agricultural efficiency of counties in China. Specifically, we begin by a theoretical framework in which we disentangle the different channels by which urban proximity can affect the agricultural efficiency of nearby rural counties. After that, we empirically assess the net effect of cities on rural efficiency by using county-level data for the period of 2005-2009. We truly believe that our analysis sheds some light on the role of cities on both the agriculture and technical efficiency of counties.

Second, to our knowledge, we are the first to highlight that urban effects are considerably heterogeneous across Chinese regions. Ke (2010) has already estimated that urban effects on rural counties were heterogeneous between Eastern and Western China. This chapter extents the study of Ke (2010) by separating China into seven macro-regions, that differ both in terms of natural conditions and of economic development, and by allowing urban effects to vary across these regions. We estimate that while cities produce significant positive effects on nearby counties in Northeastern, Northern and Eastern regions, their effects are much less significant in the Central provinces and not significant at all for the Southwestern and the Northwestern regions.

The remainder of the chapter proceeds as follows. Section 4.2 identifies the main channels by which urban proximity can affect the agricultural efficiency of counties and highlights that urban spillovers are likely to be heterogeneous both across regions and urban tiers. Section 4.3 describes the methodology and the data. Econometric results are analyzed in Section 4.4. Section 4.5 concludes and discusses the implications of these findings in terms of urban and regional planning.

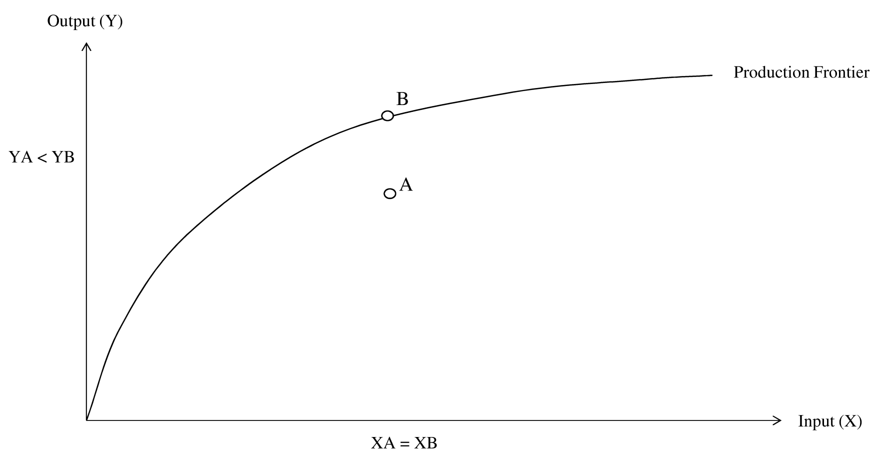
4.2 Theoretical analysis: urban proximity and technical efficiency

This section is divided into four subsections. First, we briefly define technical efficiency. Second, we disentangle the channels by which cities can affect efficiency in the hinterland. Finally, in the third and fourth subsections, we explain why urban effects are likely to vary across regions and urban tiers.

4.2.1 Technical efficiency

Producers often do not adopt the best practice methods of the application of technology, and as a result, they do not realize the full potential of the technology (Coelli *et al.*, 2005). Technical inefficiency, then, refers to the gap between the effective production level of a producer and the maximum production level he could reach, given the existing technology and the inputs used. There are three main causes of inefficiency: (1) producers lack incentives to efficiently use the technology; (2) producers do not manage to efficiently use the existing technology (lack of knowledge); (3) there is input excess. In Figure 4.1, the production frontier represents the maximum output that can be produced given the technology and the inputs. Graphically, producer A is inefficient as his production level lies below the existing production frontier. Technically, producer A could increase his output without raising the quantity of inputs employed, simply by adopting better practice methods, *i.e.* by reducing the level of technical inefficiency. Graphically, this is represented by the shift from A (the producer is inefficient) to B (the producer is fully efficient).

Figure 4.1: Output-oriented measure of technical efficiency



4.2.2 How can urban proximity stimulate agricultural efficiency in nearby rural areas?

Urban proximity is likely to work on the three causes of inefficiency: (1) producer incentives; (2) producer knowledge; (3) inputs excess.

First of all, producers close to cities face a stimulating economic environment that raises their incentives to efficiently use the entire technology. Major agricultural reforms have been implemented in China since 1978. As they reward individual efforts, they have led to important productivity gains in agriculture (Fan, 1991; Lin, 1992). Yet, market access heavily determines whether or not farmers can enjoy these opportunities. Thus, while remote farmers are forced into self-consumption, farmers close to cities benefit from significant market outlets, which encourages them to intensify labor efforts (Benziger, 1996). Moreover, proximity to suppliers and consumers reduces transport costs and thus, increases producers' profit opportunities, which could encourage them to efficiently use the technology. In addition, farmers close to cities also face a more competitive environment, due to the high number of efficient firms on the urban market, which may conduce to a reduction in X-inefficiency (Leibenstein, 1966). However, the seizure of farmland, more likely to happen in rural areas close to urban centers, could also discourage farmers in providing labor efforts[6]. Since the beginning of the transition, peri-urban areas have increasingly suffered from losses in arable land which are converted for urban uses. For example, in Beijing, Tianjin and Hebei provinces, urban areas rose by 71% between 1990 and 2000, and among the new areas converted for urban uses, 74% were farmlands. The lack of respect for leases of farmland could lead farmers to progressively give up agriculture for more secure activities and could discourage them to provide labor efforts in the agricultural sector.

Secondly, urban proximity may affect producers' knowledge regarding existing technologies. Indeed, producers close to cities can benefit from the diffusion of urban knowledge which enables them to better control existing technologies (Jacobs, 1969; Barkley *et al.*, 1996).

Last, urban proximity is likely to enhance efficiency in surrounding rural areas by reducing excess in different inputs. First, rural areas close to cities usually benefit from a much more

[6] As explained in the general introduction of the thesis, farmers have leases which give them the right to use their land but the land ownership remains collective. Although the duration of the lease has been increased these last years, reaching 50 years today, some farmers still suffer from relocation. Since land ownership is collective, the local authorities decide what to do with the land although farmland are under lease. Thus, local authorities are used to requisition farmland to dedicate them to non-agricultural uses which are more lucrative (Naughton, 2007). As non-agricultural uses are more numerous in areas next to cities, farmers have more probabilities to be expropriated in rural areas close to cities.

developed infrastructure and input suppliers network, as well as from an easier access to a wide range of services, which facilitates the sharing of indivisible inputs and facilities (Tveteras and Battese, 2006). As such, urban proximity enables producers to save on investments in indivisible inputs that are necessary for production but usually not fully utilized (for example, by enabling farmers to rent farm equipment). Second, urban proximity might enhance efficiency by reducing labor surplus in agriculture. Despite a loosening of institutional constraints on labor mobility, population movement remains very restricted in China (Chan and Buckingham, 2008). As a result, labor surplus remains considerable (Golley and Meng, 2011) and its level heavily depends on the extent of opportunities to work out of agriculture locally (Ke and Feser, 2010). As rural areas close to cities benefit from a more developed local non-agricultural sector (Knight and Song, 2003), they might bear a lower labor surplus, resulting in a higher efficiency level in the agricultural sector. All the transmission channels are summarized in Table 4.1.

Table 4.1: Urban proximity and agricultural efficiency: transmission channels

Transmission channels	**Effect on efficiency**
1. Affects producers' incentives	
1.1. Increased profit opportunities	+
1.2. Toughen competition	+
1.3. Uncertainty of land ownership	-
2. Affects producers' knowledge of existing technologies	+
3. Reduces inputs excess	
3.1. Sharing indivisible inputs and facilities	+
3.2. Reduces surplus labor	+

In addition to the aforementioned mechanisms, according to which urban proximity affect efficiency in the *agricultural* sector, urban proximity may also lead to huge efficiency gains in the *whole* economy of rural counties. In China, there are still major distortions in rural markets and there are two main sectors in rural areas: the agricultural sector, with a low level of efficiency, and the non-agricultural sector, with a high level of efficiency (Zhang and Tan, 2007). In this context, cities may have generated considerable efficiency gains in nearby rural areas by fostering structural change of the rural economy. Indeed, thanks to their locational advantage, rural areas surrounding cities have benefited from a substantial shift of labor from the lower efficient agricultural sector to the more efficient non-agricultural sector, leading to huge efficiency gains (Zhang and Tan, 2007). On the contrary, in remote areas most workers remain in the traditional agricultural sector, limiting efficiency gains. It is worth noting that our empirical analysis will not capture this last transmission channel as we focus on the effect of urban proximity on agricultural efficiency.

4.2.3 Heterogeneous urban effects across regions

Chinese provinces are traditionally grouped into three regions (Eastern, Central and Western) according to their level of economic development. Eastern China is by far the most developed and urbanized part of the country. In our view, cities might be more likely to enhance the efficiency of nearby rural areas in Eastern than in Interior provinces.

First, the infrastructure network is much more developed in Eastern China, leading rural counties to interact more with cities. A better connection between counties and cities should result in stronger urban externalities (profit opportunities, competition, uncertainty of land ownership, knowledge diffusion, diversification, and reduction in inputs excess) in Eastern China.

Second, urban proximity mainly leads to a higher demand for rural labor (and thus to a lower labor surplus) in Eastern provinces. Indeed, as Eastern counties benefit from location advantages, rural industry concentrates much more in the vicinity of Eastern cities than in the vicinity of other cities (Naughton, 2007). In addition, congestion costs have mostly appeared in large Eastern cities over the last few years. Thus, the relocation of cost-sensitive industries to nearby rural counties is primarily a phenomenon that occurs in Eastern China. Finally, as the service sector develops, industry is relocating to nearby smaller cities and counties (Chan *et al.*, 2008). However, services are both more significant and growing faster in the largest Coastal cities, leading to more firm relocations to counties close to cities in Eastern China.

4.2.4 Heterogeneous urban effects across urban tiers

Previous studies have emphasized that different cities in the urban hierarchy produce various spillover effects on counties in China (Benziger, 1996; Ke, 2010; Ke and Feser, 2010; Chen and Partridge, 2011). The effect of cities on rural efficiency is also likely to vary according to their administrative rank.

On the one hand, rural producers close to higher-level (prefecture and provincial) cities benefit from higher profit opportunities and face more competition. Services are also more developed in large cities, enhancing the relocation of industrial firms to nearby counties. Overall, counties close to larger cities may thus benefit from higher agglomeration externalities, strongly enhancing the overall efficiency level.

On the other hand, however, the largest Chinese cities, mainly provincial cities, could produce less beneficial (or even detrimental) effects on rural efficiency. First, provincial cities benefit from a higher population growth rate (see Appendix 4.A and Chan *et al.* (2008)). As a result, urban sprawl, and thus farmland requisitioning, are more likely to happen in the vicinity of provincial cities. Second, there are very high congestion costs in China's largest cities (Fu and Hong, 2011). If urban congestion can lead to the relocation of industries to nearby rural areas, cities bearing very high congestion costs can entail congestion effects in nearby rural areas, thus lowering urban externalities. Specifically, urban congestion can reduce accessibility to the urban market for nearby rural producers and thus, reduce their profit perspectives. Congestion in provincial cities can also increase commuting costs for nearby rural residents[7], resulting in lower job opportunities for rural workers than in the surroundings of smaller cities.

Finally, county-level cities are also likely to produce different spillover effects because, contrary to other cities, they have a very similar economic structure to counties given that they still heavily depend upon agriculture (see Appendix 4.A). This could lead county-level cities to compete with rural counties, setting back the development of the rural non-agricultural sector (Ke and Feser, 2010) and thus deteriorating rural efficiency.

4.3 Methodology and data

While the previous section highlights the different transmission channels by which cities can enhance rural efficiency, the empirical investigation consists in estimating the *net* effects of cities on efficiency in nearby counties. While testing the transmission channels by which cities can affect the efficiency of counties is an important area that requires further research, it is well beyond the scope of this chapter and would require additional data which is not available to us.

[7]Henderson (2002) points out that around the world, on average, commuting times increase by 80% when the city size goes from 250,000 to 2.5 million inhabitants.

Two broad types of methodologies exist to study technical efficiency: Data Envelopment Analysis (DEA) and stochastic frontiers. If both methods have their own merits, the stochastic frontier method is usually considered as the best one to study agriculture[8].

4.3.1 Stochastic production frontier

Unlike the standard production function, the stochastic production frontier relaxes the assumption that all producers are fully efficient. The stochastic production frontier model (Aigner *et al.*, 1977; Meeusen and van den Broeck, 1977) takes the following form:

$$\ln y_{it} = \beta_0 + \sum_{k=1}^{K} \beta_k \cdot \ln x_{kit} + \varepsilon_{it} \tag{4.1}$$

The error term ε_{it} is composed of two parts:

$$\varepsilon_{it} = v_{it} - u_{it} \tag{4.2}$$

where i refers to the county and t to the year. The dependant variable, y_{it}, is the output which is a function of a vector of K inputs (x_{kit}) and of a vector of unknown parameters to be estimated (β_k). The error term ε_{it} is composed of two parts: a traditional symmetric error component (v_{it}) and an inefficiency term (u_{it}). On the one hand, v_{it} is assumed to be independent and identically distributed and to follow a normal distribution centered at zero $[N(0, \sigma_v^2)]$. It is also assumed to be independent of the inefficiency term. On the other hand, u_{it} is a non-negative random variable. This component reflects the lack of ability of the producer to reach the maximum output it could produce (technical inefficiency). Indeed, the production frontier represents the maximum output that can be produced given the inputs and the technology. Thus, if $u_{it} = 0$, county i is fully efficient and its effective level of production equals the maximum potential output. However, if u_{it} is positive, then, county i is technically inefficient as its effective level of production is inferior to the maximum output it could produce. The technical efficiency score of county i at year t is obtained as:

$$TE_{it} = e(-\hat{u}_{it}) \tag{4.3}$$

[8]The DEA method does not account for noise and shocks (such as climatic shocks) and considers them as inefficiency (Coelli *et al.*, 2005). The inherent stochastic nature of agriculture leads us to use the stochastic production frontier model.

Technical efficiency corresponds to the ratio of the effective output of county i relative to the output that would be produced by a fully efficient county. Therefore, technical efficiency scores take a value between zero and one.

4.3.2 Inefficiency effects in a stochastic production frontier

In this study, we do not only seek to estimate the inefficiency component but are also interested in explaining it. More specifically, we want to assess whether urban proximity affects technical efficiency. To do that, we estimate the model for inefficiency effects in a stochastic frontier production function (Battese and Coelli, 1995). This model is composed of the following two equations:

$$\ln y_{it} = \beta_0 + \sum_{k=1}^{K} \beta_k \cdot \ln x_{kit} + v_{it} - u_{it} \tag{4.4}$$

$$u_{it} = \delta_0 + \sum_{m=1}^{M} \delta_m \cdot \ln z_{mit} + w_{it} \tag{4.5}$$

Equation 4.4 is the production frontier and Equation 4.5 is the inefficiency effects equation. The inefficiency effects (u_{it}) are independently distributed and are obtained by truncation at zero of the normal distribution with mean $z_{it}\delta$ and variance σ_u^2. It is assumed to have a deterministic and a random component. On the one hand, the inefficiency effects are assumed to be a function of a set of explanatory variables (z_{mit}) and of a vector of unknown parameters (δ_m) to be estimated (deterministic component). Thus, the Equation 4.5 enables us to identify the factors which can explain differences in technical efficiency across rural areas (of primary interest here, urban proximity). On the other hand, w_{it} is a random variable which includes the effect of the unobserved factors. It is defined by the truncation of the normal distribution with zero mean and variance σ_u^2 such that the point of truncation is $-z_{it}\delta$. This is consistent with the assumption that u_{it} is a non-negative truncation of the normal distribution with mean $z_{it}\delta$ and variance σ_u^2.

Under the assumption that v_{it} is independent of u_{it}, x_{kit} and z_{mit}, the parameters of Equations 4.4 and 4.5 are consistently estimated in one-step by the maximum likelihood. The likelihood function is expressed in terms of the variance parameters $\sigma^2 = \sigma_u^2 + \sigma_v^2$ and $\gamma = \sigma_u^2/\sigma^2$. Note that σ^2 is positive and γ, which represents the share of inefficiency term in the variance of the composed error term, lies between 0 and 1. Finally, Equations 4.4 and 4.5 are simultaneously estimated; this approach is much more preferable than the two-step one which leads to severe estimation bias[9].

4.3.3 Data and empirical model

To explicitly test whether cities produce spillover effects on counties, we estimate the model for inefficiency effects in a stochastic frontier production function using county-level data. The limited availability of indicators at the county level has led us to carry out the analysis for 910 counties belonging to 19 provinces for the period of 2005 to 2009[10]. Specifically, we have data for the following 19 provinces, listed in alphabetical order: Anhui, Beijing, Chongqing, Gansu, Hainan, Hebei, Heilongjiang, Henan, Inner Mongolia, Jiangsu, Jiangxi, Jilin, Ningxia, Qinghai, Shaanxi, Shanghai, Sichuan, Tianjin and Xinjiang. As there were a total of 1,636 counties[11] in China over the period of 2005-2009, we carry out the analysis for more than half of the counties in China. Thus, our dataset covers a very large part of China, spanning from the North to the South (with Heilongjiang and Hainan) and from the West to the East (with Xinjiang and Jiangsu provinces) of the country.

Previous analyses on agricultural productivity have stressed that there are seven macro-regions in China, differing both in terms of economic development, institutions and agro-climatic conditions (Fan, 1991; Bhattacharyya and Parker, 1999; Cho *et al.*, 2007; 2010). Specifically, the country is broken down into the following seven zones: Central, East, North, Northeast,

[9]Indeed, the two-stage approach first estimates a standard stochastic production frontier in order to predict the inefficiency effects, assuming that these effects are not influenced by other variables. In a second stage, the predicted inefficiency effects are regressed on a set of explanatory variables, which contradicts the assumption made in the first stage. Thus, in the two-step approach, the model estimated in the first step is misspecified leading to estimations bias. Caudill and Ford (1993) provide evidence on the bias in the estimated technology parameters. Wang and Schmidt (2002) provide evidence on the bias at all stages of the procedures (both in the estimation of technology parameters, of the estimated efficiency scores and of the estimated determinants of efficiency) due to the two-step approach.

[10]While a number of indicators at the county level are available in the China Statistical Yearbooks for Regional Economy as well as in the Provincial Yearbooks, information is relatively scarce. For example, gross agricultural output has only been published in the China Statistical Yearbooks for Regional Economy since 2005 and only some provinces published such information in their Yearbook before 2005. Moreover, information on fertilizers is not published in the China Statistical Yearbooks for Regional Economy but rather in the Provincial Yearbooks so that its availability greatly varies over time and across provinces. For this reason, few studies that analyze Chinese agriculture consider all counties. The only studies with data on all counties use the cross-sectional data of 1999 from the county-level socio-economic survey (Cho *et al.* 2007; 2010; Chen and Song, 2008; Monchuk *et al.*, 2010). After reviewing every Provincial Yearbook from 2002 to 2009, we have restricted the analysis for the period from 2005 to 2009 in order to keep the highest possible number of provinces in our sample. Nevertheless, 12 provinces are not included because they did not publish data on all of the necessary indicators (mainly fertilizers).

[11]Includes autonomous counties as well as banners and autonomous banners.

Northwest, Southwest and South as shown in Figure 4.2[12]. Such differences in economic and geographic conditions lead agricultural production technology to differ across Chinese regions (Cho *et al.*, 2007; 2010; Chen *et al.*, 2009; Zhou *et al.*, 2011). Thus, as each region has its own frontier production, it is necessary to estimate a separate frontier production for each of the seven macro-regions in order to obtain unbiased estimates of efficiency scores[13] (Chen and Song, 2008). Given that efficiency scores are the outcome of interest in the present study, this point is of primary importance.

Table 4.2 gives the name of the provinces and the number of counties in our sample for each of the seven zones along with some descriptive statistics. Given our dataset, we are able to estimate a production frontier for each region except for the South. Indeed, Hainan is the only Southern province for which we have data and it contains merely 10 counties.

Estimating the model for inefficiency effects in a stochastic frontier production function separately for each of the six zones enables us (1) to obtain unbiased efficiency scores and (2) to account for heterogeneity of urban effects across the six regions. Alternative groupings of provinces exist and could have been used to analyze heterogeneity of urban effects across regions. The most common grouping divides Chinese provinces into Eastern, Central and Western China. However, this grouping is likely to be inappropriate for taking into account all the regional heterogeneity of urban effects.

For example, as highlighted in Table 4.2, such a grouping would not enable us to account for the considerable variation in the level of economic development and urbanization within Eastern, Central and Western provinces. Southern provinces lag behind other Eastern provinces in terms of GDP per capita, density of infrastructures and wages. Moreover, Southwest provinces are much more endowed with infrastructures than Northwestern ones and services are also both more significant and growing faster in Southwest than in Northwest China. As a result, grouping provinces into Coastal, Central and Western would not adequately capture the regional heterogeneity of urban effects.

[12]Provinces are grouped into the seven zones as follows: Central (Henan, Hubei, Hunan); East (Shanghai, Jiangsu, Zhejiang, Anhui, Jiangxi and Shandong); North (Beijing, Tianjin, Hebei, Shanxi and Inner Mongolia); Northeast (Liaoning, Jilin, Heilongjiang); Northwest (Shaanxi, Gansu, Qinghai, Nongxia and Xinjiang); Southwest (Guangxi, Guizhou, Sichuan, Chongqing, Tibet, Yunnan) and South (Fujian, Guangdong and Hainan). See Cho *et al.* (2007) for a description of the climatic characteristics of each area.

[13]Remember that efficiency scores are obtained by comparing the effective level of production with the maximum output that can be produced (represented by the frontier production). Thus, if the frontier production is not consistently estimated, this will lead to biased efficiency scores.

Figure 4.2: Seven areas of China

Source: author (using Phildigit and Philcarto)

Table 4.2: Data on the seven zones of China

	China	**NE**	**N**	**E**	**C**	**NW**	**SW**	**S**
(1) Data in the sample:								
Provinces in the sample	19 provinces	Heilongjiang Jilin	Beijing Hebei Inner Mongolia Tianjin	Anhui Jiangsu Jiangxi Shanghai	Henan	Gansu Ningxia Qinghai Shaanxi Xinjiang	Chongqing Sichuan	Hainan
Nb. counties	910	66	188	152	88	261	145	10
(2) Descriptive statistics on the seven regions*:								
GDP per capita	22,479	21,708	34,453	31,783	15,989	14,712	12,183	24,710
% of tertiary industry	42	39	47	41	37	39	43	44
Indice of tertiary industry	112.03	111.93	112.46	111.87	111.57	111.10	112.72	112.40
Average wage	17167	15734	18924	18883	15223	15269	16882	17825
Density of railway lines	19	21	39	24	19	8	9	14
Density of highway	784	500	851	1276	1141	291	611	785
Urbanization rate	45	56	59	54	40	39	34	53
Nb. Cities	654	89	77	165	103	60	84	75
Nb. provincial cities	4	0	2	1	0	0	1	0
Nb. prefecture cities	283	34	31	69	42	30	44	32
Nb. county-level cities	367	55	44	95	61	30	39	43

Note: NE=Northeast, N=North, E=East, C=Central, NW=Northwest, SW=Southwest, S=South.
* Indicators calculated using 2009 data on every province of each region *i.e.* we do not just consider the provinces in our sample. GDP per capita refers to the annual gross domestic product per capita in yuan. Indice of tertiary industry gives the evolution of the tertiary industry between 2008 and 2009 (calculated using constant prices). Average wage refers to the average wage of employed persons in urban private units (in yuan). Density of railway (highway) is measured in meter of railway (highway) per km^2. Urbanization rate corresponds to the share of urban population in total population. Data is from the 2010 China Statistical Yearbook.

To summarize, breaking China down into seven areas was primarily due to the necessity of matching differences in production technology in order to obtain unbiased efficiency scores. However, this classification seems fully appropriate for accounting for regional heterogeneity of urban effects, as these seven areas also differ in terms of economic and urban development.

We estimate simultaneously the following two equations for China as a whole and separately for each of the Chinese macro-regions[14]:

$$\ln y_{it} = \beta_0 + \sum_{k=1}^{4} \beta_k \cdot \ln x_{kit} + \beta_5 \cdot trend + \sum_{p=1}^{P} \alpha_p \cdot prov_p + v_{it} - u_{it} \tag{4.6}$$

$$u_{it} = \delta_0 + \delta_1 \cdot \ln prox_{it} + \sum_{m=2}^{4} \delta_m \cdot \ln z_{mit} + \delta_5 \cdot trend + \sum_{p=1}^{P} \lambda_p \cdot prov_p + w_{it} \tag{4.7}$$

where i refers to the county, p to the province and t to the year.

In the estimated model, we identify two different categories of variables: the production frontier variables (Equation 4.6) and the inefficiency variables (Equation 4.7). First, with regard to the production frontier variables, the dependent variable, y_{it}, and the inputs, x_{it}, are the variables currently introduced in the literature on agricultural productivity. We use the logarithm of the gross output value of agriculture in constant prices as dependent variable[15]. We consider two traditional inputs (labor and land) and two modern inputs (chemical fertilizers and machinery). We also introduce provincial fixed-effects ($prov_p$) to control for agro-climatic conditions in each region and a time trend to take into account technical change. The stochastic approach forces us to choose a specification for the production frontier. Although it imposes restrictions on the technology, we estimate a Cobb-Douglas function which does not suffer from multicolinearity problems, contrary to flexible functional forms, such as the translog function (Hassine and Kandil, 2009; Mayen *et al.*, 2010).

Second, regarding the inefficiency effects equation, to test whether urban proximity affects technical efficiency, we introduce a measure of urban proximity ($prox_{it}$) among the determinants of technical inefficiency (z_{mit}). As explained, the goal of the empirical analysis consists in estimating whether cities produce *net* spread or *net* backwash effects on the agriculture of

[14] Estimations are made with the maximum likelihood using *Frontier 4.1*.

[15] Fan and Zhang (2002) underline that using constant prices for aggregate output cannot account for changes in relative prices, which can lead to a bias in the estimation of productivity. The authors propose a method to minimize this potential bias. However, such a method cannot be implemented with county-level data due to data unavailability.

counties in China. To test for this, we follow Chen and Partridge (2011) by constructing a set of measures of market potential (Harris, 1954) to account for urban proximity. First, we construct an aggregated measure of market potential as follows:

$$Prox_i = \sum_{j=1}^{J} \frac{GDP_j}{DIST_{ij}} \tag{4.8}$$

where i refers to the county and j to the city. $DIST_{ij}$ is the number of kilometers from the centroid of county i to the centroid of city j[16] and GDP_j is the gross domestic product of city j in 2005. We use GDP of city j at the initial period to minimize the potential endogeneity problem which could arise from common shocks affecting both counties and cities[17] (we will further discuss the problem of endogeneity in Section 4.4.3). This market potential variable captures all the potential effects of urban proximity outlined in Section 4.2. To construct this aggregated market potential variable, we consider all kinds of cities: provincial, prefecture and county-level cities. Second, to take into account potential heterogeneity across the urban hierarchy, we create different market potential variables according to the administrative rank of the city (provincial, prefecture and county-level). By using similar indicators of market potential to those of Chen and Partridge (2011) who study urban effects on counties's GDP and employment growth, we are able to clearly compare whether cities produce varying impacts on the agriculture and the other sectors of counties.

Finally, following Liu and Zhuang (2000) and Chen and Song (2008), we assume that inefficiency depends on the level of education, health and loan (z_{mit}) of the county. We also introduce provincial dummies ($prov_p$) and allow inefficiency to vary over time by introducing a time trend. Data is taken from the 2006-2010 China Statistical Yearbooks for Regional Economy and from the 2006-2010 Provincial Yearbooks. The precise definitions and descriptive statistics of all the variables are provided in Appendices 4.B and 4.C.

[16]Data on cities' GDP is from the 2006 China City Statistical Yearbook. Distance is calculated using the latitude and longitude of each county and city using data available on the U.S. Geological Survey website.

[17]We are aware that this does not completely rule out endogneneity problems. However, given that no instrumental variables approach has been developed for the model for inefficiency effects in a stochastic frontier production function, this is the best strategy to minimize endogeneity. Indeed, even if some empirical studies have introduced instrumental variables in the model for inefficiency effects in a stochastic frontier production function, they do not discuss the econometric procedure in detail (neither regarding the implementation of the procedure or the test of the instruments or the property of the estimator). Thus, we prefer not to implement an instrumental variables approach given that such a method remains very uncommon and uncertain in the framework of the model for inefficiency effects in a stochastic frontier production function.

4.4 Results

4.4.1 Does urban proximity enhance technical efficiency in each Chinese region?

We begin by estimating the model for China as a whole and for each of the six macro-regions, using the aggregated market potential variable. Table 4.3 presents estimates of the inefficiency effects in the production frontier model. The production frontier estimates are reported in the first part of the table. First of all, estimated elasticities for inputs significantly vary across regions, confirming that estimating a different production frontier is necessary in order to obtain unbiased efficiency scores. Thus, results for China as a whole (Column 1) are likely to be biased. Second, overall estimated elasticities are consistent. For example, the coefficient associated with machinery is insignificant in all regions, with the exception of Northern and Northwestern China, which is not surprising, as labor is abundant in China and so, we expect mechanical technologies (or labor-saving technologies) to be insignificant. On the contrary, for the Northern and Northwestern regions, where population density is low and farmland large, machinery consistently has a positive and significant impact[18]. We also find decreasing returns to scale in each region. Finally, the coefficient associated to the time trend is positive, high and very significant for all regions except Central China. This confirms that technical progress is a strong component of total factor productivity growth in China (Chen *et al.*, 2008).

The second part of Table 4.3 is of particular interest, as it gives the results of the estimation of the inefficiency model. First, inefficiency does exist in Chinese agriculture. Indeed, the estimated variance parameters are significant and the parameter γ is close to one. More importantly, the likelihood ratio test of the null hypothesis that there are no technical inefficiency effects is strongly rejected at the 1% level in every case[19]. Average technical efficiency ranges from about 55% in the Southwest to 79% in the North. Efficiency estimates are close to those found by Wang *et al.* (1996) and Yao and Liu (1998) but lower than those found by Tian and Wan (2000). Second, several studies warn that agricultural efficiency has been deteriorating in China since the 1980s (Mao and Koo, 1997; Chen *et al.*, 2008). Our result confirms that most regions suffer from a decrease in their technical efficiency level given that the coefficient associated

[18]For the Northern region, this result is probably driven by Inner Mongolia

[19]The likelihood ratio statistic has a mixed Chi-square distribution (Coelli, 1995). The critical values, which are reported in the table, can be found in Kodde and Palm (1986).

to the time trend is positive[20] and significant for most regions. Regarding the determinants of technical efficiency, counties with better health infrastructures are consistently significantly more efficient. One surprising result is that education increases inefficiency in most regions whereas we expected better educated farmers to be more able to utilize existing technologies. Although this result is unexpected, it is not new in the literature (Chen *et al.*, 2008; Chen and Song, 2008). This is most likely due to the fact that education variables at the county level are no longer appropriate indicators of the level of education of farmers because most educated rural workers are involved in non-agricultural activities. "*Loan*" is also found to be a significant determinant of efficiency but its impact varies across regions. This probably arises because loan exerts two opposite impacts on technical efficiency. On the one hand, access to credit alleviates capital constraints and thus, it allows farmers to buy every input whenever necessary. As a result, farmers who benefit from better access to credit can undertake optimal agricultural operations by using the necessary inputs at the optimal timing, increasing technical efficiency (Binam *et al.*, 2004). On the other hand, credit also raises investment in new technologies. Yet a high rate of technical change can lead to deterioration in efficiency when farmers do not have the time to assimilate new technologies (Mao and Koo, 1997).

When it comes to the effect of urban proximity, we find considerable heterogeneity across regions. Indeed, urban proximity significantly enhances efficiency in the Northeastern, Northern and Eastern regions, while its effect is lower and less significant for the Central region and not significant at all for the Southwest and the Northwest. As predicted in Section 4.2.3, urban proximity has a much more positive impact in Eastern China due to the well-developed infrastructure network. In addition, large coastal cities bear high congestion costs and a rapidly growing tertiary sector, leading industrial firms to relocate to nearby rural counties. Finally, we find that cities have no impact on rural efficiency in the West. However, at this stage we do not know whether this is the result of compensation between spread and backwash effects or of the absence of ties between cities and counties in the West. The next subsection sheds light on this issue.

[20] A positive sign in the inefficiency model means that the associated variable increases technical inefficiency (and so, reduces efficiency).

Table 4.3: Urban effects across Chinese regions

	(1) China	(2) Northeast	(3) North	(4) East	(5) Central	(6) Northwest	(7) Southwest
Production Frontier Model							
Constant	8.060***	10.736***	5.876***	6.553***	7.805***	4.892***	8.441***
	(0.081)	(0.503)	(0.315)	(0.215)	(0.805)	(0.219)	(0.204)
Land	0.047***	0.009	0.006	0.350***	0.344***	0.115***	0.019**
	(0.006)	(0.006)	(0.021)	(0.027)	(0.057)	(0.017)	(0.007)
Labor	0.397***	0.337***	0.232***	0.223***	0.240***	0.193***	0.729***
	(0.016)	(0.059)	(0.025)	(0.029)	(0.052)	(0.020)	(0.030)
Machinery	0.009**	-0.056	0.447***	-0.006	0.047	0.278***	-0.001
	(0.004)	(0.055)	(0.023)	(0.012)	(0.032)	(0.021)	(0.003)
Fertilizer	0.230***	0.115***	0.056***	0.162***	0.021	0.187***	0.121***
	(0.009)	(0.044)	(0.018)	(0.020)	(0.031)	(0.012)	(0.015)
Trend	0.127***	0.130***	0.039***	0.125***	-0.043	0.039***	0.154***
	(0.006)	(0.020)	(0.012)	(0.005)	(0.138)	(0.008)	(0.037)
Provincial dummies	Yes	Yes	Yes	Yes	No†	Yes	Yes
Inefficiency effects model							
Constant	-26.248***	-1.973	26.146***	4.482***	4.809**	-5.472*	3.229
	1.364	(4.483)	(2.516)	(0.830)	(1.872)	(2.803)	(2.195)
Urban Proximity	-0.137	-3.695***	-6.801***	-0.729***	-0.682**	0.582	-0.386
	0.249	(0.730)	(0.510)	(0.153)	(0.319)	(0.533)	(0.409)
Education	0.501***	3.977***	1.754***	0.111**	0.161**	-0.231***	0.581***
	0.153	(0.578)	(0.195)	(0.044)	(0.082)	(0.073)	(0.058)
Health	-0.182**	-4.985***	-2.013***	-0.137***	-0.208***	-0.116***	-0.136***
	0.089	(0.304)	(0.181)	(0.036)	(0.069)	(0.042)	(0.024)
Loan	0.044	1.102***	1.608***	-0.107***	-0.184***	0.091***	-0.031*
	0.062	(0.212)	(0.103)	(0.028)	(0.043)	(0.030)	(0.018)
Trend	2.856***	0.857***	0.239**	0.086***	-0.087	-0.142***	0.116***
	0.033	(0.173)	(0.119)	(0.011)	(0.139)	(0.018)	(0.040)
Provincial dummies	Yes	Yes	Yes	Yes	No†	Yes	Yes
Average efficiency level	0.674	0.664	0.785	0.614	0.624	0.703	0.545
σ^2	9.216***	4.973***	2.575***	0.043***	0.062***	0.204***	0.101***
	(0.124)	(0.613)	(0.187)	(0.003)	(0.006)	(0.013)	(0.007)
γ	0.991***	0.985***	0.965***	0.999***	0.527	0.659***	0.590***
	(0.004)	(0.003)	(0.004)	(0.005)	(0.549)	(0.039)	(0.137)
Likelihood ratio test statistic	7339.66	359.99	755.58	64.47	51.52	207.67	198.54
Critical value of LR test	43.696	19.384	22.525	20.972	17.755	24.049	19.384
N	881‡	65	186	151	88	242	139
$N * T$	4317	325	930	755	352	1210	695

Note : *, **, *** indicate significance at the 10%, 5% and 1% levels respectively. Standard-errors in parenthesis. A negative sign in the inefficiency model means that the associated variable reduces technical inefficiency (and so, enhances efficiency).

† No provincial dummies are introduced given that Henan is the only province included in the Central region.

‡ The total number of counties for China is higher than the sum of the counties belonging to each region. This difference is due to Hainan province (10 counties) which is included in the regression for China and which belongs to the South region. Remember that we do do not run estimation for the South region because of the lack of sufficient observations.

4.4.2 Do all cities exert the same impact?

We further investigate the effect of urban proximity by substituting the aggregated market potential variable for the disaggregated variables. Table 4.4 presents the results when allowing urban effects to vary both across regions and across the urban hierarchy.

First of all, our results indicate that provincial cities have a detrimental impact on counties. As population growth is the fastest in provincial cities, urban sprawl is likely to be higher, leading to a higher number of seizure of farmland and thus, discouraging farmers to efficiently use the technology. These results are complementary with the estimations of Chen and Partridge (2011) and, as the authors highlight, this finding tends to invalidate the expectations of the government according to which the provincial cities produce spread effects on the rest of the country. Consistently, provincial-level cities have a significant impact in the North because of the proximity to Beijing and Tianjin, in the East because of Shanghai, and in the West because of Chongqing. Conversely, counties located in the Northeast and Central regions are not affected by provincial cities which are located too far away.

Second, contrary to provincial cities, we find that prefecture-level cities enhance agricultural efficiency in most regions. Our results are complementary to previous studies (Ke, 2010; Ke and Feser, 2010; Chen and Partridge, 2011) which find that high-level cities produce spread effects on counties' (non-agricultural) GDP growth. In addition, Northeastern China is the only region in which prefecture cities deteriorate rural efficiency. One likely explanation is that Northeastern prefecture-level cities generate a high level of pollution due to their specialization in heavily polluting industries. Indeed, Northeastern China has been the traditional industrial base of the country, specializing in heavy industry, and it has already been estimated that pollution has a detrimental effect on agricultural efficiency in China[21] (Monchuk *et al.*, 2010).

Turning to county-level cities, we find that their impact varies a great deal across regions. While they produce positive effects in the Southwest, Northwest and Northeast, they have no net impact in the East and Center and they produce significant negative effects in the North. Such a geographic pattern probably arises for two reasons. First, in the West, where the urbanization rate and the number of large cities is low, county-level cities may constitute attractive destinations for rural migrants. In other words, proximity to county-level cities in the West should significantly help in reducing rural labor surplus. Conversely, in the more developed

[21] We will further discuss the issue of input quality in Section 4.4.3.

and urbanized parts of China, almost every county-level city is close to a higher-level city. Yet, as rural workers generally prefer to migrate to large cities rather than to county-level cities (Chan *et al.*, 2008), proximity to a county-level city does not entail a reduction of rural labor surplus in more urbanized provinces. Second, as underlined in Section 4.2.4, given their similar economic structure, growth in county-level cities can produce backwash effects on counties (Ke and Feser, 2010). Such a phenomenon may be particularly at work in Eastern and Northern China where county-level cities have benefited from higher growth rate than in the rest of the country. Indeed, small cities have benefited from high growth rates in Coastal provinces, where export processing jobs have developed, and close to large cities, which stimulate the economic development of smaller cities (Chan *et al.*, 2008).

Finally, using disaggregated market potential variables, we are able to conclude that the absence of impact of cities on counties in the West, as estimated in Table 4.3, arises from the compensation of spread and backwash effects. Thus, the use of an aggregated indicator for urban proximity can be misleading, as one could conclude that counties and cities in Western China are two separate worlds. On the contrary, Table 4.4 highlights that cities and counties in Western China are interconnected. Indeed, the coefficient associated to the disaggregated market potential variables are statistically significant both in the Northwestern and Southwestern regions. However, cities produce both spread and backwash effects on counties, resulting in a non-significant aggregated impact. This issue has important policy implications. Indeed, if Western counties and cities did not interact, an optimal policy would be a local one, targeting only rural areas. However, as counties and cities are interconnected, the optimal policy should be a regional one, including both rural and urban areas (Roberts, 2000).

Table 4.4: Urban effects across regions and urban tiers

	(1) China	(2) Northeast	(3) North	(4) East	(5) Central	(6) Northwest	(7) Southwest
Production Frontier Model							
Constant	8.085***	10.840***	5.236***	6.628***	7.569***	4.730***	8.100***
	(0.082)	(0.530)	(0.282)	(0.195)	(0.760)	(0.210)	(0.178)
Land	0.044***	0.008	0.032	0.367***	0.316***	0.132***	0.016**
	(0.005)	(0.006)	(0.023)	(0.026)	(0.060)	(0.018)	(0.007)
Labor	0.388***	0.349***	0.208***	0.193***	0.226***	0.189***	0.703***
	(0.013)	(0.055)	(0.027)	(0.027)	(0.054)	(0.021)	(0.035)
Machinery	0.010***	-0.065	0.415***	-0.014	0.102**	0.287***	0.001
	(0.003)	(0.059)	(0.026)	(0.013)	(0.040)	(0.023)	(0.003)
Fertilizer	0.231***	0.115***	0.072***	0.152***	0.016	0.176***	0.120***
	(0.008)	(0.043)	(0.020)	(0.019)	(0.030)	(0.012)	(0.015)
Trend	0.127***	0.129***	0.036***	0.126***	-0.069	0.035***	0.138***
	(0.006)	(0.024)	(0.009)	(0.009)	(0.133)	(0.009)	(0.032)
Provincial dummies	Yes	Yes	Yes	Yes	No†	Yes	Yes
Inefficiency effects model							
Constant	-30.508***	-0.296	16.731***	-0.744	7.591*	-13.245***	4.421
	(2.050)	(1.012)	(2.107)	(1.305)	(4.298)	(1.551)	(3.170)
Provincial cities	1.343**	-0.999	3.584***	0.768**	-0.049	4.164***	0.425*
	(0.589)	(2.353)	(0.775)	(0.310)	(0.678)	(0.326)	(0.236)
Prefecture cities	-0.016	9.536***	-19.717***	-0.663***	-1.364***	-2.118***	-0.107
	(0.798)	(1.366)	(0.782)	(0.112)	(0.352)	(0.471)	(0.236)
County-level cities	-0.945	-15.977***	12.133***	-0.300	0.368	-2.634***	-1.311**
	(0.953)	(4.210)	(0.905)	(0.411)	(0.489)	(0.427)	(0.665)
Education	1.395***	1.902***	2.720***	0.109*	0.150*	-0.344***	0.597***
	(0.263)	(0.326)	(0.121)	(0.062)	(0.078)	(0.083)	(0.064)
Health	-0.569***	-5.147***	-0.833***	-0.122***	-0.228***	-0.060	-0.151***
	(0.184)	(0.907)	(0.191)	(0.039)	(0.065)	(0.048)	(0.026)
Loan	0.103	1.349**	0.845***	-0.159***	-0.192***	0.031	-0.033*
	(0.092)	(0.530)	(0.100)	(0.036)	(0.038)	(0.029)	(0.018)
Trend	2.635***	0.656***	0.105***	0.095***	-0.106	-0.144***	0.218**
	(0.061)	(0.156)	(0.049)	(0.016)	(0.133)	(0.020)	(0.093)
Provincial dummies	Yes	Yes	Yes	Yes	No†	Yes	Yes
Average efficiency level	0.668	0.666	0.774	0.617	0.597	0.709	0.559
σ^2	8.604***	4.035***	2.945***	0.041***	0.059***	0.156***	0.104***
	(0.191)	(0.671)	(0.164)	(0.004)	(0.005)	(0.008)	(0.008)
γ	0.991***	0.981***	0.971***	0.999***	0.519	0.558***	0.642***
	(0.001)	(0.005)	(0.003)	(0.016)	(0.462)	(0.033)	(0.094)
Likelihood ratio test statistic	7512.563	366.232	776.889	240.444	64.466	345.745	271.783
Critical value of LR test	46.349	22.525	25.549	24.049	20.972	27.026	22.525
N	881‡	65	186	151	88	242	139
$N * T$	4317	325	930	755	352	1210	695

Note : *, **, *** indicate significance at the 10%, 5% and 1% levels respectively. Standard-errors in parenthesis. A negative sign in the inefficiency model means that the associated variable reduces technical inefficiency (and so, enhances efficiency).

† No provincial dummies are introduced given that Henan is the only province included in the Central region.

‡ The total number of counties for China is higher than the sum of the counties belonging to each region. This difference is due to Hainan province (10 counties) which is included in the regression for China and which belongs to the South region. Remember that we do do not run estimation for the South region because of the lack of sufficient observations.

4.4.3 Discussion

To our knowledge, this study is the first to estimate the effect of urban proximity on agricultural technical efficiency in China. We find that on average, *i.e.* when using the aggregated market potential variable, being close to a city increases technical efficiency in the Northeastern, Northern, Eastern and Central regions. For other regions, we find that cities, at the aggregated level, have no impact on the agricultural efficiency level of counties. This is interesting to note that our conclusion differs from that of Nehring *et al.* (2006) according to which urban proximity negatively affects farmers' technical efficiency level in the US. However, their study is carried out on a sample of farmers in the Corn Belt, the production context of which is very different from the Chinese context. Therefore, we do not expect urban proximity to impact technical efficiency by the same transmission channels. For example, if urban proximity most likely enhances efficiency in China giving farmers more opportunities to access market to sell their produce, in the Corn Belt, this transmission channel should not be at work, as even farmers in remote areas have easy access to markets.

One possible shortcoming of this study however, is that we assume that remote counties and counties close to cities produce the same agricultural products, which could be misleading. Efficiency could be higher close to cities if the output produced there is less complicated to yield than that of remote counties. To relax the assumption that all counties produce the same type of agricultural output, we could estimate a production frontier, either with several outputs or with only one type of output (for example grain or vegetables). Yet the lack of disaggregated output data at the county level prevents us from estimating these models.

Another objection could be made regarding the lack of control for input quality. Strictly speaking technical efficiency is considered as an indicator of management. If there is no control for input quality, differences in input quality can wrongly be attributed to differences in efficiency levels and lead to bias estimates[22]. Most of the time, it is thus highly desirable to control for input quality (Alvarez and Gonzalez, 1999).

Nevertheless, the present study constitutes a very specific case because urban proximity *itself* could impact input quality. First, counties close to cities are likely to suffer from more

[22]For example, if land quality is poor, then more quantity of land is required to produce the same agricultural output. However, if land quality is not controlled for in the econometric specification, this is attributed to technical inefficiency.

land degradation than remote counties, due to a higher level of pollution[23]. Second, as rural areas close to cities benefit from a more developed local non-agricultural sector, there is a risk that the most efficient workers (typically young men) leave agriculture to work in the more remunerative and socially rewarding non-agricultural activities (Song *et al.*, 2009; Chang *et al.*, 2011). Thus, urban proximity itself could deteriorate both land and labor quality. As a result, we can wonder whether or not it is appropriate to control for such "urban proximity-induced" (or "endogenous") variations in input quality. In other words, do the degradation of input quality induced by urban proximity should be considered as an omitted variable or as a transmission channel influencing efficiency?

In this study, we have not introduced any controls for "endogenous" input quality and thus, our econometric results capture the effect of urban proximity on both management and input quality. In our opinion, it seems appropriate to also capture the potential negative impact of urban proximity on input quality, such as the estimated effect of prefecture-level cities in Northeastern China. Of course, the best would have been to separably estimate the effect of urban proximity on technical managerial efficiency and on input quality. However, the lack of available data prevents us from doing this. Thus, assuming that the lack of control for land and labor quality affect the results, this would underestimate the "pure" effect of urban proximity on technical managerial efficiency.

Finally, a last objection could be made regarding the direction of causality. It could indeed be argued that farmers sort across rural areas according to their individual characteristics, which could be one major source of endogeneity. For example, the most talented and enterprising farmers may move close to cities in order to benefit from the urban market. In this case, the higher level of technical efficiency would not stem from urban proximity but from differences in farmers' characteristics (omitted variable problem). However, in China, it is very likely that the causality runs from urban proximity to rural efficiency. Indeed, farmlands are allocated to farmers by the authorities, according to birth place, and nothing indicates that the most enterprising farmers are given land close to urban centers. Moreover in China, the land market is under-developed and migration from one rural area to another area is very low[24]. As a result, spatial sorting of farmers across rural areas is not likely to lead to estimation bias and thus, the

[23]Chapter 6 of the thesis will shed light on this issue.

[24]According to the 2007 Chinese Household Income Project rural survey, more than 90% of migrant rural laborers leave their local countryside to work in towns or cities.

location of Chinese farmers should be exogenous to their ability to produce.

4.5 Conclusion

The present chapter provides a comprehensive analysis of the effect of cities on agricultural efficiency, which is one of the most crucial determinants of potential agricultural growth in China. First, in a theoretical analysis we disentangle the transmission channels by which cities can affect agricultural efficiency in neighboring counties and we emphasize that urban effects are probably heterogeneous both across regions and across the urban hierarchy. Second, we carry out an empirical investigation to estimate the net impact of cities on the technical efficiency level of nearby counties.

Using an aggregated indicator of market potential, we find no evidence that cities produce significant net negative effects on the agriculture of counties, at least in terms of technical efficiency. Thus, it appears that cities can produce significant positive effects on both the non-agricultural (Ke and Feser, 2010) and agricultural sectors of nearby counties. Moreover, we find that the effect of cities strongly varies across Chinese regions. In Eastern provinces, we find that cities strongly enhance efficiency in nearby counties. In the less developed Central provinces, spread effects are much less significant and they are not significant at all in Western provinces. The evidence of positive and significant urban effects on the agricultural efficiency level of rural counties in Eastern China, may explain why the urban-rural gap is lower in Eastern China, as estimated by Sicular *et al.* (2007). This may also explain why distance to the nearest county town is one major determinant of rural poverty in Coastal, Northeastern and Central China but only poorly explains rural poverty in Southwestern and Northwestern China (World Bank, 2009).

Second, spillover effects not only appear to vary across regions but also across the urban hierarchy. Provincial-level cities are found to produce significant backwash effects on counties. Thus, the current policies that favor provincial-level cities are unable to enhance rural development. On the contrary, prefecture-level cities, and to some extent county-level ones, produce spread effects on counties in almost every region. In terms of urban-planning, favoring the development of a network of medium-sized cities scattered across the territory would be much more likely to enhance rural development and achieve balanced growth than the development of a few huge cities.

In addition, cities appear to interact with their neighboring counties in every region of China. Indeed, close to the Coast and in Central China, counties benefit from positive urban effects. Moreover, in the West, we found that the absence of significant urban effects at the aggregated level arises as a result of compensation of equal positive and negative urban effects and not as a result of a lack of ties between counties and cities.

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Appendix to Chapter 4

4.A Provincial, prefecture and county-level cities

Table 4.5: Provincial, prefecture and county-level cities

	Population (10,000 persons)	Primary sector (% GDP)	Secondary sector (% GDP)	Tertiairy sector (% GDP)	Population growth
Provincial cities	1196.17	2.53	43.80	53.67	3.87
Prefecture-level cities	115.75	7.78	50.82	41.41	1.57
County-level cities	66.82	17.01	47.89	34.99	0.70

4.B Definition of the variables

Table 4.6: Definition of the variables

Variable	Definition	Unit
	Frontier variables	
Output	Gross output value of agriculture	100 million yuan (constant prices)
Land	Cultivated area	100 hectares
Labor	Agricultural labor	10,000 persons
Machinery	Total power of agricultural machinery	10,000 kW
Fertilizer	Consumption of chemical fertilizer	100 tons
Plain	Dummy equal to 1 if the county is located in a plain area, 0 otherwise	
	Inefficiency variables	
Aggregated market potential	Sum of GDP in cities weighted by the inverse of the distance between each city and county	
Market potential: provincial cities	Sum of GDP in provincial cities weighted by the inverse of the distance between each city and county	
Market potential: prefecture-level cities	Sum of GDP in prefecture cities weighted by the inverse of the distance between each city and county	
Market potential: county-level cities	Sum of GDP in county-level cities weighted by the inverse of the distance between each city and county	
Education	Share of students enrolled in regular secondary schools in population	%
Health	Number of beds in hospitals and sanitation agencies	10,000 beds
Loan	Outstanding loan of financial institutes at year-end	100 million yuan

4.C Descriptive statistics

Table 4.7: Descriptive statistics

Variable	Obs	Mean	Std. Dev.	Min	Max
Frontier Variables					
Agricultural output	4417	16.71	14.53	0.16	102.08
Land	4317	482.80	484.84	0.02	4699.26
Labor	4512	11.94	10.03	0.04	59.51
Machinery	4369	33.69	34.94	0.17	290.00
Fertilizer	4452	248.14	293.91	0.02	2597.57
Plain	4550	0.40	0.49	0	1
Inefficiency variables					
Aggregated Market Potential	4550	294.29	68.25	135.11	688.39
Market potential: provincial cities	4550	6544.97	1577.28	2021.85	11939.75
Market potential: prefecture-level cities	4550	391.04	84.26	184.84	731.81
Market potential: county-level cities	4550	136.82	32.65	53.23	303.29
Education	4518	6.07	1.85	0.29	27.00
Health	4496	0.07	0.05	0.01	0.38
Loan	4511	16.48	17.62	0.03	341.06

Chapter 5

Urban Proximity and Non-agricultural Wages

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5.1 Introduction

In the development economics literature, it is widely recognized that non-agricultural employment enables rural households to get out of poverty. Indeed, non-agricultural work can enable households both to raise their income and to reduce instability (Ellis, 1998). In addition, as income risk often leads individuals to hold unproductive assets -in the form of precautionary savings (Giles and Yoo, 2007) or grain stocks (Park, 2006)- diversification reduces unproductive behaviors which fosters growth. As a result, the literature regularly found a positive relationship between non-agricultural employment and households' welfare (Barrett *et al.*, 2001).

In China, rural non-agricultural employment has played a major role in reducing poverty (de Janvry *et al.*, 2005). Indeed, getting access to non-agricultural employment is particularly important in rural China for several reasons. First, as farm size is extremely small, farmers have few opportunities to generate agricultural income. Second, in rural China, where transient poverty[1] accounts for a large share of total poverty (Jalan and Ravallion, 1998; World Bank 2009), it is extremely important to diversify income. Finally, rural non-agricultural employment has played a key role in reducing labor surplus in rural China.

Thanks to the economic reforms implemented in China over the last thirty years, nowadays, many rural households are involved in some kind of non-agricultural activities. According to the nationally representative 2002 Chinese Household Income Project (CHIP) rural survey, 78% of rural households were involved in non-agricultural wage-employment and 53% in self-employment in 2002 (Liu and Sicular, 2009). However, over the last thirty years, non-agricultural employment has developed unevenly across rural China, leading to a significant increase in intra-rural inequality (Scott, 1994; Kung and Lee, 2001). For example, more than 60% of rural industrial employment was concentrated in the 10% richest villages whereas only 8% of rural industrial employment occurred in the 10% poorest villages in 1995 (Mohapatra *et al.*, 2006). In addition, urban proximity plays a major role in determining the probability of an individual to engage in non-agricultural employment. Indeed, rural areas close to cities and towns benefit from productive advantages given their greater access to market, transport networks, communication and technologies. Moreover, in China a large proportion of rural in-

[1] Transient poverty is due to an abrupt temporary fall in consumption or income. It has been estimated that as much as one-third of Chinese rural households has fallen into poverty at least once between 2001 and 2004, because of income shocks (World Bank, 2009).

dustries has been engaged in subcontracting with urban firms, leading rural industry to further concentrate close to cities (Naughton, 2007). As a result, the closer the urban area, the higher the probability for an individual to engage in non-agricultural employment. This has been estimated for several developing countries[2] (Corral and Reardon, 2001; Ferreira and Lanjouw, 2001; Micevska and Rahut, 2008; Winters *et al.* 2009; Deichmann *et al.*, 2009; Jonasson and Helfand, 2010) and also specifically for China (Knight and Song, 2003; de Janvry *et al.*, 2005; Mohapatra *et al.*, 2006; Zhu and Luo, 2006).

Aim and contributions of the chapter

The present work aims at studying more deeply how urban proximity affects non-agricultural employment, by investigating whether rural workers closer to cities engage in better remunerated non-agricultural employment. Therefore, unlike previous studies, our focus is not on the *level* but on the *kind* of non-agricultural employment that rural workers manage to get according to their location. In our opinion, this issue is of particular interest. Indeed, non-agricultural employment is nearly always considered as a mean to get out of poverty thanks to its capacity to raise income and to reduce its instability. However, if on average non-agricultural activities are much more income-generating than agricultural activities[3], there is a significant variation in the remuneration of non-agricultural employment. There are even low-paid non-agricultural jobs where earnings are lower than agricultural earnings (Lanjouw, 1999), so that one cannot assume *a priori* that non-agricultural employment enables workers to increase their income.

To our knowledge, no empirical evidence exists on the effect of urban proximity on rural non-agricultural wages in China, although there is some empirical evidence for other developing countries. On the one hand, non-agricultural earnings tend to be higher in rural areas closer to urban centers and roads (Corral and Reardon, 2001; de Janvry and Sadoulet, 2001; Micevska and Rahut, 2008). However, these studies estimate the determinants of annual non-agricultural earnings which depend on both the intensity of participation in the non-agricultural sector and on the hourly wage. As urban proximity increases the intensity of participation in the non-agricultural sector (Knight and Song, 2003), one cannot infer from these studies that workers

[2]On the contrary, according to Elbers and Lanjouw (2001) and Lanjouw *et al.* (2001), there are fewer non-agricultural activities in peri-urban rural areas as cities already produce all the necessary non-agricultural products. However very few empirical studies, and to our knowledge none studies on China, support this view.

[3]Wage-employment is estimated to be paid more than twice, and self-employment three to five times as much as agricultural work in China (Kung, 2002).

close to urban areas are paid higher wages. On the other hand, others assess whether workers closer to cities have a higher probability of being involved in high-paid[4] jobs and find mixed evidence. Deichmann *et al.* (2009) estimates that high-paid jobs are concentrated in rural areas surrounding urban centers in Bangladesh. In contrast, Jonasson and Helfand (2010) find that there is no clear relation, as both high-paid and low-paid jobs are concentrated around urban agglomerations in Brazil.

The 2002 and 2007 Chinese Household Income Project (CHIP) rural surveys, gives some insights on the differences in wages both across rural areas and between suburban and other villages in China. First, in 2002 the average daily wage was 2.5 times higher in the ninth decile than in the first decile. Even if the gap narrowed slightly[5] from 2002 to 2007, the average daily wage was still two times higher in the ninth decile than in the first decile in 2007. This data shows that intra-rural and intra-urban wage inequality are of comparable magnitude (see Combes *et al.* (2012) for data on intra-urban wage inequality). Second, suburban villages benefit from higher wages, as the average daily wage in these villages was about 1.25 higher than in other villages.

In our opinion, in China workers close to cities may be likely to engage in more remunerative non-agricultural jobs for three reasons: (i) agglomeration externalities, (ii) market potential, both leading to differences in productivity, and thus in wages, across villages, and (iii) commuting to nearby urban centers, that enables workers to benefit from the higher urban wages. Firstly, nowadays Chinese suburban areas are highly urbanized and with densely concentrated industries (Naughton, 2007). In these villages, a large number of TVE work together to produce a single product, each being highly specialized in a given stage of the production process. Suburban villages are therefore likely to benefit from some kinds of agglomeration economies, leading to higher productivity and so, to higher wages[6] (Puga, 2010). Second, villages close to cities benefit from a large market potential. Thus, firms in these villages, which enjoy lower transport costs to reach their consumers, can afford to pay higher wages. Previous studies have highlighted that market potential plays a major role in determining wages in Chinese cities (Hering and Poncet, 2010). Market potential should also play a crucial role in determining

[4]Non-agricultural jobs are high-paid if the hourly wage falls above the earnings of wage laborers in agriculture.

[5]Note that the 2002 and 2007 CHIP surveys were not carried out in the same villages so that the narrowing in wage differentials could be lead by differences in villages surveyed between 2002 and 2007.

[6]For example, TVE close to cities can specialize their production, leading to efficiency gains, through learning-by-doing and a reduction in costs as workers do not have to switch tasks.

rural wages given that rural non-agricultural production is closely tied to urban production, through subcontracting and technical assistance to urban firms. Third, workers close to cities are likely to benefit from higher wages because of commuting. Indeed, workers close to urban areas are much more likely to commute to nearby urban centers and thus, to benefit from the higher level of wages that is paid in urban areas.

Using data from the 2002 CHIP survey, we investigate whether workers close to cities are paid higher wages. We make two main contributions to the existing literature. First, we highlight that rural workers close to cities benefit from higher wages than workers in outlying rural areas. This issue has been largely ignored in the literature on spatial disparities in China, which mainly focuses on disparities either between urban and rural areas or within urban areas. Second, to our knowledge, we offer the most comprehensive study on the impact of urban proximity on rural earnings in China. We find very robust evidence that workers close to cities are paid significantly higher wages. In addition, the closer to the urban center, the more detrimental is the impact of distance on wages. Workers closer to the biggest cities are also found to benefit from the highest wage premium. Finally, workers close to cities manage to engage in better remunerated jobs because they benefit of both higher wages in their villages and higher opportunities to commute.

The rest of the chapter proceeds as follows. Section 5.2 briefly describes the rural non-agricultural sector in China. Section 5.3 presents the data and Section 5.4 the methodology used. We describe the results in Section 5.5 and finally, we conclude in Section 5.6.

5.2 The rural non-agricultural sector in China

Before the Mao era, Chinese rural households were quite extensively engaged in non-agricultural activities (Naughton, 2007). Traditionally, the rural non-agricultural sector consisted of a dense network of household processing businesses: households converted the agricultural products they grew and sold the transformed products on markets. However, these traditional household processing businesses disappeared during the Mao era because of the establishment of the state's monopoly control over agricultural goods. Indeed, during the 1950s the state began collecting the agricultural products of households just after the harvest. As a result, households were left with no agricultural products to process and thus, household processing businesses progressively disappeared. This deindustrialization process of rural areas led to a significant drop in rural household incomes.

Later in the Mao era, several attempts were undertaken to develop rural industry. In the 1970s, the government tried to foster rural industrialization through the creation of "communes and brigade enterprises"[7]. As a result, in the 1970s the countryside started to industrialize again, although this new type of industrialization was very different from that characterized by the traditional household processing businesses. On the whole, the communes and brigade enterprises were much larger, were capital-intensive and did not employ many rural workers (Naughton, 2007). Consequently, despite the industrialization process which occurred at the end of the Mao era, in 1978 nearly all of the rural labor force remained engaged in agriculture.

The rural non-agricultural sector has heavily developed since the beginning of the economic transition. First, the agricultural reforms undertaken at the beginning of the transition has led to a significant increase in agricultural productivity. This has released a large number of rural workers from agriculture and has generated capital that could be re-invested in the rural non-agricultural sector. Second, the government has allowed rural workers to engage in non-agricultural activities, either as wage-earners in rural industries or by setting up their own non-agricultural business. Labor surplus, as well as low and irregular incomes in agriculture, have led farmers to engage in non-agricultural activities. As the government continued to heavily control rural migration, especially until the 1990s, farmers were especially encouraged to develop non-agricultural activities locally and thus, to "leave the land but not the village".

The rural non-agricultural sector is often equated with Township and Village Enterprises (Heston and Sicular, 2008). Township and Village Enterprises (TVE) refer to enterprises located in townships and villages. The "TVE" designation encompasses both collectively owned enterprises, privately-owned enterprises and foreign invested enterprises. While TVE were predominantly collective businesses at the beginning of the reforms, they are now overwhelmingly private as collective firms represent less than 10% of total TVE employment today (Naughton, 2007).

Nowadays, TVE are typically labor-intensive, produce low-profit products and are independent from agriculture (de Janvry *et al.*, 2005). They are primarily involved in industry, but

[7]In 1982, the "communes and brigade enterprises" became the "Township and Village Enterprises" when the communes and brigades were respectively renamed townships and villages.

are also significantly engaged in construction, transport and commerce. In 2002, 77% of the value-added was produced in the secondary sector, 22% in the tertiary sector and 1% in the primary sector (Heston and Sicular, 2008). From 1978 to the mid-1990s, TVE were a very dynamic component of the Chinese economy, with an annual growth rate of 9%. TVE employment increased from 28 million workers in 1978 to 135 million workers in 1996, absorbing a significant share of rural labor.

After the mid-1990s, however, TVE began facing a much more competitive environment and more difficulty obtaining credit. As a result, the growth rate of the sector declined, TVE undertook a substantial restructuring and a huge wave of privatization of TVE occurred. Beginning in the 2000s, TVE began growing again; in 2004, TVE employment reached 139 million workers, surpassing the 1996 peak level for the first time (Naughton, 2007). In addition to the wide wave of privatization, since the 2000s TVE have been turned into highly competitive "industrial clusters" (Naughton, 2007). Nowadays, TVE are usually grouped together in villages surrounding urban areas, linked to cities by efficient transport networks and are usually highly specialized in production. A large number of TVE work together to produce a single product, each TVE unit being highly specialized in a given stage of the production process. Finally, one striking characteristic of the rural non-agricultural sector is that the number of self-employed firms in the non-agricultural sector (traders, merchants, household run businesses) has recently surged (Mohapatra *et al.*, 2007). These firms are either part of the formal rural non-agricultural sector (TVE) or form part of the informal segment of the rural non-agricultural sector. As Mohapatra *et al.* (2007) have highlighted, such businesses are run by especially productive and innovative entrepreneurs.

The rest of the chapter is an empirical analysis which aims at investigating whether rural workers close to cities are paid higher non-agricultural wages.

5.3 Data

To carry out the empirical analysis, we use the 2002 rural survey of the CHIP[8]. This survey was conducted by the Chinese Academy of Social Sciences and investigates households' conditions in 2002. The database is composed both of an individual, a household and a village level

[8] We do not use the 2007 CHIP survey as there is no detailed information on rural non-agricultural work to calculate hourly wages. A detailed description of the 2002 rural survey can be found in Gustafson *et al.* (2008).

survey. Thus, we benefit from detailed information on individual labor allocation and from household and village characteristics. In addition, this is a nationally representative survey which investigates 37,969 individuals of 9,200 households from 961 villages belonging to 122 counties of 22 provinces[9]. As a result, compared to most microeconomic studies on rural areas in developing countries, we benefit from a great range of variability in terms of remoteness-proximity to urban areas.

5.3.1 Labor allocation of workers in the sample

We restrict the CHIP sample to workers. Every individual above 15 years old, who reports having earned some income or having spent some time working, is considered as a worker. We have classified rural workers according to their primary activity[10] in one of the following four categories: (1) Local agricultural workers, (2) Local non-agricultural wage earners, (3) Local non-agricultural self-employed and (4) Migrant workers. Local agricultural workers are individuals whose primary activity consists of working on the family farm or as a farm-employee. Local non-agricultural wage earners include workers who spend most of their time working out of agriculture as wage earners. Local non-agricultural self-employed are workers who are self-employed in the non-agricultural sector. The three previous categories only include local workers, *i.e.* individuals working in their home county. On the contrary, we considered as migrant every individual whose primary activity takes place out of his home county (Zhao, 1999). Indeed, given the size of counties, it is impossible for a worker to commute from a county to another county. This ensures that individuals working out of their home county, *i.e.* migrants, are both working and living in towns and cities. On the contrary, this criteria ensures that commuters, who work out of their village but who come back to their home village every day, are classified as local workers (de la Rupelle *et al.*, 2010)[11]. As stated in the introduction, workers close to cities are expected to be paid higher wages partly because they can commute

[9] The sample includes the following 22 provinces, listed in alphabetical order: Anhui, Beijing, Chongqing, Gansu, Guangdong, Guangxi, Guizhou, Hebei, Henan, Hubei, Hunan, Jiangsu, Jiangxi, Jilin, Liaoning, Shaanxi, Shandong, Shanxi, Sichuan, Xinjiang, Yunnan and Zhejiang.

[10] The primary activity is the activity to which the worker devotes most, if not all, of his working time. Many workers also declare having a secondary activity, which is an activity to which they devote a smaller part of their time. As some workers have both agricultural and local non-agricultural or migratory work, we have classified individuals according to their primary activity so that each worker belongs to only one category. The worker's primary activity has been demonstrated to be the most relevant criteria to classify rural workers with multiple activities (Deichmann *et al.*, 2009).

[11] Consistently, in our sample 75% of the local workers spent less than 14 days out of their households during the year, whereas 75% of migrants spent more than 180 days out of their households.

to cities and thus, benefit from the higher wages that are paid in urban areas. Thus, to capture the entire effect of urban proximity, commuters must be classified in the local workers category. Table 5.1 presents the classification of workers in our sample. Our sample is composed of 22,551 workers[12]. Regarding local non-agricultural employment, 4530 workers are wage earners and 863 are self-employed workers. 2652 workers are migrants (nearly all of them are in the non-agricultural sector). Thus, about 35% of the labor-force is involved in the non-agricultural sector as a primary activity, which is very consistent with previous findings (Knight and Song, 2003; Shi *et al.*, 2007). Finally, given land rights reallocation and the scarcity of non-agricultural jobs in rural China, a large share of the labor force continues to work primarily in agriculture[13].

Table 5.1: Classification of workers (1^{ary} activity)

	Effective	%
Local agricultural workers	14,506	64.32
Local non-agricultural wage-earners	4530	20.09
Local non-agricultural self-employed	863	3.83
Migrant workers	2652	11.76
Total workers	22,551	100

5.3.2 Non-agricultural hourly wage

To study whether workers close to cities are engaged in better paid non-agricultural jobs, we focus on *local* non-agricultural workers. As described above, local non-agricultural work is composed by wage earners and self-employed workers. However, most information on labor time and earnings is not available at the individual level for self-employed workers. Thus, the present study focuses on local non-agricultural wage earners.

The explained variable is the individual non-agricultural hourly wage (hereafter NAHW).

[12]On the 37,969 individuals surveyed, 7869 are children and 30,100 are adults. 26,065 adults are workers and 4035 are inactive. However, we have missing information on place of work, labor time and/or wage for 949 workers. Finally, there are 2565 individuals for whom explanatory variables are missing. As a result, our sample is composed of 22,551 workers.

[13]It is worth noting that even in each of the first three categories, most workers spend a small portion of their labor time in the agricultural sector. Precisely, only 784 workers in the sample declared not having worked at all in the agricultural sector during the year.

Another option could be to use annual non-agricultural earnings. However, annual earnings depend on both the intensity of participation in the non-agricultural sector and on the hourly wage. Given that urban proximity increases the intensity of participation in the non-agricultural sector (Knight and Song, 2003), using annual earnings would lead to over-estimating the effect of urban proximity. As a result, the NAHW is the most appropriate variable. This variable is calculated as:

$$NAHW_i = \frac{W_i}{D_i * H_i} \tag{5.1}$$

with W_i the annual wage[14] earned by individual i, D_i the number of days worked during the year and H_i the number of hours worked per day. Both W_i, D_i and H_i refer to the worker's primary activity.

5.3.3 Variables of interest

The relationship between urban proximity and wages is likely to be characterized by two phenomena: nonlinearity and heterogeneity. First, distance is likely to have a nonlinear impact on wages. Indeed, there is extensive evidence that most urban agglomeration effects disappear quite rapidly across space (Rosenthal and Strange, 2001; Aminiti and Cameron, 2007). Thus, the closer to the urban areas, the more detrimental the impact of the distance should be. In remote areas, where almost all agglomeration effects have disappeared, distance should have a much lower effect, or no effect at all, on wages. Secondly, Partridge *et al.* (2009) have demonstrated that urban hierarchy effects were at work in the determination process of wages; specifically, if wages are higher close to cities, the effect is the strongest close to the biggest cities because they generate the largest agglomeration effects.

We use two indicators to measure the degree of urban proximity of workers' villages. These two indicators are designed to take into account nonlinearity and urban hierarchy effects. First, in the survey we have data on the number of kilometers between each worker's village and the nearest county seat (*Distance*). To account for the nonlinearity of the effect of distance, we have created four dummy variables (*Quartile*) to indicate which quartile of distance the village is located in ($q_1 = 10km$; $q_2 = 20km$; $q_3 = 30km$; $q_4 = 160km$). Thus, the dummy "$Quartile_1$"

[14] Following Hering and Poncet (2010) and Démurger *et al.* (2012), this includes the basic wage, bonuses and in-kind earnings.

is equal to 1 if the village is located within 10 km from the county seat, the dummy "$Quartile_2$" is equal to 1 if the village is located between 10 and 20 km from the county seat and so on. To test whether distance has a non-linear impact on wages, we have introduced in the estimates the *Distance* variable, together with interactive terms between the *Distance* variable and the *Quartile* dummies. These interactive terms enable us to test whether an increase of 1 km in the distance between the county seat and the worker's village has a more detrimental impact on wages close to the county seat.

Second, to test whether wages are highest close to the biggest cities, we use the official codes of the counties available in the dataset to construct the following two variables. *Provincial City* is a dummy equal to 1 if the worker's village is located in the suburb of a provincial city, and 0 otherwise. *Low level City* is a dummy variable equal to 1 if the worker's village is a suburb of a prefecture city, or if it is located in the administrative area of a county-level city, and 0 otherwise[15]. As provincial cities are much bigger and more economically developed than other cities, we expect workers located close to these cities to benefit from the highest wages.

Table 5.2 gives descriptive statistics on the hourly wages in yuan according to the distance to urban areas. It appears that wages decrease with the distance to the county seat. In addition, they are significantly higher in suburban villages than in non-suburban villages.

[15] As explained in Chapter 2, villages located in the suburb of a provincial/prefecture city or in the administrative area of a county-level city are considered as urban areas in county and city-level data but are considered as rural according to the more accurate definition used in the censuses and in the CHIP survey. Thus, this is particularly interesting to asses the effect of urban proximity on these villages.

Table 5.2: Distance to urban centers and non-agricultural hourly wages

	Mean	SD	Median	Difference†
All sample	3.07	3.92	2.31	
Distance to county seat				
[0-10] km	3.13	3.97	2.38	
]10-20] km	3.06	4.28	2.24	
]20-30] km	3.05	4.01	2.31	
]30-160] km	3.03	3.47	2.33	
Suburban village				
Yes	3.47	4.72	2.50	0.46**
No	3.01	3.80	2.28	(-2.52)

Notes: †A test of difference between means has been conducted; *t-statistic* reported in parenthesis. *, **, *** indicate significance at the 10%, 5% and 1% levels respectively.

5.4 Methodology

5.4.1 Selection bias correction based on a multinomial logit model

To test whether workers close to urban centers are paid higher wages, we estimate an income function on the sub-sample of local non-agricultural wage earners. To get unbiased estimates of the coefficients in the income function, we need to correct for the potential selective decision of workers to engage in local non-agricultural wage-employment rather than in other activities. The standard solution to tackle selection bias consists in estimating the two-step Heckman selection model (Heckman, 1979). In our case, selection is over more than two choices, given that workers choose to engage in one of the following four activities: local agriculture, local non-agricultural wage-employment (hereafter NAWE), local non-agricultural self-employment (hereafter NASE) and migration. Several methods have been proposed to correct for selection bias when selection is over more than two exclusive choices (Lee, 1983; Dubin and MacFadden, 1984; Dahl, 2002); these models take into account the potential effects of endogenous selection in the different activities on earnings. Essentially, these models consist in estimating a Heckman selection model but, in the first step, a multinomial logit model is estimated instead of a simple binomial logit model. Thus, these models consist in the following two steps. First, a multinomial logit model is estimated, accounting for all the different possible choices. Second, the results of the first-step equation are used to compute the appropriate correction terms, which are included as control variables in the second-step earning equation. Bourguignon *et al.* (2007) show that the Dahl (2002) semi-parametric model (with full specification) should be preferred to the other models. Following their recommendation, we use the Dahl's method in the empirical analysis.

5.4.2 Baseline specification

In the first-step multinomial logit model, the explained variable takes the following four values, according to the worker's primary activity: 0 if local agriculture, 1 if NAWE, 2 if NASE and 3 if migration. In the second step, we estimate a hourly earnings function by the OLS, by adding the correction terms calculated from the first-step model to the set of explanatory variables[16].

Regarding the income function, to test whether workers close to cities are paid higher wages, we introduce as determinants of the hourly wage the variables of interest described in Section 5.3. We also introduce a wide range of controls, both at the worker and village levels, which are expected to affect the level of hourly wages. Thus, we control for worker's age and its square, education, experience and its square, gender, ethnic minority and Communist Party membership. We introduce two more variables, at the village level, to control for frictional distance (Bird and Sheperd, 2003): a dummy variable to control for the topography and a dummy variable indicating whether or not a road reaches the village. In addition, as wages are expected to be lower in poorer areas, we introduce a variable indicating whether the village is in a province level poverty township. Regional (East, Center, West) and provincial dummies are introduced to control for differences in development, endowments and policies. These dummies also partially control for living costs. However, living costs are also likely to vary *within* a given province, and especially between remote rural areas and other ones. As wages are expected to be an increasing function of living costs, and as living costs are expected to be higher close to urban areas, the coefficients associated with the variables of interest could be over-estimated[17] (Hering and Poncet, 2010). To precisely control for living costs, we calculate an index of living

[16] In the Dahl's model, the correction terms are a polynomial of choice probabilities. Following Bourguignon *et al.* (2007), we use all the probabilities, which are included as a fourth-order polynomial and with all interactions between them.

[17] If living costs are often assumed to be higher close to cities, other argues that living costs are lower close to cities due to lower transport costs.

costs at the village level, using information on the market price, in yuan per kg, of six non-staple foods (meat, eggs, edible oil, sugar, vegetables, fruit and melons)[18].

As identifying restrictions, we use the quantity of land per capita in the worker's household and a dummy indicating whether the worker is unmarried. These variables, which are assumed to affect the participation choice of the worker but not his wage, have been demonstrated to be good indentifying restrictions (Micevska and Rahut, 2008; Démurger *et al.*, 2009). Finally, as we introduce village-level variables in our worker level-analysis, the standard errors are clustered at the village level in order to obtain unbiased standard errors (Moulton, 1990). Definition of the variables and descriptive statistics are given in Appendices 5.A and 5.B.

5.5 Results

5.5.1 Baseline results

Table 5.3 presents the baseline estimates of the Dahl's model. The first three columns give the results of the multinomial logit model. The reference category is made up of local agricultural workers. The results of the income equations are reported in columns (4), (5) and (6). In Column (4), we only control for living costs by introducing provincial level dummies, whereas in Column (5) we add the index of living costs at the village level to the set of control variables. Finally, in Column (6) we use the index of living costs to calculate the real hourly wage, which is used as explained variable instead of the nominal wage.

First of all, the multinomial logit model assumes the Independence of Irrelevant Alternative (IIA) hypothesis. According to this assumption, the probability of choosing one category over another does not depend on other alternatives. To check the validity of this assumption, we have carried out the Small and Hsiao (1985) test[19]. According to Appendix 5.C, the Small and Hsiao (1985) test indicates that we cannot reject the null hypothesis of validity of the IIA assumption. Moreover, Bourguignon *et al.* (2007) have shown that "the selection bias correction based on

[18]We do not use information on the market prices of fish and shellfish due to too many missing values. Moreover, market prices of non-staple foods are reported at the household level. As market prices are likely to vary across villages, and to avoid measurement errors, we construct an index at the village level. First, for each of the six non-staple foods, we calculate the average of its market price at the village level. Second, we create the living cost index by averaging the market price of the six non-staple foods.

[19]According to this test, the IIA assumption holds if omitting one working category from the entire choice set does not change the estimates for the remaining alternatives. Thus, the Small and Hsiao test compares the estimated results of a restricted model (in which one of the working categories is omitted) with the estimated results of the unrestricted model (containing the entire choice set). The null hypothesis of validity of the IIA assumption is not rejected if the restricted and unrestricted models give similar results.

the multinomial logit model can provide fairly good correction for the outcome equation, even when the IIA hypothesis is violated".

The selection correction terms enter the income equation significantly, suggesting that the selection model is appropriate[20]. In addition, the identifying restrictions are jointly significant in the participation model for each category of workers.

5.5.1.1 Participation model

The estimation results of the participation model are very consistent with previous findings (de Brauw *et al.*, 2002; Xia and Simmons, 2004; Liu and Sicular, 2009; Démurger *et al.*, 2010), indicating that older workers as well as more educated and experienced workers have a higher probability of engaging in the local non-agricultural sector. On the contrary, ethnic minority workers and those living in poor townships have much lower probability of working locally out of agriculture. Regarding our variables of interest, as estimated by Knight and Song (2003), distance to urban areas significantly decreases the participation in local non-agricultural employment. However, we provide additional evidence on the role of urban proximity by breaking down local non-agricultural employment into wage-employment and self-employment. According to our estimates, if urban proximity increases the probability of engaging in local non-agricultural employment, the effect seems stronger for wage-employment than for self-employment, which should not be a surprise. Indeed, large-scale rural industries are heavily concentrated in peri-urban areas, where they benefit from lower transport costs and easy access to information and technology (Mohapatra *et al.*, 2006). Moreover, industrial linkages with urban firms (through subcontracting) lead rural industry to further concentrate close to cities (Peng, 1998). Thus, local wage-employment might be the dominant type of non-agricultural employment close to cities. However, the relation between urban proximity and self-employment is slightly weaker, probably because two opposite forces are at work. On the one hand, households close to cities benefit from significant market outlets, which encourages them to build up family businesses. As a result, the closer the urban area, the higher the probability of engaging in local self-

[20] We do not report the whole set of coefficients associated with the polynomials of the selection probabilities in the table because they have no direct interpretation and because of their high number. Instead, we report the F-test indicating whether or not the selection correction terms are jointly significant in the income equation, which is much more informative.

Table 5.3: Baseline estimation

	Multinomial logit model			**Income equation**		
	NAWE	NASE	Migration			
	(1)	(2)	(3)	(4)	(5)	(6)
Individual characteristics						
Age	0.007***	0.002***	-0.0001	0.044***	0.045***	0.046***
	(0.000)	(0.001)	(0.576)	(0.000)	(0.000)	(0.000)
Age^2	-0.011***	-0.003***	-0.005***	-0.054***	-0.055***	-0.056***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Education	0.011***	0.001***	-0.002***	0.043***	0.045***	0.043***
	(0.000)	(0.001)	(0.000)	(0.000)	(0.000)	(0.000)
Experience	0.082***	0.015***	0.034***	0.122***	0.127***	0.116***
	(0.000)	(0.000)	(0.000)	(0.001)	(0.000)	(0.001)
$Experience^2$	-0.220***	-0.051***	-0.122***	-0.310***	-0.326***	-0.297***
	(0.000)	(0.000)	(0.000)	(0.002)	(0.000)	(0.001)
Party member	0.053***	-0.010***	-0.022***	0.196***	0.200***	0.183***
	(0.000)	(0.006)	(0.001)	(0.000)	(0.000)	(0.000)
Male	0.154***	0.014***	0.032***	0.426***	0.440***	0.423***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Minority	-0.034***	-0.003	-0.018***	-0.097	-0.101*	-0.104*
	(0.009)	(0.319)	(0.000)	(0.108)	(0.088)	(0.063)
Village characteristics						
Distance q1	-0.004**	-0.001**	0.002**	-0.022***	-0.022***	-0.022***
	(0.018)	(0.023)	(0.025)	(0.000)	(0.000)	(0.000)
Distance q2	-0.001*	-0.0004**	0.001***	-0.006**	-0.006**	-0.006**
	(0.066)	(0.034)	(0.008)	(0.011)	(0.016)	(0.011)
Distance q3	-0.002***	-0.0003**	0.001***	-0.006***	-0.006***	-0.005***
	(0.000)	(0.026)	(0.004)	(0.003)	(0.005)	(0.005)
Distance q4	-0.002***	-0.0004***	0.0005***	-0.003**	-0.003**	-0.003**
	(0.000)	(0.000)	(0.001)	(0.024)	(0.018)	(0.018)
Low level city	0.058***	0.008***	-0.019***	0.119**	0.103**	0.077*
	(0.000)	(0.002)	(0.000)	(0.010)	(0.015)	(0.072)
Provincial city	0.108***	-0.002***	0.521***	0.543**	0.623***	0.567**
	(0.000)	(0.004)	(0.000)	(0.012)	(0.009)	(0.015)
Road	0.050***	0.005	-0.0001	0.192***	0.190**	0.170**
	(0.003)	(0.198)	(0.593)	(0.008)	(0.011)	(0.024)
Topography	-0.011	0.002	0.009***	-0.045*	-0.047**	-0.045**
	(0.149)	(0.361)	(0.001)	(0.059)	(0.034)	(0.037)
Township	-0.025**	-0.016***	0.009	-0.119**	-0.107**	-0.104*
	(0.018)	(0.000)	(0.164)	(0.028)	(0.044)	(0.079)
Living costs					0.479***	
					(0.005)	
Land per capita	-0.007***	-0.002**	-0.003***			
	(0.000)	(0.020)	(0.000)			
Unmarried	-0.002	-0.012***	0.061***			
	(0.480)	(0.005)	(0.000)			
Constant	-4.977***	-7.246***	-6.491***	-39.84	-33.79	-47.29
	(0.000)	(0.000)	(0.000)	(0.422)	(0.461)	(0.311)
Provincial dummies	Yes	Yes	Yes	Yes	Yes	Yes
Regional dummies	Yes	Yes	Yes	Yes	Yes	Yes
Observations		22,551		4530	4530	4530
Adj. R^2				0.21	0.21	0.18
Selection correction terms				2.02***	1.99***	1.98***
Wald test for identifying restrictions	15.62***	13.99***	114.75***			
Distance q1 = Distance q2				13.01***	12.88***	13.51***
Distance q2 = Distance q3				0.05	0.03	0.18
Distance q3 = Distance q4				4.81**	4.55**	3.47*
Provincial city = Low level city				4.31**	5.68**	4.81**

Notes: *, **, *** indicate significance at the 10%, 5% and 1% levels respectively. *p-values* in parenthesis. The reference category in the multinomial logit model is made up of local agricultural workers. The dependent variable in the earning equation is the logarithm of hourly earnings. The models have been estimated using a bootstrap procedure with 500 replications.

employment. On the other hand, however, the positive impact of urban proximity on the participation in local self-employment is probably counter-balanced by the greater availability of non-agricultural goods close to cities. Indeed, the ease in finding manufactured goods from urban and local rural industries may reduce the probability that local non-agricultural family businesses set up (Corral and Reardon, 2001). In remote areas, on the contrary, as households bear high transport costs, they are usually involved in some self-employment production in order to satisfy their own consumption of non-agricultural produce (Fafchamps and Shilpi, 2003).

5.5.1.2 Income equation

Turning to the income equation, it appears that, as for urban areas (Hering and Poncet, 2010; Démurger *et al.*, 2012), hourly wages in rural China are an increasing function of a worker's age, education and experience. Men and party members also benefit from higher wages. Regarding our indicators of interest, the distance[21] to the county seat has a negative impact on wages, whereas living in a suburban village significantly increases wages. Interestingly, distance exhibits a strongly nonlinear impact. A 1 km increase in the distance between a worker's village and the county seat has a significantly stronger impact on wages within 10 km from the county seat (first quartile). The effect is the lowest for villagers located at more than 30km from the county seat (last quartile), indicating that most urban spillover effects occur in the vicinity of the county seat. In addition, we find strong evidence of urban hierarchy effects. While workers in the suburb of the county and prefecture-level cities earn about $7\% - 12\%$ more than workers not located in the suburb of a city, workers in the suburbs of provincial-level cities earn about $54\% - 62\%$ more. To our knowledge, we are the first to demonstrate that rural workers are paid different wages according to their location in rural China. As for physical distance, wages also decrease with frictional distance: wages are higher in villages linked by a road and lower in mountainous areas. Finally, the results are robust whatever the controls introduced for living costs. Interestingly, the coefficients of the *Distance variables* remain almost the same when controlling for living costs, which probably arises from the fact that distance to the county seat does not lead to differences in living costs. On the contrary, the magnitude of the coefficients of the *Provincial city* and *Low level city* dummies are more affected by this additional control,

[21] In order to make the interpretation of the results easier, we directly present in the estimation tables the coefficients of the distance variable by quartiles. To do this, we have recalculated the coefficients of distance for each quartile, together with their standard errors, using information on both the additive terms and the interactive terms between distance and the quartiles.

which highlights that living costs are probably significantly different in the suburb of cities than in other villages. In the rest of the chapter, we use the real wage as dependant variable so that results have to be compared with Column (6) of Table 5.3. The next step of the chapter aims at understanding why workers in villages close to urban areas are paid higher wages, even after controlling for differences in prices. This could arise from two main channels: (i) rural workers are more productive close to urban areas, leading to higher wages in villages close to urban areas; (ii) rural workers manage to commute to nearby urban areas and to benefit from the better-paid urban jobs.

5.5.2 Transmission Channels

One additional contribution of this study is to disentangle the role of the potential transmission channels. As stated in the introduction, workers close to urban areas can be paid higher wages because of both agglomeration externalities, a higher market potential and commuting.

To assess the effect of agglomeration externalities, we test the specific effect of specialization (or localization economies)[22], and diversification (or urbanization economies). We use two indicators of specialization at the village level: the share of employees in township and village enterprises and the number of non-agricultural family businesses. Following Combes *et al.* (2008), to capture the effect of the diversity of the economy, we use the log of the inverse of the Herfindahl index. Specifically, in the village questionnaire, the data on the labor force is disaggregated into the following five sectors: agriculture; manufacturing; construction; wholesale, retail and food services; and other industries.

To test for the effect of market potential, as is widely done, we have constructed a Harris market potential indicator as follows:

$$Harris\ MP_i = \sum_{j=i}^{J} w_{ij} \cdot GDP_j \tag{5.2}$$

where GDP_j is the Gross Domestic Product of county j[23] and w_{ij} a spatial weighting matrix

[22] In our opinion, the notion of specialization in the context of rural areas in developing countries is different than the usual notion used in the literature on agglomeration economies in urban areas. In agrarian economies, what matters for an economy is to specialize out of agriculture so that new non-agricultural knowledge can emerge, in addition to traditional agricultural knowledge. In this context, looking at the effect of specialization out of agriculture is more relevant than testing the effect of specialization in one particular non-agricultural sector.

[23] Data at the county-level comes from the 2003 China Statistical Yearbook for Regional Economy.

defined as follows:

$$w_{ij} = 1 \quad if \quad i = j \tag{5.3}$$

$$w_{ij} = \frac{1}{dist_{ij}} \quad if \quad dist_{ij} \leq 200km \tag{5.4}$$

$$w_{ij} = 0 \; if \quad dist_{ij} > 200km \tag{5.5}$$

where $dist_{ij}$ is the number of kilometers between county i and county j. The distance 200km is chosen as the cut-off parameter, *i.e.* beyond 200 km, interactions are considered as negligible[24]. Following Aminiti and Cameron (2007), we include in the measure of the market potential the GDP of the county in which the village is located (Equation 5.3). As the authors highlight, working with micro-level data alleviates the potential problem of the endogeneity of the own county GDP that affect studies at the aggregated regional level. Moreover, excluding the market of the own county would lead to an irrelevant measure of the market potential for villages located in the periphery of a city. In addition, we follow Partridge *et al.* (2009) by using the aggregate income in surrounding concentric rings, measured from the population-weighted center of the county, as an additional indicator of market potential. We use the aggregate income in surrounding concentric rings of 0-50km, 50-100km, 100-150km and 150-200km[25]. It is worth noting that the market potential is calculated at the county level. The market potential of a given village is not calculated by using disaggregated data on neighboring villages for three reasons. First, the rural non-agricultural production is much more directed to the *urban* market than to the *rural* market. As highlighted in the introduction, rural non-agricultural production is closely tied to urban production, trough subcontracting and technical assistance to urban firms. Thus, market potential measures constructed from village data would not provide a relevant measure of the market potential. Calculating spatial lagged variables using the GDP of the whole county (which includes both urban and rural areas) provides a much better measure of market potential. Second, we use survey data on 961 villages. Population data disaggregated at the village level is not available, neither in our survey, nor in any official statistical yearbook. Third, even if we know the precise name of every village of the sample, accurate geographical

[24]The cut-off value chosen is similar to the values used in previous studies (Ke and Feser, 2010; Chen and Partridge, 2011). Moreover, to check the sensibility of our results, we have used other cut-off values. Results are robust to this change.

[25]The intervals chosen are consistent with previous studies (Ke and Feser, 2010).

coordinates of the villages are not available so that distance is calculated using the geographical coordinates at the county level.

Finally, it is worth noting that using micro-level data rules out the risk of endogeneity of the indicators of agglomeration externalities. In our study, wages are measured at the individual level whereas our indicators of agglomeration externalities are measured at the village (specialization and diversification) or at the county-level (market potential). Thus, a shock to a worker's wage is very unlikely to affect the indicators of agglomeration externalities, measured at a more aggregated level.

To investigate the effect of commuting, we decompose local workers into two categories: individuals working in their village and individuals working out of their village (but within their home county), *i.e.* commuters. To asses the effect of commuting, we estimate the income equation on the sub-sample of individuals working within their village. To do this, we consider commuting as a distinct choice in the multinomial logit model[26]. If commuting plays a significant role, once commuters excluded the coefficients of interest should become less significant.

Table 5.4 presents the estimation results. We begin by testing the effect of agglomeration externalities and market potential. As shown in columns (1) and (2) of Table 5.4, workers living in villages where the economy is diversified are not paid higher wages[27]. Regarding specialization, the share of employees in TVE has a positive effect on wages; however, the effect is not robust when excluding commuters. Turning to market potential, workers are paid higher wages, the higher the market potential of the county. The impact is robust, whatever the measure used. Our result is consistent with Hering and Poncet (2010) who estimate that standard agglomeration effects does not affect wages in Chinese cities, whereas market potential has a very significant impact. Compared with the baseline estimation (Column (6) in Table 5.3), the coefficients of *Provincial City* and *Low Level City* are less (or no longer) significant and of lower magnitude when we control for agglomeration externalities. Thus, market potential

[26]In this case, the explained variable of the first-step selection equation takes the following values: 0 if local agriculture, 1 if NAWE working within their home village, 2 if NAWE commuters, 3 if NASE and 4 if migration. The estimation results of the multinomial logit model, and of the income function for commuters, are available in Appendix 5.D

[27]We can wonder whether this result arises from a lack of effect of diversification or from the construction of the variable. Indeed, Combes *et al.* (2012) also estimate that diversification has no effect on wages in urban China. However, the authors point out that they only have data on a few industrial sectors, which does not allow them to appropriately capture the effective diversification of the economy. As we have data on only five sectors, we are very likely to meet the same measurement problem.

Table 5.4: Transmission channels

	Agglo. ext.		No commuters	All channels	
	(1)	(2)	(3)	(4)	(5)
Individual characteristics					
Age	0.046***	0.043***	0.063***	0.052***	0.052***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Age^2	-0.056***	-0.053***	-0.068***	-0.060***	-0.059***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Education	0.041***	0.042***	0.048***	0.039***	0.042***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Experience	0.109***	0.105***	0.152***	0.096***	0.113***
	(0.000)	(0.000)	(0.003)	(0.008)	(0.001)
Experience^2	-0.278***	-0.267***	-0.406***	-0.261***	-0.298***
	(0.000)	(0.000)	(0.004)	(0.010)	(0.002)
Party member	0.174***	0.170***	0.372*	0.200	0.279
	(0.000)	(0.000)	(0.088)	(0.252)	(0.100)
Male	0.423***	0.408***	0.432***	0.384***	0.403***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Minority	-0.058	-0.103*	-0.182**	-0.102	-0.191**
	(0.276)	(0.053)	(0.031)	(0.219)	(0.022)
Village characteristics					
Distance q1	-0.019***	-0.019***	-0.027**	-0.026**	-0.025**
	(0.000)	(0.000)	(0.013)	(0.019)	(0.028)
Distance q2	-0.006***	-0.006***	-0.004	-0.007	-0.007
	(0.003)	(0.006)	(0.456)	(0.207)	(0.252)
Distance q3	-0.005***	-0.005***	-0.006	-0.008	-0.007
	(0.001)	(0.004)	(0.230)	(0.112)	(0.182)
Distance q4	-0.002***	-0.002**	-0.003	-0.003*	-0.003
	(0.006)	(0.016)	(0.160)	(0.098)	(0.167)
Low level city	0.038	0.078**	0.101	0.035	0.083
	(0.242)	(0.020)	(0.111)	(0.560)	(0.139)
Provincial city	0.227	0.108	1.734***	0.106	0.752*
	(0.194)	(0.597)	(0.000)	(0.496)	(0.077)
Road	0.162***	0.143**	0.417**	0.294**	0.333**
	(0.008)	(0.018)	(0.016)	(0.046)	(0.023)
Topography	-0.016	-0.032*	0.030	0.015	0.017
	(0.387)	(0.080)	(0.616)	(0.790)	(0.750)
Township	-0.101**	-0.090*	-0.346***	-0.301***	-0.272***
	(0.033)	(0.056)	(0.000)	(0.000)	(0.001)
Transmission channels					
Share of workers in TVE	0.040***	0.041***		0.065	0.109*
	(0.009)	(0.006)		(0.289)	(0.091)
NA family businesses	4.52E-05	4.35E-06		1.57E-05	4.02E-05
	(0.777)	(0.978)		(0.953)	(0.879)
Diversification	0.032	0.035		-0.015	0.016
	(0.335)	(0.294)		(0.767)	(0.771)
Harris market potential	0.096***			0.075**	
	(0.000)			(0.015)	
Agg inc 0 - 50 km		1.03E-04***			1.43E-04***
		(0.001)			(0.005)
Agg inc 50 - 100 km		8.79E-05**			1.17E-04**
		(0.011)			(0.020)
Agg inc 100 - 150 km		1.14E-04***			1.26E-04***
		(0.000)			(0.006)
Agg inc 150- 200 km		1.09E-04***			1.19E-04**
		(0.000)			(0.020)
Constant	-16.73	-21.01	24.95	8.404	5.589
	(0.673)	(0.581)	(0.214)	(0.645)	(0.745)
Provincial dummies	Yes	Yes	Yes	Yes	Yes
Regional dummies	Yes	Yes	Yes	Yes	Yes
Observations	4530	4530	1997	1997	1997
Adj. R^2	0.18	0.18	0.20	0.20	0.20

*, **, *** indicate significance at the 10%, 5% and 1% levels respectively. *p-values* in parenthesis. The dependent variable is the logarithm of hourly earnings. The models have been estimated using a bootstrap procedure with 500 replications.

appears to be one significant transmission channel leading workers close to cities to be paid higher wages[28].

Secondly, we investigate whether workers close to cities are paid higher wages thanks to commuting. As shown in Column (3), when excluding commuters, the coefficients associated with the variables distance are no longer significant. This indicates that workers in villages close to the county seat are more likely to commute to the county seat, where they engage in better paid jobs. Thus, differences in commuting opportunities play a very significant role in explaining wages disparities across rural workers. On the contrary, the coefficient of *Provincial City* remains strongly significant and its magnitude increases. Thus, even when commuters are excluded, workers close to cities are paid higher wages. This clearly arises from the higher level of wages in villages close to cities. As a consequence, workers close to cities are paid higher wages due to both spatial differences in wages across villages and to greater opportunities to commute. Finally, when controlling both for agglomeration externalities and for commuters, almost all the variables of interest are no longer significant, indicating that we have successfully captured the transmission channels at work.

5.5.3 Robustness checks

We investigate the robustness of our results by addressing the issues of ownership structure and endowments.

5.5.3.1 Ownership structure

Wages in the public sector are higher than the average in urban China (Démurger *et al.*, 2012). If wages are also higher in the public sector in rural China, and if the public sector is concentrated close to cities, this would upwardly bias the coefficients associated with urban proximity. Tables 5.5 and 5.6 present descriptive statistics in order to give some insights about whether or not the lack of control for ownership is likely to bias our results. Table 5.5 gives the average hourly wage in our sample for each specific sector: public, semi-public, private and other ownerships. Consistently, workers in the public sector benefit from the highest wages. Table 5.6 gives the share of non-agricultural workers in the village involved in each different ownership sector.

[28] The coefficients of the distance are almost not affected when we control for agglomeration externalities. This is consistent because market potential is measured at the county level. As every village located in the same county is given the same market potential, the market potential indicator does not capture the effect of the distance to the county seat variable.

According to the table, the ownership structure would not significantly differ between suburban and non-suburban villages. The semi-public sector would be slightly more present in suburban areas. However, given that wages in the semi-public sector are not significantly different than average wages (Table 5.5), this is unlikely to lead to estimation bias.

Even if the lack of control for ownership is not likely to lead to estimation bias, controlling for public ownership is an interesting robustness check. Indeed, wages in the public sector could be less influenced by market access compared with other sectors in China (Hering and Poncet, 2010).

It is quite challenging to take into account the ownership sector in the sample selection model. A first option would be to introduce a dummy variable to control for the sector. However, as we only observe ownership for local non-agricultural workers, it would not be correct to introduce this variable in the selection equation of the Heckman model. Another option would be to simply drop public workers from the analysis but this would lead to a selection bias. The most satisfactory solution consists in modeling the decision to work in the public sector as a specific choice, different from working in other sectors (see De Vreyer *et al.* (2010) and Wu (2010) for empirical applications). Consequently, to control for ownership, we consider non-agricultural wage-employment in the public sector as a distinct choice in the multinomial logit model[29] and we estimate the income equation for local non-agricultural wage-earners in the non public sector. Estimation results are reported in Table 5.7. Excluding public workers does not lead to an increase in the coefficients of interest. This may be due to the fact that public workers only account for a small share of our sample (about 8%). In addition, these additional results confirm that the lack of control for ownership does not lead to estimation bias.

[29]We do not distinguish between four ownerships (public, semi-public, private and other) but rather between two: public and not public. From an economic point of view, this is completely justified because Hering and Poncet (2010) demonstrate that all enterprises, except public ones, react to market potential. This classification is also justified from an econometric point of view. Indeed, the flexible Dahl model suffers from a significant loss of efficiency when the number of categories in the multinomial logit increases and when the sample size decreases (Bourguignon *et al.*, 2007). Distinguishing four ownerships would lead (i) to an increase in the number of categories in the multinomial logit model and (ii) to estimate the income equation for each respective ownership and thus, with few observations, both resulting in important losses of efficiency.

Table 5.5: Hourly wages disaggregated by ownership

	Nb. of workers	Average wage	SD	Difference†
All NAWE	4530	3.07	3.92	
According to ownership:				
Public	349	3.81	3.18	3.66***
Semi-public	526	3.11	2.65	0.24
Private	1694	2.76	3.79	-4.02***
Other	1961	3.19	4.39	1.79*

Notes: NAWE means local non-agricultural wage earners. † Tests of difference between means have been conducted to compare the wage in each sector to the average wage in the rest of the economy; *t-statistics* are reported in this column. *, **, *** indicate significance at the 10%, 5% and 1% level respectively.

Table 5.6: Share of non-agricultural wage-earners by ownership

	All villages♭ (N=788)		Suburban (N=62)		Non-suburban (N=726)		Difference†
	Mean	SD	Mean	SD	Mean	SD	
All NAWE	20.55	18.03	34.32	23.14	19.40	17.06	6.71***
According to ownership:							
Public	8.77	18.95	9.78	17.94	8.68	19.05	0.44
Semi-public	9.08	20.11	13.85	22.29	8.67	19.87	1.95*
Private	34.21	33.08	32.60	27.20	34.35	33.54	-0.40
Other	47.94	35.45	43.76	30.58	48.29	35.83	-0.97
Total	100		100		100		

Notes: NAWE means local non-agricultural wage earners. ♭ Villages with no local non-agricultural wage-earners are excluded from the table. † Tests of difference between means have been conducted to compare the ownership structure between suburban and non-suburban villages; *t-statistics* are reported in this column. *, **, *** indicate significance at the 10%, 5% and 1% level respectively.

Table 5.7: Ownership: excluding public workers

	No channels (1)	Agglo. externalities (2)	No commuters (3)	All channels (4)
Individual characteristics				
Age	0.045***	0.047***	0.058***	0.043***
	(0.000)	(0.000)	(0.000)	(0.002)
Age^2	-0.054***	-0.056***	-0.057***	-0.047***
	(0.000)	(0.000)	(0.000)	(0.001)
Education	0.032***	0.028***	0.030**	0.020
	(0.001)	(0.001)	(0.049)	(0.154)
Experience	0.086***	0.081***	0.122**	0.051
	(0.009)	(0.002)	(0.014)	(0.186)
$Experience^2$	-0.233***	-0.224***	-0.337**	-0.149
	(0.010)	(0.002)	(0.013)	(0.168)
Party member	0.202***	0.191***	0.483*	0.226
	(0.000)	(0.000)	(0.051)	(0.278)
Male	0.410***	0.411***	0.386***	0.311***
	(0.000)	(0.000)	(0.000)	(0.001)
Minority	-0.093	-0.047	-0.220**	-0.105
	(0.104)	(0.398)	(0.023)	(0.264)
Village characteristics				
Distance q1	-0.022***	-0.019***	-0.018	-0.022*
	(0.000)	(0.000)	(0.144)	(0.097)
Distance q2	-0.006**	-0.005***	-1.84E-04	-0.005
	(0.013)	(0.009)	(0.977)	(0.444)
Distance q3	-0.005***	-0.005***	-0.002	-0.005
	(0.009)	(0.002)	(0.680)	(0.339)
Distance q4	-0.002**	-0.002**	-8.56E-04	-0.001
	(0.034)	(0.023)	(0.750)	(0.549)
Low level city	0.066*	0.034	0.068	-0.005
	(0.100)	(0.318)	(0.322)	(0.929)
Provincial city	0.304**	0.247**	1.451***	0.961**
	(0.016)	(0.024)	(0.001)	(0.018)
Road	0.141**	0.136**	0.424**	0.282*
	(0.034)	(0.035)	(0.029)	(0.094)
Topography	-0.045**	-0.020	0.049	0.005
	(0.025)	(0.297)	(0.487)	(0.932)
Township	-0.101*	-0.092*	-0.277***	-0.236**
	(0.055)	(0.072)	(0.004)	(0.012)
Share of workers in TVE		0.048***		0.067
		(0.006)		(0.339)
NA family businesses		-2.88E-05		-3.77E-04
		(0.883)		(0.274)
Diversification		0.028		-0.011
		(0.419)		(0.841)
Harris market potential		0.091***		0.061*
		(0.000)		(0.063)
Constant	-2.721	-2.828	17.81	9.357
	(0.850)	(0.839)	(0.287)	(0.550)
Provincial dummies	Yes	Yes	Yes	Yes
Regional dummies	Yes	Yes	Yes	Yes
Observations	4181	4181	1862	1862
Adj. R^2	0.18	0.18	0.22	0.22

*, **, *** indicate significance at the 10%, 5% and 1% levels respectively. *p-values* in parenthesis. The dependent variable is the logarithm of hourly earnings. The models have been estimated using a bootstrap procedure with 500 replications.

5.5.3.2 Endowments

Differences in endowments are one major source of spatial differences in wages because endowments can affect workers' productivity (Hanson, 2000). Moreover, endowments are one major source of spatial agglomeration, so that they may be correlated with our indicators of urban proximity, leading to estimation bias. According to Hering and Poncet (2010), endowments are likely to vary across Chinese provinces so that provincial dummies should control for such differences.

However, to ensure robustness, we carry out two more tests. First, we substitute provincial dummies with county-level dummies[30]. Second, we follow Fally *et al.* (2010) by excluding from our analysis sectors which depend on natural resources. To do so, we consider non-agricultural wage employment in these sectors as a distinct choice in the multinomial logit model (as we did for commuters and for public workers). Estimation results are reported in Tables 5.8 and 5.9. We have re-estimated the baseline model and the "augmented" model with transmission channels. To limit the number of results, we only provide the estimation results obtained with the Harris market potential indicator, which is much more commonly used. Thus, results obtained in Tables 5.8 and 5.9 have to be compared with results presented in Column (6) of Table 5.3 and to columns (1), (3) and (4) of Table 5.4. With the exception of the coefficient of *Low level city*, which is no longer significant, results are very similar to those obtained until now, indicating that the results previously obtained are not driven by differences in endowments.

[30] In this case we cannot estimate the coefficient of the market potential given that the market potential is measured at the county level.

Table 5.8: Endowments: county-level dummies

	No channels (1)	Agglo. externalities (2)	No commuters (3)	All channels (4)
Individual characteristics				
Age	0.049***	0.050***	0.054***	0.054***
	(0.000)	(0.000)	(0.000)	(0.000)
Age^2	-0.061***	-0.060***	-0.060***	-0.060***
	(0.000)	(0.000)	(0.000)	(0.000)
Education	0.047***	0.046***	0.038***	0.040***
	(0.000)	(0.000)	(0.000)	(0.000)
Experience	0.142***	0.128***	0.091**	0.095***
	(0.000)	(0.000)	(0.040)	(0.005)
$Experience^2$	-0.368***	-0.332***	-0.261**	-0.266***
	(0.000)	(0.000)	(0.032)	(0.005)
Party member	0.201***	0.190***	0.263*	0.249*
	(0.000)	(0.000)	(0.099)	(0.053)
Male	0.485***	0.460***	0.328***	0.340***
	(0.000)	(0.000)	(0.000)	(0.000)
Minority	0.037	0.034	0.059	0.054
	(0.592)	(0.617)	(0.643)	(0.666)
Village characteristics				
Distance q1	-0.020***	-0.019***	-0.022**	-0.019*
	(0.000)	(0.000)	(0.028)	(0.078)
Distance q2	-0.006***	-0.006***	-0.003	-0.002
	(0.007)	(0.009)	(0.525)	(0.670)
Distance q3	-0.007***	-0.007***	-0.006	-0.006
	(0.000)	(0.000)	(0.130)	(0.134)
Distance q4	-0.003***	-0.003***	-0.002	-0.002
	(0.000)	(0.000)	(0.262)	(0.297)
Low level city	0.128	0.120	0.085	0.099
	(0.151)	(0.182)	(0.540)	(0.482)
Provincial city	1.714***	1.645***	2.187***	1.980***
	(0.000)	(0.000)	(0.004)	(0.005)
Road	0.154**	0.136**	0.277*	0.272*
	(0.017)	(0.033)	(0.082)	(0.061)
Topography	0.026	0.023	0.016	0.012
	(0.309)	(0.357)	(0.774)	(0.805)
Township	-0.0740	-0.0762*	-0.249***	-0.240***
	(0.110)	(0.100)	(0.001)	(0.001)
Share of workers in TVE		0.050***		0.082
		(0.000)		(0.102)
NA family businesses		1.64E-04		5.21E-05
		(0.325)		(0.834)
Diversification		0.017		0.008
		(0.637)		(0.893)
Harris market potential		-		-
Constant	5.455	-2.321	-7.900	-9.075
	(0.847)	(0.934)	(0.584)	(0.516)
Regional dummies	Yes	Yes	Yes	Yes
Provincial dummies	No	No	No	No
County-level dummies	Yes	Yes	Yes	Yes
Observations	4530	4530	1997	1997
Adj. R^2	0.22	0.23	0.29	0.29

*, **, *** indicate significance at the 10%, 5% and 1% levels respectively. *p-values* in parenthesis. The dependent variable is the logarithm of hourly earnings. The models have been estimated using a bootstrap procedure with 500 replications.

Table 5.9: Endowments: excluding workers engaged in natural resources sectors

	No channels (1)	Agglo. externalities (2)	No commuters (3)	All channels (4)
Individual characteristics				
Age	0.043***	0.045***	0.065***	0.057***
	(0.000)	(0.000)	(0.000)	(0.000)
Age^2	-0.053***	-0.055***	-0.072***	-0.067***
	(0.000)	(0.000)	(0.000)	(0.000)
Education	0.044***	0.043***	0.052***	0.042***
	(0.000)	(0.000)	(0.000)	(0.000)
Experience	0.103***	0.103***	0.169***	0.106***
	(0.002)	(0.000)	(0.002)	(0.005)
$Experience^2$	-0.258***	-0.257***	-0.446***	-0.283***
	(0.005)	(0.000)	(0.002)	(0.006)
Party member	0.187***	0.180***	0.372	0.191
	(0.000)	(0.000)	(0.102)	(0.291)
Male	0.362***	0.374***	0.433***	0.388***
	(0.000)	(0.000)	(0.000)	(0.000)
Minority	-0.063	-0.023	-0.192**	-0.112
	(0.276)	(0.683)	(0.034)	(0.216)
Village characteristics				
Distance q1	-0.020***	-0.017***	-0.023**	-0.024**
	(0.000)	(0.001)	(0.030)	(0.035)
Distance q2	-0.006**	-0.005***	-0.004	-0.007
	(0.013)	(0.007)	(0.483)	(0.221)
Distance q3	-0.005**	-0.005***	-0.006	-0.007
	(0.013)	(0.003)	(0.255)	(0.137)
Distance q4	-0.002**	-0.002**	-0.003	-0.003
	(0.033)	(0.018)	(0.167)	(0.103)
Low level city	0.060	0.037	0.087	0.030
	(0.136)	(0.269)	(0.194)	(0.641)
Provincial city	0.514**	0.251	1.850***	1.437***
	(0.011)	(0.163)	(0.000)	(0.001)
Road	0.133**	0.132**	0.401**	0.298**
	(0.041)	(0.038)	(0.020)	(0.042)
Topography	-0.069***	-0.046**	0.004	0.011
	(0.004)	(0.039)	(0.933)	(0.841)
Township	-0.107**	-0.113**	-0.316***	-0.275***
	(0.037)	(0.023)	(0.001)	(0.002)
Share of workers in TVE		0.033**		0.056
		(0.035)		(0.365)
NA family businesses		1.01E-04		5.36E-05
		(0.542)		(0.855)
Diversification		0.037		0.005
		(0.269)		(0.923)
Harris market potential		0.087***		0.079**
		(0.000)		(0.015)
Constant	-32.98	-5.468	11.84	-2.176
	(0.217)	(0.833)	(0.552)	(0.904)
Provincial dummies	Yes	Yes	Yes	Yes
Regional dummies	Yes	Yes	Yes	Yes
Observations	4414	4414	1932	1932
Adj. R^2	0.18	0.18	0.21	0.21

*, **, *** indicate significance at the 10%, 5% and 1% levels respectively. *p-values* in parenthesis.
The dependent variable is the logarithm of hourly earnings.

5.5.4 Discussion

5.5.4.1 Firm size

A first objection could be made regarding the lack of control for firm size. Bigger firms are more able to specialize their production, leading to productivity gains, for example through learning-by-doing and through a reduction in costs as workers do not have to switch tasks. Thus, bigger firms may be able to pay higher wages. Moreover, bigger firms, which are more able to survive in a more competitive environment, could be more numerous close to cities. Thus, firm size may be correlated with our indicators of urban proximity, leading to an upward estimation bias. In the literature, very few studies have controlled for firm size. On the one hand, studies at the county-level are unable to control for firms' characteristics. On the other hand, most micro-economic studies lack data on firms' characteristics (Aminiti and Cameron (2007), Mion and Naticchioni (2009) and Fally *et al.* (2010) are notable exceptions). In our case, the lack of data prevents us from controlling for firm size; this point should be kept in mind.

5.5.4.2 Industry structure

Another objection could be made regarding the lack of control for industry structure. As for ownership, if the most remunerative industries are concentrated around cities, this would lead us to over-estimate the effect of urban proximity. Tables 5.10 and 5.11 give some insights about whether or not the lack of control for industry is likely to bias our results. First, wages are significantly different from the average in most industries. Consistently, they are significantly lower than the average in the construction and restaurant industries, whereas they are higher in transport and communication, education and government (Table 5.10). However, according to Table 5.11, there would be almost no difference in the industry structure across villages. Indeed, "Commerce and trade" and "Services" would be the only industries for which there would be a difference. Yet, as wages in these sectors are not statistically different than the average wage, this is unlikely to bias our results. Given that, and because of the three following additional reasons, we do not control for ownership in our study. The first additional reason is that, in fact, some industries are already controlled for. Specifically, the industries for which we expect the effect of urban proximity to be the lowest (education and government) belong to the public sector. As a result, controlling for the public sector is very similar to controlling for those two activity sectors. Moreover, to control for endowments, we have excluded from the analysis workers that belong to the "mineral and geological survey" sector. The second reason is that, contrary to studies on agglomeration economies in urban areas, we do not need to estimate a model disaggregated by sector to capture the effect of specialization. As already explained in this chapter, what matters in the context of agrarian economies is to specialize out of agriculture. In this context, looking at the effect of specialization out of agriculture is more relevant than testing the effect of specialization in one particular non-agricultural sector. Lastly, controlling for activity sectors would result in very high losses of efficiency due to an increase in the number of categories in the selection equation and to a reduction of the sample size in the income equation (Bourguignon *et al.*, 2007).

Table 5.10: Hourly wages disaggregated by industry

	Nb. of workers	Average wage	SD	Difference†
All NAWE	4530	3.07	3.92	
According to industry:				
Mineral and geological survey	116	2.95	1.95	-0.32
Industry	1259	2.96	3.98	-1.13
Construction	745	2.63	3.22	-3.32***
Transport and communication	128	4.13	4.76	3.13***
Commerce and trade	146	2.80	3.60	-0.81
Restaurant	99	2.32	2.44	-1.89*
Education	224	3.49	2.56	1.66*
Government agencies	251	3.88	3.70	3.40***
Services	158	2.79	2.00	-0.87
Other	1404	3.20	4.63	1.55

Notes: NAWE means local non-agricultural wage earners. † Tests of difference between means have been conducted to compare the wage in each sector to the average wage in the rest of the economy; *t-statistics* are reported in this column. *, **, *** indicate significance at the 10%, 5% and 1% level respectively.

Table 5.11: Share of non-agricultural wage-earners by industry

	All villages[♭] (N=788)		Suburban (N=62)		Non-suburban (N=726)		Difference[†]
	Mean	SD	Mean	SD	Mean	SD	
All NAWE	20.55	18.03	34.32	23.14	19.40	17.06	6.71***
According to industry:							
Mineral and geological survey	2.86	12.64	1.91	10.65	2.94	12.79	-0.62
Industry	19.91	28.51	21.66	25.70	19.76	28.75	0.50
Construction	18.21	26.87	15.66	23.18	18.42	27.16	-0.78
Transport and communication	3.23	10.37	4.04	8.17	3.16	10.53	0.64
Commerce and trade	2.95	9.84	5.30	12.99	2.75	9.50	1.95*
Restaurant	2.56	10.89	2.35	5.76	2.58	11.23	-0.16
Education	6.22	16.47	3.59	13.42	6.44	16.69	-1.31
Government agencies	7.45	18.72	6.26	12.98	7.55	19.13	-0.52
Services	3.52	11.61	6.62	13.07	3.26	11.45	2.20**
Other	33.09	33.12	32.61	31.98	33.14	33.23	-0.12
Total workers	100		100		100		

Notes: NAWE means local non-agricultural wage earners. [♭] Villages with no local non-agricultural wage-earners are excluded from the table. [†] Tests of difference between means have been conducted to compare the industrial structure between suburban and non-suburban villages; *t-statistics* are reported in this column. *, **, *** indicate significance at the 10%, 5% and 1% level respectively.

5.5.4.3 Spatial sorting of workers

We could also wonder whether wages are higher close to cities because the most productive workers agglomerate in villages close to cities. Indeed, spatial differences in wages can arise from spatial differences in the skill composition of the workforce (Glaeser and Maré, 2001; Combes *et al.* 2008; Mion and Naticchioni, 2009). As Combes *et al.* (2008) highlight, the best way to control for the spatial sorting of workers consists in using individual-level data (to control for observable characteristics of workers) and in using panel data (to control for invariant and unobserved workers' characteristics).

First, by using micro-level data, we are able to control for a wide range of workers' characteristics in our estimates. Thus, we control for the fact that workers can sort across locations according to their observable characteristics.

Nevertheless, workers could also sort across locations according to their unobservable characteristics. Specifically, our results could be biased if the most motivated and talented rural workers moved to villages close to cities. Thus, spatial sorting of workers could still lead to estimation bias because of the migration of workers[31]. In this case, the best solution to control for spatial sorting of workers would be to use panel data. However, we only have data for the year 2002. Indeed, although there are several waves of rural surveys in the CHIP data (1988; 1995; 2002; 2007), individuals, villages and provinces surveyed are not the same from one survey to another. The questionnaires themselves also change from one wave to another.

In our view, even if we lack panel data, it is highly unlikely that the spatial sorting of workers leads to estimation bias in our study for the following two reasons. First, as Combes *et al.* (2012) highlight, spatial sorting of workers is almost non-existent in China because of the institutional system, which for decades has strictly restricted internal migration (Household registration system or *hukou*). The authors make this observation for urban China but it is also relevant (indeed, even more relevant) for rural China, where migration is much lower than in urban areas[32]. In other words, spatial sorting across rural areas is very unlikely in China because there are almost no migrants who settle in rural China, due to the specific institutional and economic context. Second, our study is carried out on the sample of local workers. Thus, even if migration is very low in rural China, it is controlled for in our empirical analysis. Even if the most talented workers moved to villages close to cities, they are classified in the "migrants" category and thus, they are not taken into account in our analysis of the determinants of hourly wages. As a consequence, working on the sample of local workers eradicates any potential spatial sorting of workers.

Finally, it is worth noting that, if we had panel data, it would be impossible for us to control for selection bias. Indeed, models of selection bias corrections based on the multinomial logit model can only be applied to cross-sectional data (Combes *et al.*, 2011). Thus, while we acknowledge that the lack of panel data makes it impossible to control for the improbable spatial sorting of workers, the lack of panel data is highly "preferable" because it enables us to control for the selection bias which is, according to our estimates, at work in our study.

[31]According to Mion and Naticchioni (2009), the spatial sorting of workers does not necessarily require that workers migrate across location. For example, if returns to education are higher in villages close to cities, this would foster human capital accumulation, leading to a concentration of skilled workers in these villages. However, this type of spatial sorting is already controlled for in our study, thanks to the micro-level data.

[32]The 2000 census data gives valuable information about migration across rural and urban areas. On the whole, 6.34% of the population in China resides outside his home county. The percentage reaches 15.97% of the population in cities whereas migrants only represent 2.28% of the population in rural counties. Thus, most migrants in China leave the countryside to go to cities, which offer the most numerous and the best employment opportunities. On the contrary, there are very few migrants who settle in rural China, because of the very limited employment opportunities.

5.5.4.4 Regional heterogeneity

As presumed in the general introduction of the thesis, and as estimated in Chapter 4, urban effects on rural areas are likely to vary across Chinese regions. Until now, we have found that urban proximity enhances agricultural efficiency much more in Eastern China than in Central and Western China. In our opinion, urban areas are also more likely to impact non-agricultural wages in nearby rural areas in Eastern China. Indeed, as Eastern rural areas benefit from location advantages, rural industry concentrates much more in the vicinity of Eastern urban areas than in the vicinity of other urban areas (Naughton, 2007). Specifically, the new competitive industrial clusters that have appeared over the last decade in rural China (see Section 5.2), are mainly located in Eastern provinces. Thus, agglomeration externalities are much more likely to occur in rural areas close to cities in *Eastern* China. Consistently, Table 5.12 confirms that the rural non-agricultural sector is more developed in Eastern China as a larger share of rural workers are involved in local non-agricultural wage employment in Eastern provinces (28.21%) than in Central and Western provinces (respectively 18.21% and 14.44%).

Table 5.12: Local non-agricultural wage-earners by region

	Total workers	Local NAWE	
		Effective	% in total workers
Full sample	22,551	4530	20.09
East	6754	1905	28.21
Central	9134	1663	18.21
West	6663	962	14.44

To test whether urban effects are heterogeneous across Chinese regions, we have re-estimated the baseline model separately for Eastern, Central and Western provinces. Results are reported in Table 5.13. Consistent with what we expected, it appears that urban proximity has a higher effect on rural non-agricultural workers' wages in Eastern China, although urban effects are not limited to Eastern China. Indeed, the coefficient associated to the variables of interest is of the expected sign and statistically significant in every case for the sub-sample of Eastern provinces. On the other hand, urban proximity does not have a significant effect on wages in Central provinces[33]. Finally, in Western China rural workers closer to the county seat are paid

[33] Consistently, as there are no provincial-level cities in Central China, the coefficient associated to the *Provincial*

significantly higher wages. However, being close to a city does not have any significant impact on wages.

Table 5.13: Regional heterogeneity

	Full sample (1)	East (2)	Center (3)	West (4)
Individual characteristics				
Age	0.046***	0.035**	0.024	0.074***
	(0.000)	(0.010)	(0.103)	(0.002)
Age^2	-0.056***	-0.041***	-0.031*	-0.085***
	(0.000)	(0.003)	(0.052)	(0.004)
Education	0.043***	0.060***	0.030***	0.042**
	(0.000)	(0.000)	(0.000)	(0.016)
Experience	0.116***	0.132**	0.040	0.080
	(0.001)	(0.019)	(0.349)	(0.399)
Experience^2	-0.297***	-0.307**	-0.094	-0.175
	(0.001)	(0.030)	(0.458)	(0.530)
Party member	0.183***	0.215**	0.144**	0.087
	(0.000)	(0.018)	(0.032)	(0.295)
Male	0.423***	0.388***	0.274**	0.453*
	(0.000)	(0.000)	(0.020)	(0.058)
Minority	-0.104*	0.017	-0.192	-0.116
	(0.063)	(0.888)	(0.140)	(0.193)
Village characteristics				
Distance q1	-0.022***	-0.048***	0.011	-0.038***
	(0.000)	(0.000)	(0.204)	(0.005)
Distance q2	-0.006**	-0.015***	0.007**	-0.012**
	(0.011)	(0.000)	(0.044)	(0.023)
Distance q3	-0.005***	-0.007**	0.001	-0.016***
	(0.005)	(0.019)	(0.814)	(0.009)
Distance q4	-0.003**	-0.004*	0.003	-0.005**
	(0.018)	(0.076)	(0.131)	(0.029)
Low level city	0.077*	0.180**	-0.037	-0.037
	(0.072)	(0.020)	(0.533)	(0.701)
Provincial city	0.567**	0.553***	-	0.579
	(0.015)	(0.007)		(0.159)
Road	0.170**	-0.084	0.287**	0.133
	(0.024)	(0.401)	(0.047)	(0.241)
Topography	-0.045**	-0.129***	0.002	-0.094
	(0.037)	(0.003)	(0.962)	(0.108)
Township	-0.104*	-0.391***	-0.079	0.116
	(0.079)	(0.003)	(0.340)	(0.194)
Constant	-47.29	51.96	-91.16	-30.26
	(0.311)	(0.512)	(0.111)	(0.663)
Regional dummies	Yes	No	No	No
Provincial dummies	Yes	Yes	Yes	Yes
N	4530	1905	1663	962
Adj. R^2	0.18	0.20	0.19	0.17

Notes: *, **, *** indicate significance at the 10%, 5% and 1% levels respectively. *p-values* in parenthesis. The dependent variable is the logarithm of hourly earnings. The models have been estimated using a bootstrap procedure with 500 replications.

City dummy cannot be estimated.

5.6 Conclusion

We provide a thorough analysis of the effects of urban proximity on rural non-agricultural wages, which are a crucial determinant of the level of earnings and well-being of rural households. We find that remote workers not only suffer from lower opportunities to diversify out of agriculture locally, but, in addition, when they manage to diversify, they engage in lower paid non-agricultural jobs. By demonstrating that non-agricultural wages vary according to the distance from urban centers, we shed additional light on intra-rural inequality and on the geographic repartition of poverty in China. Our results are consistent with Xia and Simmons (2004), according to which birthplace still plays a significant role in determining an individual's place of work, earnings and well-being. In order to reduce poverty and inequality in rural China, rural development policies not only must pay attention to the individual determinants of job access and earnings but also to their spatial determinants.

In addition, workers close to cities benefit from higher wages because of the combining effect of market potential, which increases wages close to cities, and of commuting. Thus, our results suggest that a minority of villages located close to urban areas benefit from significant productive advantages (mainly due to their greater market potential), which could lead to a process of cumulative causation leading new industry to primarily set up in villages close to cities. In this context, it may be difficult for rural policies to attract new industries or relocate existing ones to peripheral rural areas. This issue is extremely serious given that non-agricultural employment strongly determines rural welfare. Finally, we have found additional evidence that rural areas benefit more from urban proximity in Eastern China.

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Appendix to Chapter 5

5.A Definitions of the variables

Table 5.14: Definitions of the variables

Variables	Definition	Unit
Age	Age of the worker	Year
Education	Number of years of schooling (not including years spent on repeating a grade)	Year
Experience	Number of years since when the worker starts a non-agricultural activity as his primary activity	Year
Party member	Dummy equal to 1 if the worker is member of the Communist Party, 0 otherwise	
Male	Dummy equal to 1 if the worker is a man, 0 otherwise	
Minority	Dummy equal to 1 if the worker is an ethnic minority, 0 otherwise	
Unmarried	Dummy equal to 1 if the worker is not married, 0 otherwise	
Land per capita	Total amount of land possessed per capita in the household	Mu
Distance	Distance from the nearest county seat	Kilometers
Quartile 1	Dummy equal to 1 if the worker's village is located within 10 km from the county seat (the first quartile of the distance is equal to 10 km)	
Quartile 2	Dummy equal to 1 if the worker's village is located within 10 and 20 km from the county seat (the median of the distance is equal to 20 km)	
Quartile 3	Dummy equal to 1 if the worker's village is located within 20 and 30 km from the county seat (the third quartile of the distance is equal to 30 km)	
Quartile 4	Dummy equal to 1 if the worker's village is located within 30 and 160 km from the county seat (the fourth quartile of the distance is equal to 160 km)	
Low level city	Dummy equal to 1 if the village is in the suburb of a prefecture city or if it is located in the administrative area of a county-level city, 0 otherwise	
Provincial city	Dummy equal to 1 if the village is in the suburb of a provincial-level city, 0 otherwise	
Road	Dummy equal to 1 if a road reaches the village, 0 otherwise	
Topography	Variable equal to 1 if the village is located in a plain, 2 if in a hilly area and 3 if in a mountainous area	
Township	Dummy equal to 1 if the township the village is in is a province level poverty township	
Living costs	Average market price of six non-staple foods (meat, eggs, edible oil, sugar, vegetables, fruit and melons)	Yuan
Share of workers in TVE	Share of employees in township and village enterprises in the village	%
NA family businesses	Number of non-agricultural family businesses in the village	
Diversification	Inverse of the Herfindahl index, calculated using labor force data at the village level, disaggregated into five sectors: agriculture; manufacturing; construction; wholesale, retail and food services; other industries	
Harris market potential	Sum of the GDP of the counties, weighted by the distance in km between the county in which the worker's village is located and other counties	Yuan
Agg inc within 0-50 km ring	Aggregate income between 0 and 50 km radii from county centroid	Yuan
Agg inc within 50-100 km ring	Aggregate income between 50 and 100 km radii from county centroid	Yuan
Agg inc within 100-150 km ring	Aggregate income between 100 and 150 km radii from county centroid	Yuan
Agg inc within 150-200 km ring	Aggregate income between 150 and 200 km radii from county centroid	Yuan

5.B Descriptive statistics

Table 5.15: Descriptive statistics

	All workers		NAWE		Other workers	
	Mean	SD	Mean	SD	Mean	SD
Age	38.89	13.43	39.61	11.92	38.70	13.78
Education	7.07	2.77	7.94	2.59	6.84	2.77
Experience	2.07	4.90	6.07	7.57	1.07	3.26
Party member	0.08	0.27	0.16	0.37	0.06	0.23
Male	0.53	0.50	0.73	0.43	0.47	0.49
Minority	0.12	0.32	0.06	0.24	0.13	0.33
Unmarried	0.21	0.40	0.15	0.36	0.22	0.41
Land per capita	1.92	2.09	1.53	1.66	2.01	2.17
Distance	24.32	20.98	19.85	16.64	25.44	21.79
Low level city	0.32	0.46	0.36	0.48	0.30	0.46
Provincial city	0.03	0.17	0.06	0.24	0.02	0.15
Road	0.96	0.19	0.97	0.17	0.96	0.19
Topography	1.73	0.78	1.61	0.73	1.76	0.78
Township	0.14	0.34	0.09	0.29	0.14	0.35
Living costs	4.65	0.60	4.69	0.58	4.63	0.60
Share of workers in TVE	0.11	0.51	0.28	1.05	0.07	0.20
Family business	26.34	52.58	33.58	69.44	24.53	47.26
Diversification	2.34	0.75	2.36	0.70	2.32	0.76
Harris market potential	107.84	223.07	153.16	284.39	96.48	203.31
Agg inc within 0-50 km ring	19 355.09	14 206.66	20 444.64	14 249.61	19 081.20	14 183.08
Agg inc within 50-100 km ring	698.98	808.65	1037.18	1150.51	613.97	670.55
Agg inc within 100-150 km ring	992.73	1028.73	1318.94	1340.29	910.72	916.17
Agg inc within 150-200 km ring	1281.84	1109.88	1633.89	1350.54	1193.34	1021.80
Total	22551		4530		18021	

Notes: NAWE means local non-agricultural wage earners.

5.C Test of the IIA assumption: Small-Hsiao test

Table 5.16: Test of the IIA assumption: Small-Hsiao test

Omitted working category	**LnL(full)**	**LnL(omit)**	**chi2**	**P>chi2**
Local non-agricultural wage-earners	-4194.584	-4151.552	86.064	0.123
Local non-agricultural self-employed	-7296.032	-7257.804	76.455	0.338
Migrants	-5778.988	-5739.797	78.382	0.284

Notes: LnL(full) refers to the log-likelihood for the unrestricted model (containing the entire choice set) and LnL(omit) refers to the log-likelihood for the restricted model (in which one of the working categories is omitted). The test statistics is calculated as: $chi2 = -2 \cdot (LnL(full) - LnL(omit))$.

5.D Commuting as a distinct choice in the multinomial model

Table 5.17: Commuting as a distinct choice in the multinomial logit model

	Multinomial logit model				**Income equations**	
	(1)	(2)	(3)	(4)	(5)	(6)
	NAWE No commuters	NAWE Commuters	NASE	Migration	NAWE No commuters	NAWE Commuters
Individual characteristics						
Age	0.073***	0.056***	0.085***	0.010	0.063***	0.029**
	(0.000)	(0.000)	(0.001)	(0.571)	(0.000)	(0.014)
Age^2	-0.089***	-0.109***	-0.129***	-0.117***	-0.068***	-0.023*
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.081)
Education	0.075***	0.078***	0.060***	0.047***	0.048***	0.032***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Experience	0.610***	0.592***	0.750***	0.785***	0.152***	-0.002
	(0.000)	(0.000)	(0.000)	(0.000)	(0.003)	(0.957)
$Experience^2$	-1.693***	-1.635***	-2.443***	-2.726***	-0.406***	0.036
	(0.000)	(0.000)	(0.000)	(0.000)	(0.004)	(0.781)
Party member	0.752***	-0.360***	-0.406***	-0.468***	0.372*	0.297*
	(0.000)	(0.000)	(0.005)	(0.000)	(0.088)	(0.082)
Male	0.834***	1.244***	0.828***	0.872***	0.432***	0.162*
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.097)
Minority	-0.283**	-0.271**	-0.206	-0.435***	-0.182**	0.015
	(0.031)	(0.028)	(0.320)	(0.000)	(0.031)	(0.841)
Village characteristics						
Distance q1	-0.006	-0.037***	-0.043**	0.029**	-0.027**	-0.006
	(0.656)	(0.002)	(0.024)	(0.027)	(0.013)	(0.443)
Distance q2	0.006	-0.017***	-0.017**	0.015**	-0.004	0.001
	(0.369)	(0.001)	(0.037)	(0.010)	(0.456)	(0.806)
Distance q3	-1.75E-04	-0.026***	-0.012**	0.011***	-0.006	0.004
	(0.966)	(0.000)	(0.027)	(0.006)	(0.230)	(0.303)
Distance q4	-0.005**	-0.013***	-0.017***	0.006***	-0.003	0.001
	(0.020)	(0.000)	(0.000)	(0.001)	(0.160)	(0.597)
Low level city	0.251***	0.393***	0.337***	-0.295***	0.101	-0.017
	(0.001)	(0.000)	(0.002)	(0.000)	(0.111)	(0.767)
Provincial city	2.990***	2.299***	1.840***	4.367***	1.734***	0.340
	(0.000)	(0.000)	(0.004)	(0.000)	(0.000)	(0.231)
Road	0.739***	0.114	0.286	0.059	0.417**	0.227*
	(0.000)	(0.404)	(0.203)	(0.661)	(0.016)	(0.052)
Topography	0.113**	-0.177***	0.065	0.151***	0.030	-0.030
	(0.020)	(0.000)	(0.345)	(0.001)	(0.616)	(0.533)
Township	-0.273***	-0.100	-0.830***	0.117	-0.346***	0.115*
	(0.007)	(0.273)	(0.000)	(0.143)	(0.000)	(0.073)
Land per capita	-0.040**	-0.066***	-0.072**	-0.063***		
	(0.025)	(0.000)	(0.022)	(0.000)		
Unmarried	-0.122	0.150	-0.474***	0.900***		
	(0.299)	(0.108)	(0.005)	(0.000)		
Constant	-8.237***	-4.629***	-7.271***	-6.486***	24.95	-11.23
	(0.000)	(0.000)	(0.000)	(0.000)	(0.214)	(0.511)
Regional dummies	Yes	Yes	Yes	Yes	Yes	Yes
Provincial dummies	Yes	Yes	Yes	Yes	Yes	Yes
Observations		22,551			1997	2533
Adj. R^2					0.20	0.19
Selection correction terms					1.32**	1.73***
Wald test for identif. restrict.	6.40**	17.11***	13.80***	114.92***		

Notes: *, **, *** indicate significance at the 10%, 5% and 1% levels respectively. *p-values* in parenthesis. The reference category in the multinomial logit model is made up of local agricultural workers. The models have been estimated using a bootstrap procedure with 500 replications.

Chapter 6

Environmental Inequality

The Role of Urban Proximity and Regional Borders

This chapter is an adapted version of an article published under the reference: C. Duvivier and H. Xiong "Transboundary Pollution in China: a Study of Polluting Firms' Location Choices in Hebei Province". *Environment and Development Economics*, available on CJO2013. doi:10.1017/S1355770X13000168.

6.1 Introduction

Since the beginning of the economic reforms, dramatic environmental degradation has accompanied China's spectacular economic performance. The level of pollution is now threatening both economic development and public health. According to the World Bank (2007), the total cost of air and water pollution in China amounts to 5.8% of GDP.

State of the environment in rural China

While it is widely recognized that cities suffer more from pollution than rural areas, over recent years rural areas have experienced much more significant environmental degradation. In cities, where environmental problems are extremely worrying and where incomes have significantly risen, urban dwellers have begun demanding better environmental quality. As a result, relatively stringent environmental regulation has been adopted in cities, which has progressively led to better environmental quality in urban areas. By contrast, in rural areas, where environmental standards are very low, environmental quality has been continuously deteriorating. Moreover, not only is environmental regulation more stringent in cities, it is also much better enforced in cities than in rural areas. As we will see in further detail in Section 6.2, China's environmental policy is decentralized: while the central government sets environmental standards, the local governments monitor and impose sanctions on polluters. Yet, local governments in urban areas have many more incentives and resources to enforce environmental standards than those in rural areas. As a result, rural areas may have turned into China's new "pollution havens", both because of lower environmental standards set at the national level and because the decentralized environmental policy has led to an "implementation gap" of environmental standards between urban and rural areas.

According to several descriptive works, the tightening of environmental regulations in cities has led an increasing number of polluting firms to locate in the recently established industrial zones in rural areas located just outside city boundaries (Economy, 2004; Wang, 2009). Thus, while stricter environmental regulation in urban areas has led to improvements in urban environmental quality, it may also have led to an accelerated relocation of polluting firms in nearby rural places, explaining why emissions remain high at the regional level. As a result, in addition to the pollution generated by agricultural production (especially due to the use of fertilizers and pesticides), rural areas have significantly and increasingly suffered from the effects of industrial pollution. For example, in 2000 it was estimated that Township and Village Enterprises (TVEs) generated as much as half of total national pollutant emissions (Tianje, 2008).

Environmental degradation in rural China is all the more problematic as rural households are extremely vulnerable to pollution (Liu, 2010). Indeed, degradation of land and water reduces agricultural yields and thus, farmers' income. For example, the World Bank (2007) has estimated that the use of polluted water for irrigation leads to a loss, in terms of production yields and quality, of about seven billion yuan each year. Furthermore, there has been virtually no state investment to develop environmental protection infrastructure in rural areas. Thus, while the rural population produces about 280 million tonnes of rubbish and nine billion tonnes of waste water, almost no villages are equipped with waste water and rubbish treatment facilities[1]. Rural inhabitants are also used to drinking water from natural sources so that water pollution has disastrous effects on their health. Finally, the rural population has limited access to health care and is often too poor to pay for treatment so that pollution has much more detrimental health consequences in rural areas than in urban areas.

Environmental degradation in rural areas, in conjunction with the high vulnerability of rural populations to pollution, has led to disastrous health consequences for rural inhabitants. According to the 2008 Third National Survey on Causes of Death of the Ministry of Health of China, cancer is the second cause of death in rural China, accounting for as much as 21% of deaths (Liu, 2010). The most dramatic illustration of the devastating impact of industrial pollution on health in rural areas is given by "cancer villages" (*aizheng cun*). These are villages where the number of cancer cases is extremely high, victims are younger than average, and industrial pollution is the likely cause of the cancer. The phenomenon appeared in the 1990s when a high number of chemical, steel and electronic factories began to locate in farming villages, heavily polluting the air and water. A striking fact is that contrary to the U.S., where cancer clusters are located in industrial urban sites, cancer villages are a *rural* phenomenon in China (Liu, 2010). According to Liu, the clustering of cancers in rural China is primarily due to the high vulnerability of rural households to pollution and to the government's environmental policy, which has continuously favored urban areas to the detriment of rural areas. Typically, cancer villages are located close to the largest Chinese cities as Houwanggezhuang village located about

[1] Jane Qiu, "China vows to clean up rural environment", *Nature*, April 1, 2011.

40 miles of the centre Beijing[2], or Liukuaizhuang village in Tianjin province, where nowadays almost every family has lost at least one member to cancer.

This critical situation has led to a very rapidly growing number of environmental disputes in rural China. In fact, although environmental disputes in urban China have attracted a great deal of attention, rural China has actually experienced a larger, and more rapidly growing number of "environmental mass incidents". However, environmental disputes in cities have attracted much more attention because they benefit from quite extensive media coverage, contrary to rural areas, where media coverage has often been censored (Tianje, 2008).

Aims and contributions of the chapter

Testing for the role of urban proximity

The present chapter aims at investigating whether, and why, localities close to cities disproportionately suffer from industrial pollution. In our opinion, polluting firms may be more likely to locate in the vicinity of cities for two reasons: (i) a "pure market effect", and (ii) to avoid the more stringent environmental regulation of cities.

First, counties close to cities benefit from locational advantages, leading firms to locate there disproportionately, whatever the pollution level they generate. As already explained in Chapter 3, counties close to cities benefit from productive advantages that make them much more attractive destinations for profit-maximizing firms than more remote areas[3] (Wu and Gopinath, 2008). Moreover, as cities develop, factor costs increase and the service sector grows, leading to a progressive reallocation of industrial activities to peripheral areas. As a result, counties close to cities are likely to suffer from more industrial pollution than areas further away from cities, simply because there are more firms locating there. It is worth noting that this phenomenon may concern both highly polluting and "non-polluting" firms and that it may occur even in the absence of stringent environmental regulation in urban areas.

Second, polluting firms may disproportionately locate close to cities in order to escape the more stringent environmental regulation of cities. Indeed, due to the tightening of environmental regulation in urban China, existing polluting firms may have closed and re-opened in neighboring counties. Moreover, this increase in environmental regulation in cities has made the creation

[2] Tom Phillips, "China admits pollution has caused cancer villages", *The Telegraph*, February 22, 2013.

[3] In Chapter 5, we have also demonstrated to some extent that factories locate more often in rural areas close to cities. Indeed, we have estimated that the closer the urban area, the higher the probability to engage in non-agricultural wage employment.

of polluting firms in cities more difficult. As a result, it is possible that new polluting firms wishing to set up in cities are obliged to locate in rural counties and locate as close as possible to the cities, *i.e.* in adjacent counties.

A first contribution of this chapter is to go beyond the study of the economic impact of cities on nearby areas. By studying whether urban proximity leads to a higher level of industrial pollution, we provide complementary results to the literature on urban effects, which has overwhelmingly focused on the role of cities on the economic performance of nearby rural areas. Although urban proximity may enhance economic performance in nearby rural places (Chapters 4 and 5), we will highlight that it may also reduce quality of life and increase rural vulnerability by leading to much higher pollution levels. A key step in addressing this issue is to disentangle whether this effect arises from a "pure market effect" or from the implementation of more stringent environmental regulation in cities. To our knowledge, until now no study has empirically assessed whether counties close to cities disproportionately suffer from industrial pollution in China.

By demonstrating that this phenomenon occurs, we also contribute to the very scarce literature on environmental inequality in China. Two notable exceptions are Ma (2010) and Schoolman and Ma (2011), who investigate how socioeconomic characteristics of townships influence the geographic repartition of pollution. Ma (2010) highlights that rural migrants disproportionately suffer from pollution in Henan. Schoolman and Ma (2011) also emphasize that migrants are disproportionately exposed to pollution in Jiangsu and put forth a general theory of environmental inequality by highlighting that in China, as in the US, individuals at the bottom of the social ladder bear most of the environmental burden. By adding an additional lens (urban proximity) to analyze environmental inequality, the present study provides complementary results to these previous works.

Testing for transboundary pollution

Finally, this chapter also presents the results of an article I have co-written with Hang Xiong on transboundary pollution[4] (see Duvivier and Xiong, 2013). In my view, it is particularly relevant to integrate this work into the present chapter for the following two reasons.

First, testing for both transboundary pollution and the effect of urban proximity helps us

[4]Transboundary pollution refers to the excess of pollution at provincial borders of the country.

better understand environmental inequality in China. In other words, the present chapter not only focuses on the effects of cities but also provides more general evidence on the role of two major spatial determinants of environmental inequality in China, namely borders and urban proximity.

Second, both the effect of urban proximity and of borders are closely linked to the issue of China's decentralized environmental policy. As already explained, and as we will see in more detail in Section 6.3, local governments have fewer incentives and resources to enforce environmental regulation in rural areas. As a result, the decentralized environmental policy can lead to an "implementation gap" in environmental standards between rural and urban areas, leading polluting firms to disproportionately locate close to cities. Similarly, and as we will see in more detail in Section 6.4, there is already quite strong evidence that a decentralized environmental policy can result in an excess of pollution at regional borders.

Thus, this chapter also contributes to the literature by studying whether or not transboundary pollution does indeed exist in China today. Until now, almost all studies on transboundary pollution have been focused on the United States (Helland and Whitford, 2003; Kahn, 2004; Sigman, 2005; Konisky and Woods, 2010). Indeed, very few have looked at this issue in emerging countries and, to our knowledge no study has been done on China[5].

Main results and structure of the chapter

To test for the effect of proximity to cities and regional borders, we study the location choices of polluting firms in Hebei, one of the most highly polluted provinces in the country. Specifically, we test whether polluting firms are more likely to locate in counties: (i) close to large cities (in terms of GDP), (ii) close to cities with stringent environmental regulation, and (iii) close to provincial borders. For this purpose, we use the lists of polluting firms published annually by the Ministry of Environmental Protection and by the Environmental Protection Bureau of Hebei Province. We find no evidence that being close to a county-level city significantly increases the number of polluting firms setting up in a given county. However, it appears that counties close to prefecture-level cities disproportionately suffer from pollution. Interestingly, this appears to arise both because of a market potential effect and because polluting firms aim at escaping the more stringent environmental regulation that is implemented in these cities. Finally, we find

[5] Lipscomb and Mobarak (2011) constitute one exception with their analysis of water pollution spillovers in Brazil.

evidence that counties close to regional borders are more attractive destinations for polluting firms than interior counties.

The remainder of the chapter is organized as follows. Following the introduction, in Section 6.2 we briefly present China's environmental policy. In Section 6.3 we explain why polluting firms would tend to agglomerate in counties close to cities. In Section 6.4 we study why, in the context of a decentralized policy, polluting firms would tend to agglomerate near regional borders. Section 6.5 describes the study area and the data. We present the estimation strategy in Section 6.6 and the results in Section 6.7. Finally, in Section 6.8 we conclude and offer some policy recommendations.

6.2 Environmental policy in China

6.2.1 A decentralized environmental policy

The Chinese environmental policy has gradually developed since the late 1970s, when the first environmental protection laws were adopted. Nevertheless, it is only after 1990 that environmental protection really becomes a political objective (Sinkule and Ortolano, 1995). The 2000s mark a new step in China's environmental policy, which has clearly been tightened over the past decade. For example, from 2002 to 2008, the total amount of collected pollution levies rose from 6.74 to 18.52 billion yuan (State Environmental Protection Agency, 2003; Ministry of Environmental Protection, 2009).

At the beginning, the power of the regional environmental agencies was extremely limited. During the 1980s, the environmental policy followed the general movement of decentralization occurring in the country; since then, environmental protection has depended largely on local governments. Nowadays, it is thereby managed at the national level by the Ministry of Environmental Protection (MEP) and at the regional and local level (provinces, prefectures and counties) by the Environmental Protection Bureau (EPB). The central government (MEP) establishes environmental standards, is responsible for coordinating regional interests and conflicts, and evaluates regional environmental performances. However, environmental policy is implemented by the regions (EPB). They monitor the emissions of polluters and impose penalties if the standards are not met. Decentralization of environmental policy in a country as heterogeneous as China offers undeniable advantages. Indeed, a decentralized environmental policy allows for greater flexibility as well as better information and adaptation to the local context. In other words, a decentralized policy is more efficient than a centralized one that would apply uniform rules across the country. However, Chinese local governors are evaluated more on their economic performance than on their environmental performance (Li and Zhou, 2005). Therefore, environmental protection has often been sacrificed to economic performance.

Facing this critical situation, we have recently observed a certain recentralization of environmental policy in China. In 2008, the State Environmental Protection Agency (SEPA) became the Ministry of Environmental Protection (MEP) in order to give more power to central government in terms of environmental protection. Moreover, between 2006 and 2008, six major supervision centers [6] were created. Each of these major centers is responsible for several provinces and supervises if they respect the environmental standards established by the central government. The centers are also in charge of coordinating interprovincial conflicts. These new centers constitute in fact a new intermediate level between central government and provinces, created in order to limit the negative effects of decentralization. However, until now, the power of these new centers has been very limited and the environmental policy is still largely implemented by Chinese provinces.

6.2.2 Impact of environmental regulations on polluting firms

Like all firms, those that pollute do not choose their location randomly: they decide to locate in a particular region to maximize their profit. Several studies show that in China, the location choice of both foreign (Wu, 1999) and Chinese firms (Wen, 2004) depends today on "rational economic considerations". Thus, firms are generally attracted to regions with good market opportunities and where labor is cheap and skilled.

Polluting firms, in addition, usually take into account the severity of environmental regulation when deciding where to locate. This is likely to be the case in China, where it has been shown that environmental regulations significantly raise the costs of polluting firms. For example, Wang (2002) estimates that pollution charges lead to a significant increase in expenditures on end-of-pipe water treatment facilities at the plant-level. Moreover, a higher number of

[6] Five centers were created in 2006 : the center of South China (Hubei, Hunan, Guangdong, Guangxi and Hainan), of the Southwest (Chongqing, Sichuan, Guizhou, Yunnan and Tibet), of the Notheast (Liaoning Jilin and Heilongjiang), of the Northwest (Shaanxi, Ningxia, Gansu, Qinghai and Xinjiang) and of the East (Shanghai, Jiangsu, Zhejiang, Fujian, Anhui, Jiangxi and Shandong). In 2008 the center of North China was created (Beijing, Tianjin, Hebei, Shanxi, Inner Mongolia and Henan).

inspections leads to a higher expected penalty for firms that do not comply with environmental standards and thus, significantly reduces the level of water and air pollution of industries in the city of Zhenjiang (Dasgupta *et al.*, 2001). In addition, although state-owned enterprises have more bargaining power with local authorities in terms of the charges they pay (Wang *et al.*, 2003), environmental policy also has a significant impact on them (Wang and Wheeler, 2005). As a consequence, given that environmental regulation in China imposes significant costs on polluting firms, we would expect these firms to locate in regions with less stringent environmental regulation.

6.3 Why would polluting firms be more likely to locate close to cities?

As explained in Section 6.2.2, polluting firms are expected to locate in regions with less stringent environmental regulations. In this section, we explain why there are differences between urban and rural areas in China both in terms of environmental regulations and the level of their enforcement. Because of this gap between cities and rural areas, existing polluting firms in urban areas are likely to relocate to nearby localities and new polluting firms are likely to locate directly in counties close to cities.

In China, the environmental policy has been strongly urban-biased for a long time, resulting in a strong divide in environmental laws between rural and urban areas. (Liu, 2010). For example, while emission targets have been adopted in cities for quite a long time, it was only in 2011 that the Vice Minister of Environmental Protection, Li Gangjie, announced that specific emission targets would also be imposed in rural areas. Until then, air and water pollutant emissions in rural areas were not taken into account by the central government in its evaluation of emission levels at the national level[7]. For the first time, the central government has also committed in its 12^{th} Five-year Plan (2011-2015) to implement more stringent environmental regulation in rural areas and environmental protection in rural areas has been included in China's Five-year budget plan.

In cities, not only is environmental regulation more stringent than in rural areas but, in addition, the *enforcement* of environmental laws is much more effective (Wang *et al.*, 2008).

[7]"Pollution rurale: le temps du grand ménage", *China Daily*, March 29, 2011.

For example, Xu (1999) observes from a field study that in 1998 in Jiangsu province, less than 10% of TVEs effectively complied with environmental laws. Moreover, while many rural enterprises generated greater pollutant emissions than their urban counterparts, most of them had never been inspected.

In our opinion, three broad reasons may explain why environmental regulation is less effectively enforced in rural areas than in urban areas: (i) local governments in rural areas have fewer resources, (ii) local government have fewer incentives, and (iii) rural industries are more difficult to monitor.

Local governments in rural areas have far fewer resources to turn away businesses and to enforce environmental regulation. Indeed, rural industries generate huge financial benefits for poor rural localities, both in terms of tax revenues and job creation (Wang *et al.*, 2008). For example, the Lianhua Gourmet Powder Company (Xiangcheng county, Henan province), which is highly suspected of poisoning the local environment, is allowed to continue operating without government interference as it employs more than 8,000 workers and is the largest taxpayer in the county[8]. In fact, local officials in rural areas are often encouraged not to comply with environmental standards in order to induce polluting firms to locate in their jurisdiction, which could lead to a "race to the bottom" phenomenon (Tianje, 2008). In addition, rural localities have far fewer resources to enforce environmental regulation because the Chinese environmental policy has been strongly urban-biased. Most resources to fight pollution and monitor enterprises are directed towards urban areas. Thus, at the county level, EPB in rural areas are much more under-staffed and benefit from much less qualified personal and fewer financial resources than EPB in urban areas (Swanson *et al.*, 2001). Moreover, at the provincial level, most monitoring staff in EPB focus on urban administrative areas so that very few inspectors and resources are effectively allocated to monitor rural enterprises (Wang *et al.*, 2008). As a result, TVEs are much less frequently inspected than their urban counterparts.

Secondly, local officials in rural areas often lack incentives to effectively enforce environmental regulation. Indeed, as in cities, political promotion in rural areas is based on economic performance and not on environmental quality. As Wang *et al.* (2008) underline, environmental quality only matters for an official's promotion when an environmental scandal is made public. Yet, environmental disasters are more likely to be made public in urban areas, where the

[8]Jim Yardley, "Rivers Run Black, and Chinese Die of Cancer", *The New York Times*, September 12, 2004.

population is much more widely covered by the media than the rural population[9]. In addition, local officials in rural areas are sometimes direct stakeholders in polluting firms, which leads to conflicts of interest. In such cases, local officials, who are usually in charge of pollution controls, have no incentive to enforce environmental laws, which would penalize their enterprise and thus, reduce their personal income (Xu, 1999). Even when local officials are not direct stakeholders, enterprise managers often maintain close relationships with local officials and with the local environmental staff. As a result, enterprise managers are usually "informed" before an inspection occurs, which enables them to temporarily stop their production and successfully pass the environmental inspection (Wang *et al.*, 2008).

Finally, the specific characteristics of rural enterprises make the enforcement of environmental standards particularly difficult in rural areas. Indeed, polluting firms in rural areas are much smaller, spatially dispersed and financially instable. As a result, the cost of monitoring polluting firms is much higher in rural than in urban areas (Xu, 1999). This, combined with the more limited resources available for environmental protection in rural China, has led local EPB to monitor only a very small number of polluting firms in rural areas, the vast majority of polluting TVEs not being bothered.

The tightening of the environmental regulation in cities, in conjunction with poorly enforced low environmental standards in rural areas, may have led to the degradation of environmental quality in rural areas. First, urban polluting firms have been obliged to replace their out-dated and dirty production technologies by cleaner ones. Unfortunately, this has created opportunities for rural firms to buy from urban firms their out-dated and used equipment production (Xu, 1999). Second, it seems that the most highly polluting firms in urban areas have generally not adopted new production technologies. Instead, they have simply closed and re-opened just outside the city boundaries to escape from the stringent environmental regulation enforced in cities (Economy, 2004). Moreover, it is also possible that new polluting firms wishing to locate in cities move to nearby counties as no better option is available.

[9] Tianje (2008) gives a very meaningful example of this issue by mentioning the construction project of a chemical plant in Fujian province. In June 2007, the construction project of a chemical plant in Xiamen city generated a huge peaceful protest in the streets of Xiamen city. The protest was extensively covered by the media so that the project to build the plant in the city was finally abandoned. However, in December it was announced that the provincial government had decided to build the plant in a rural town in the neighboring Zhangzhou prefecture (Fujian province). This news led to a wide protest in the rural area, which was severely received by the police. Moreover, the dispute in the rural area went largely unreported in the media. This case is very meaningful as it highlights how two disputes caused by the same construction project, one in Xiamen city and one in a nearby rural area, were very unevenly covered by the media.

Several descriptive works have provided evidence on specific cases, indicating that polluting firms have been relocating outside the city boundaries over the recent period. For example, Xu (1999) points out that at the end of the 1990s, about 700 industrial factories located in the center of Shanghai city and considered as "serious polluters" closed and re-opened in the close periphery. According to Xu (1999), this was due to two reasons: (i) to make room to allow the tertiary sector to develop in Shanghai city, and (ii) to reduce pollution in the city center. Economy (2004) and Tianje (2008) provide additional examples of relocations of polluting firms from downtown to peripheral areas in China.

To our knowledge, until now there is no study which empirically assesses whether the more stringent environmental regulation in Chinese cities has effectively led to a significant reallocation of polluting firms from downtown to peripheral areas. As Xu (1999) highlights, the increasing number of polluting firms in counties close to cities could arise both from the natural pattern of economic development (urban market effect, tertiarisation of cities and relocation of industry to peripheral areas) and from the tightening of environmental regulation in cities. The present study tries to provide additional evidence on this issue, especially by empirically disentangling the relative role of the "pure urban market effect" from the effect of the environmental regulation of cities.

6.4 Why would polluting firms be more likely to locate near borders?

As explained in Section 6.2.2, polluting firms are expected to locate in regions with less stringent environmental regulations. In this section, we explain how regional differences in environmental regulations may lead polluting firms to locate more frequently in border counties. Specifically, two phenomena could lead to transboundary pollution, namely "pollution havens" and "free-riding" effects. In our opinion, this may explain why over the last years more and more environmental conflicts between provinces have been attracting great attention in China[10].

[10]For example, in January 2008, residents of the *Wuqing* district (Tianjin province) complained that a cement plant in the neighboring *Xianghe* county (Hebei province) had over-discharged dust pollution which then crossed the province border and damaged their soil and crop production (Wuqing District Environmental Protection Bureau, 2008). Disputes involving the *Huai* River, which runs through Henan, Shandong, Anhui and Jiangsu provinces, are also very illustrative of ever-increasing transborder conflicts. On several occasions, downstream provinces have accused upstream provinces of dumping pollution into the river in order to evacuate it to other provinces. As polluters from a given province can evacuate a part of their pollution to other provinces, there is a risk of excess of pollution at regional borders of the countries.

6.4.1 Differences in interprovincial regulation: pollution havens hypothesis at the provincial level

In China, environmental policy implementation varies greatly from one province to another (Wang and Wheeler, 2005). Such disparity in policy enforcement by region would be at the origin of a "pollution havens" phenomenon at the provincial level[11]: polluting firms would be attracted to provinces where environmental regulations are less strict (Dean *et al.*, 2009). Indeed, at the borders, there are discontinuities in environmental regulations (Kahn, 2004). By crossing an administrative boundary, one can suddenly move from strict environmental regulation to a less restrictive one. In this context, it could be very profitable for a firm to locate on the border between two provinces. Crossing a border can therefore be a way to avoid stringent environmental regulations while continuing to benefit from the market access of the neighboring province with stricter environmental regulation. Kahn (2004) shows that in the United States, in low environmental regulation states, "dirty" industries locate more often in counties that border high regulation states than in interior counties. Conversely, in counties bordering low regulation states, there is a lower number of polluting firms. In terms of environmental regulation, Hebei is less stringent than its neighbors, with the exception of Inner Mongolia[12]. Thus, on the whole, we can expect the pollution havens effect to be positive in Hebei province, leading polluting firms to concentrate close to borders.

6.4.2 Differences in intra-provincial regulations: free-riding and intra-provincial pollution havens hypotheses

When environmental policy is decentralized, provincial regulators may be less strict in implementing the policy in border counties than in interior ones. In other words, free-riding may emerge at the boundaries between different regions of the country[13]. Two factors could encourage regulators to strategically implement environmental regulation, both leading to an excess

[11] The hypothesis of "pollution havens" is generally considered at the international level. According to this hypothesis, in a world of free trade, the South, whose environmental regulations are less stringent, has a comparative advantage in producing "dirty" goods. This can lead polluting industries to migrate from the North to the South.

[12] Using data from the 2002 China Environment Yearbook, we calculate two indicators at the provincial level to measure environmental stringency: the levy fees divided by the number of charged organizations and the share of industrial pollution treatment investment in innovation investment. In each case, Inner Mongolia is the only neighboring province with less stringent regulation than Hebei (see Appendix 6.A). Dean *et al.* (2009) obtain the same ranking using the average collected levy per ton of wastewater as the indicator of *de facto* provincial stringency.

[13] "Region" here refers to a U.S. state or a Chinese province.

of pollution at borders. First of all, at borders, a region's expenditure on pollution control does not solely benefit that region; it also benefits neighboring ones (Sigman, 2002). Since regions have limited financial resources, they prefer investing funds where they can reap the highest benefit, that is to say, in interior counties. Secondly, at borders, some of a given firm's pollution impacts the neighboring region. Thus, in border counties, the population benefits from the overall positive economic advantages related to the presence of the firm (jobs and taxes) and only suffers from part of the pollution generated (Helland and Whitford, 2003). On the contrary, in interior counties, the population benefits from job opportunities but must also bear all the pollution generated. Thus, we would expect social discontent related to the establishment of a polluting firm to be higher in interior counties. As a result, a regulator concerned with political support[14] and job promotion[15] will be more likely to oppose the arrival of a polluting firm and to apply more stringent environmental regulations in interior counties. This free-riding phenomenon can explains why, in the U.S., plants whose pollution falls partly on the population of neighboring states tend to pollute more (Gray and Shadbegian, 2004). The same free-riding argument applies to coastal counties, explaining why emissions are much higher in these counties (Helland and Whitford, 2003). It is worth noting that the free-riding effect will always lead polluting firms to concentrate in border counties, whatever the relative stringency of Hebei's environmental regulation. However, the magnitude of the effect is reduced when the neighboring state enforces stringent environmental regulation (Gray and Shadbegian, 2004).

Finally, the strategic implementation of environmental regulation (less stringent regulation at borders) can also lead to an intra-provincial pollution havens effect. Because of their less stringent regulation, we would expect border counties to attract more polluting firms than interior borders, leading to transboundary pollution.

[14] The Chinese authorities have to address a large and growing number of citizen complaints about pollution. There were already 138495 letters of complaint in 1993 (Dasgupta and Wheeler, 1997). In 2002, 428626 letters were sent to the authorities (State Environmental Protection Agency, 2003). In some extreme cases, local officials lost their posts because of public pressure after environmental crises. For example, in 2009, in the wake of a great amount of intense public pressure, numerous local officials were dismissed because of pollution accidents in Hunan, Shaanxi and Inner Mongolia.

[15] The political promotion system in China has evolved over time. While promotion used to be based solely on economic performance, since 2005 experiments have been conducted in some provinces where promotion depends now both on economic and environmental performance.

6.5 Description of the study area and data

6.5.1 Hebei province

This study is carried out in Hebei Province for several reasons. First of all, Hebei has been industrialized for many decades, which makes it one of the most polluted provinces in the country. According to the list published in 2010 by the Chinese government, which identifies the most polluting firms in China, 744 of the 9,833 top polluters in China are located in Hebei. The province has the highest number of polluting firms just after Jiangsu (838) and Shandong (774). According to Liu (2010), Hebei would also rank first in the number of officially reported "cancer villages". In addition, Hebei shares borders with seven other provinces including the provincial cities of Beijing and Tianjin (see Figure 6.1) and Hebei has already been involved in several transboundary pollution conflicts, as stated in Section 6.4. Finally, Hebei is one of the few provinces with the necessary data available to allow us to carry out our study.

Regarding the environmental protection (as measured by the levy fees per facility), in 2002 Hebei had an average charge of 7300 yuan, which was very similar to that of China (State Environmental Protection Agency, 2003; Hebei Environmental Protection Bureau, 2003). However, in 2008 Hebei lags behind China as its average levy fees were only about 30,500 yuan compared to the national level which was about 37,000 yuan (Ministry of Environmental Protection, 2009; Hebei Environmental Protection Bureau, 2009). However, this data highlights that the environmental policy has been tightened over the period (see also Appendix 6.B).

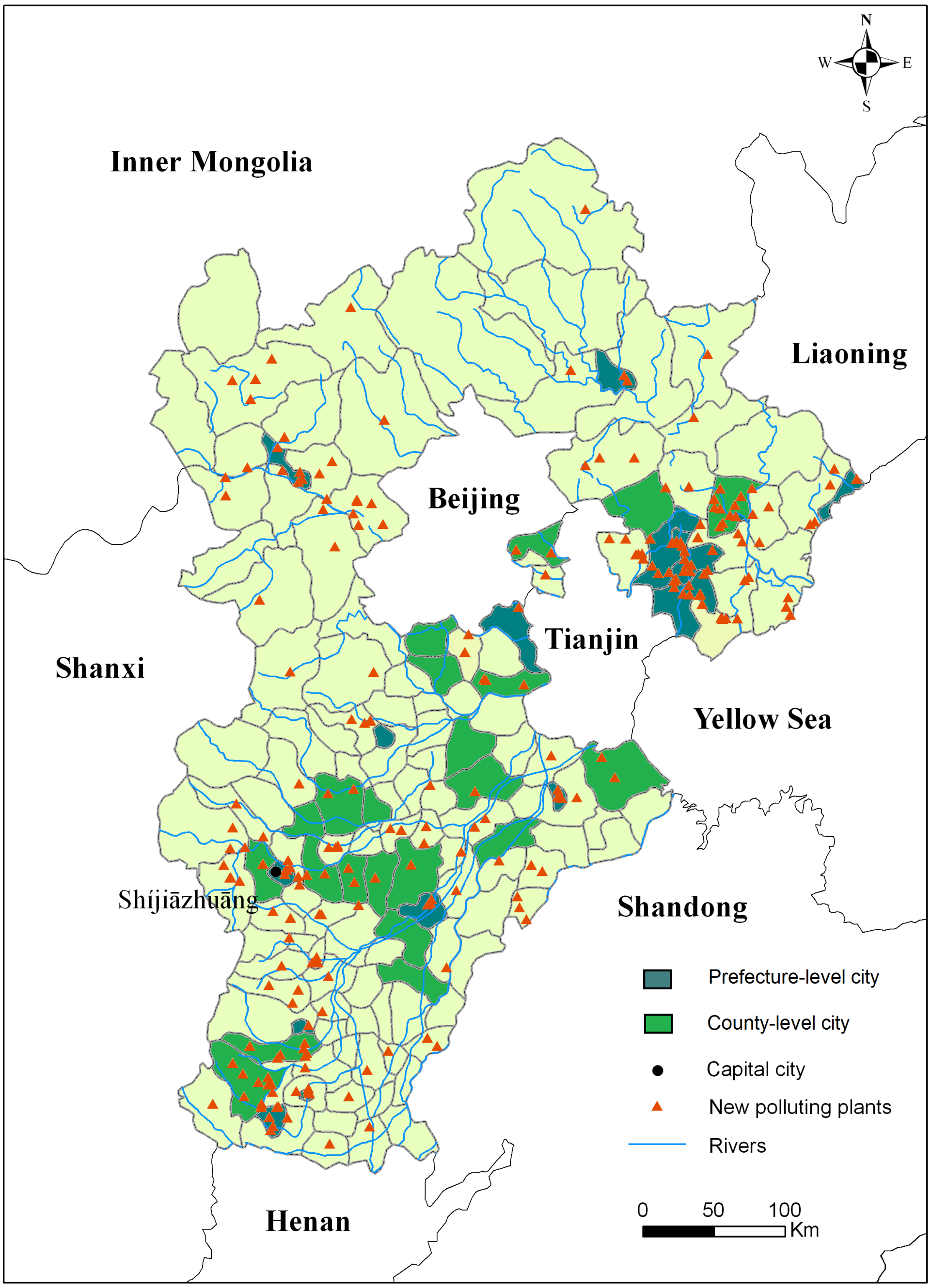
6.5.2 Construction of the dependent variable and sample

The dependent variable of our model is the annual number of polluting firms births by county. We constructed this variable from the lists published by the MEP and the EPB of Hebei[16]. Since 2007, the MEP and EPBs of provinces annually publish lists (*Guojia/Sheng zhongdian jiankong qiye mingdan*) that identify the most polluting firms in China[17]. These lists give the name of each firm and the county in which it is located. Moreover, the lists classify each firm as: "water polluting firm", "air polluting firm" or "waste water treatment facility". Waste

[16] To our knowledge, Ma (2010) is the first to use this data list for Henan province.

[17] The lists identify the most polluting firms at national and provincial level in terms of air, water and sewage pollution. More precisely, the firms identified produce 65% of total industrial emissions of SO2, NOx, COD, NH3-N and heavy metals. As these pollutants can cross regional borders, this data enables us to test for transboundary pollution. Note that there is a lag of two years between the census of firms in the list and their pollution. Thus, the 2007 list contains the firms that polluted the most in 2005.

Figure 6.1: Polluting firm births in Hebei province from 2002 to 2008



water treatment facilities are always built close to population centers in order to treat municipal waste. As they do not freely choose their location, we have excluded them from our analysis. By contrast, both air and water pollutant firms freely choose their location and thus, take into account environmental regulation when deciding where to locate. Thus, we consider both air and water polluting firms when constructing our dependent variable.

However, the MEP and EPBs lists provide no information regarding a firm's establishment date or emissions level. So, these lists give the necessary information to estimate a *model of stock*, in which the total number of firms in a county is regressed on a set of regional variables. However, in this study we estimate a *flow model* in which the number of firms created in a county at year t is regressed on the characteristics of this county at year t. Indeed, on the one hand, a firm decides to locate in a county at year t according to the current characteristics of the county. In addition, some firms in the lists were created between 1953 and 1978. At this period of time, the location choice of a firm did not depend on an economic rationale, unlike that of recent firms (Wen, 2004). As a consequence, it would be impossible to explain with the same model both the location of firms created before the 1980s and of recently established firms. Finally and most importantly, there was no environmental policy in China before 1979. To test the existence of border effects and of the hardening of environmental regulation in urban areas, we should take a sample of firms which have been recently created and which are therefore sensitive to environmental regulation. In order to estimate a flow model, we have collected the creation dates of polluting firms from the official website of the Industrial and Commercial Bureau of Hebei province.

Once the creation dates were obtained, we selected firms created after 2002, year from which we have data for the explanatory variables. In addition, the last list of polluting firms was published in 2010; it lists the most polluting firms in 2008. Thus, our sample covers the period of 2002-2008. In all, 253 air and water polluting firms were set up in Hebei province between 2002 and 2008. We have managed to collect information on the economic sector for 219 firms. According to our research, a large number of polluting firms are engaged in the steel industry (25.11%), are paper mills (21.92%), power stations (14.16%), in chemical industries (8.68%) or are coking plants (7.76%). The rest of the polluting firms (22.37%) are involved in various other industries such as textile, cement and pharmaceuticals.

6.5.3 Testing for the effect of urban proximity: market vs environmental regulations

As explained in Section 6.3, more polluting firms are likely to locate close to cities in order to avoid the stringent environmental regulation found in cities. The real challenge of the empirical analysis is then to disentangle the effect of the urban market from the effect of environmental regulation in cities. Indeed, it is widely accepted that firms are attracted to regions with high market potential, *i.e.* markets of neighboring regions matter in firms' location choices (Head and Mayer, 2004). Thus, whatever the level of environmental regulation, more firms are likely to settle close to cities in order to benefit from the higher market potential opportunities that urban proximity offers.

To disentangle the effect of urban market from the effect of urban environmental regulation, two spatial lag variables have been constructed. First, we have created an indicator of urban market potential in order to capture the "pure urban market effect" on polluting firms' location choices. As in the previous chapters, the urban market potential variable is a spatial lag variable of the following form:

$$WGDP_{it} = \sum_{j=1}^{J} \frac{GDP_{jt}}{DIST_{ij}} \tag{6.1}$$

where i refers to the county (county, district or county-level city) and j the city (prefectural-level or county-level city). $DIST_{ij}$ is the number of kilometers from the centroid of county i to the centroid of city j and GDP_{jt} is the gross domestic product of city j at year t[18].

Second, to capture the effect of environmental regulation in neighboring cities on the number of firm births in a given region, we have created a spatially-lagged indicator of environmental regulation. The indicator is calculated as follows:

$$WEnviReg_{it} = \sum_{j=1}^{J} \frac{EnviReg_{jt}}{DIST_{ij}} \tag{6.2}$$

where i refers to the county (county, district or county-level city) and j the city (prefectural-level or county-level city). $DIST_{ij}$ is the number of kilometers from the centroid of county i to the centroid of city j and $EnviReg_{jt}$ is an indicator of environmental regulation of city j. As the relocation of polluting firms primarily occurs within the provincial boundaries and

[18]Data on city GDP is from the 2003-2009 China City Statistical Yearbooks. Distance is calculated using the latitude and longitude of each county and city using data available on the U.S. Geological Survey website.

especially from cities to very nearby rural areas (Tianjie, 2008), we only consider the effect of cities within Hebei province (and not of cities located in nearby provinces) and we have used 100km as the cut-off parameter for the weighting matrix. Several indicators have been proposed to measure environmental regulation in China (He, 2006; Dean *et al.*, 2009; He and Wang, 2012). However, very few indicators are available at the city level, especially for the city Urban Administrative Area. In the present study, we use two alternative indicators of environmental stringency which are, to our knowledge the only two indicators available at the city level: the control-zone designation and the share of environmental workers out of total employees.

The Two Control Zones Policy

In 1998, the State Council officially launched the Two Control Zones Policy. A number of cities and counties were designated as either a SO2 pollution control zone or as an acid rain control zone. Localities were designated as a control zone according to their pollution emissions or concentration levels in the preceding year[19]. Figure 6.2 represents the 175 county-level localities designated as control zones[20] (the designation was made at the county level). Localities designated as SO2 pollution control zones are located in Northern China, where the cold weather leads to a much more extensive use of heating, leading to much higher SO2 emissions. By contrast, acid rain control zones are concentrated in Southern China, where climatic conditions (rain, heat and solar radiations) raise the atmospheric acidity of a given level of SO2 emissions (Tanaka, 2010). For the specific case of Hebei province, eight prefecture-level cities out of eleven and thirteen county-level cities out of twenty-two were designated as control zones[21]. No county was designated as a control zone, which is due to the fact that poor

[19]Specifically, an area was designated as an SO2 control zone if: "(i) average annual ambient SO2 concentrations exceed the Class II standard, (ii) daily average concentrations exceed the Class III standard, or (iii) high SO2 emissions are recorded". On the other hand, a locality was designated as an acid rain control zone if: "(i) average annual pH values for precipitation are less than or equal to 4.5, (ii) sulfate deposition is greater than the critical load, or (iii) high SO2 emissions are recorded". Class II and III refer to the Chinese National Ambient Air Quality Standards. According to these standards, "Class I standard means the annual average concentration level not exceeding 20 $\mu g/m^3$, Class II ranges $20\mu g/m^3 < SO2 < 60\mu g/m^3$, and Class III ranges $60\mu g/m^3 < SO2 < 100\mu g/m^3$" (Tanaka, 2010). The list of the localities designated as control zones is given in the "Official Reply of the State Council Concerning Acid Rain Control Areas and Sulphur Dioxide Pollution Control Areas" available on the Asian Legal Information Institute website

[20]The map is from the China Atlas of Population and Environment (1990-1999), available on the China Data Online website.

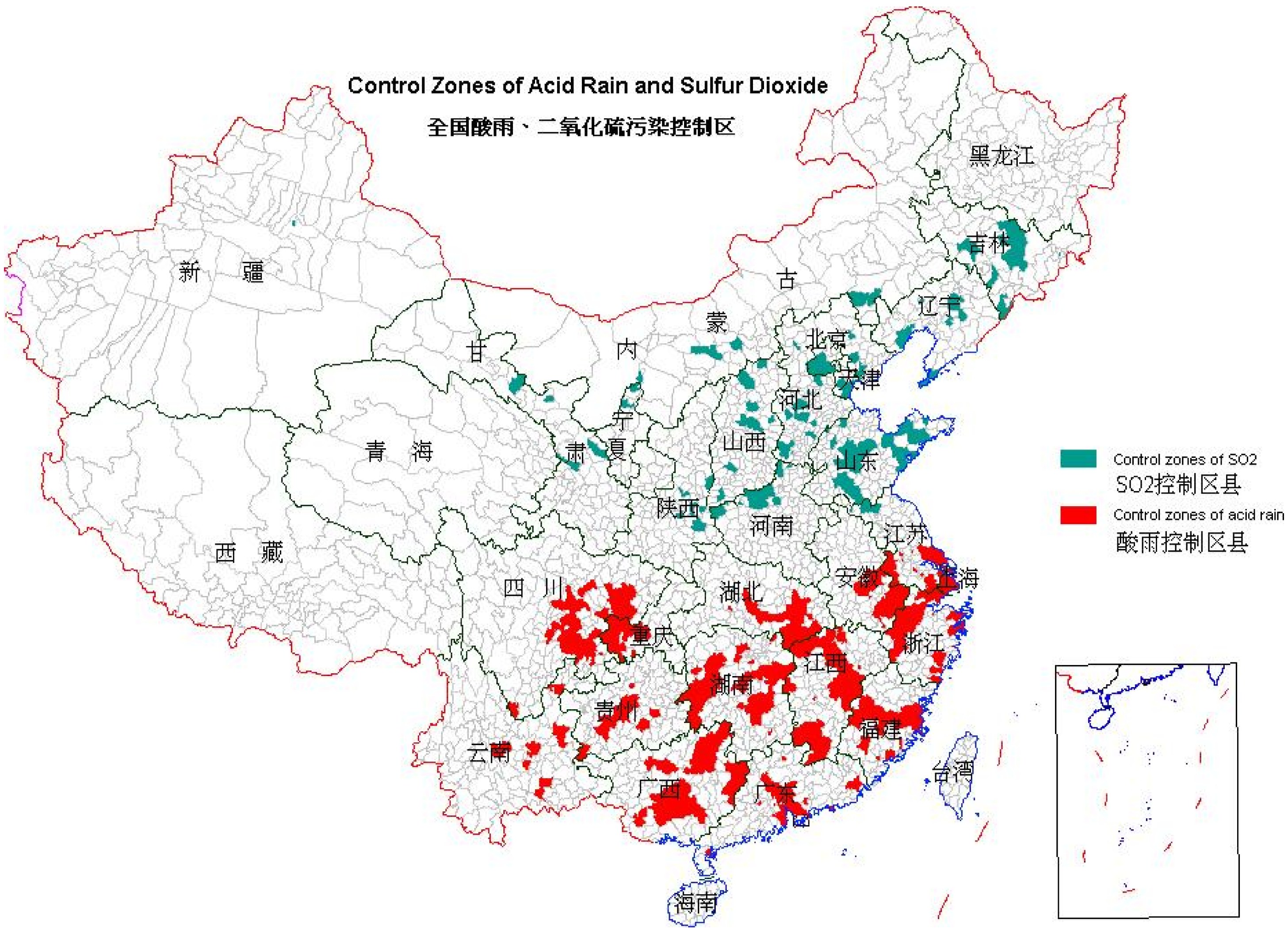
[21]The urban districts of the following eight prefecture-level cities were designated as control zones: Shijiazhuang, Handan, Xingtai, Baoding, Zhangjiakou, Chengde, Tangshan and Hengshui City. The following thirteen county-level cities were classified as control zones: Xinji, Gaocheng, Jinzhou, Xinle, Luquan, Wu'an, Nangong, Shahe, Zhuozhou, Dingzhou, Anguo, Gaobeidian and Zunhua.

areas are not concerned with the regulation. Thus, the policy has led to the implementation of more stringent environmental regulation in (a part of) urban Hebei than in rural Hebei.

The Two Control Zone Policy has led to the implementation of much more stringent environmental regulation in localities designated as control zones (hereafter, CZ localities). For example, all firms using coal with more than 3% SO2 content have been closed or required to reduce their SO2 content and new coal mines cannot locate in CZ localities if the SO2 content of coal exceeds 3%. In addition, it is prohibited for new coal burning power plants to locate in populated CZ localities (Tanaka, 2010). According to recent empirical analysis, the Two Control Zone Policy has led to significantly more stringent environmental regulation in CZ localities and thus, to a significant reduction in pollution levels. For example, Tanaka (2010) has estimated that the policy has significantly improved air quality in CZ localities, leading to a significant reduction in infant mortality. Moreover, Poncet and Hering (2013) have estimated that the implementation of the policy has led to a reduction in pollution intensive exports in CZ localities. Interestingly, the authors point out that their result may arise both from a reduction in the pollution content of exports (due for example to the use of cleaner technologies) and from a relocation of activities from CZ to non-CZ localities. The present chapter sheds some light on this issue by testing whether proximity to CZ localities significantly increases the number of polluting firms created in its own jurisdiction[22].

[22]The authors also highlight that the Two Control Zone Policy has a significant impact on private and foreign firms but not on State Owned Enterprises. Unfortunately, we do not have data on firm ownership and thus, we will be unable to control for this in our empirical specification.

Figure 6.2: County-level areas designated as control zone



In our opinion, using the control zone designation to measure environmental regulation in our study is particularly relevant for the following reasons. First, as already stated, the control zone policy has effectively led to more stringent environmental regulation in CZ localities and thus, is a good indicator of the level of environmental regulation. Second, in the 2000s specific goals have been set for CZ localities[23]. Thus, the control zone policy should have played a significant role on the location choices of polluting firms during our sample period. Third, as the designation of control zones was done at the county level, this indicator is available for all of the county-level divisions in our sample. To our knowledge, this is the only indicator available for every county-level division. Thus, using the control zone designation enables us both: (i) to test for the effect of city environmental regulation on nearby localities, and (ii) to control for the level of environmental regulation of every county-level unit in our sample. Finally, as the policy mostly targeted coal intensive industries, one may wonder whether every polluting firm in our list is affected by the Two Control Zone Policy. Indeed, if a large share of polluting firms in our sample did not belong to coal intensive industries, this could raise concerns about the accuracy of the indicator. As noted in Section 6.5.2, in our sample, the polluting firms are mainly engaged in the steel industry (25.11%), are paper mills (21.92%), power stations (14.16%), in chemical industries (8.68%) or are coking plants (7.76%). The rest of the polluting firms (22.37%) are involved in various other industries such as textile, cement and pharmaceuticals. According to Poncet and Hering (2013), who ranked 25 industrial sectors according to their coal intensity, the manufacture of coke involves the highest coal intensity, followed by coal mining (2^{nd}), the manufacture of basic metals (4^{th}), the manufacture of chemicals and chemical products (5^{th}) and the manufacture of paper and paper products (6^{th}). On the whole, given the industrial sectors of the polluting firms in our sample and the coal intensity of these sectors, the control zone designation should significantly affect the location choices of polluting firms.

Environmental staff

To check the robustness of our estimation results, we will use an additional indicator of environmental regulation. Following He and Wang (2012), we will use the share of environmental staff out of total employees as a proxy for environmental regulation[24]. However, this indicator

[23] For example, the National 10^{th} Year Plan for Environmental Protection (2001-2005) stated that annual SO2 emissions in CZ localities might be reduced by 20% from 2000 to 2005.

[24] He and Wang (2012) use the share of environmental staff out of total government staff over the period 1990-2001. However, the total number of government staff is not available for the period 2002-2008. As a result, we have used the share of environmental staff out of total employees.

is only available for prefecture-level cities and thus, it is used only to ensure robustness of the estimated impact of the environmental regulation of prefecture-level cities on nearby places.

Finally, as in the two previous chapters of the thesis, to test whether different cities have different impacts, we have created different spatial lagged variables according to the administrative rank of the city (prefecture and county-level cities).

Table 6.1 provides descriptive statistics on the polluting firm births in rural Hebei according to urban proximity. It appears that counties adjacent to a city attract more polluting firms (1.30 vs 1.18 creation of polluting firm in average per county). However, the difference is statistically significant only for counties adjacent to a prefecture-level city. In addition, counties adjacent to a city designated as a control zone also have a higher number of polluting firms setting up there. Once again, the number of polluting firms created is only statistically significant for counties adjacent to a prefecture-level city designated as a CZ.

Table 6.1: Polluting firms in rural Hebei: the role of urban proximity

	N	Nb. of births per county	Test of difference between means	
			Difference	t-statistic
All rural counties	114	1.18		
Of which:				
- Adjacent to a city	74	1.30	0.35	(0.930)
Of which:				
- Adjacent to a prefecture-level city	28	2.07	1.19***	(2.969)
- Adjacent to a county-level city	61	1.13	-0.01	(-0.265)
- Adjacent to a city designated as CZ	54	1.44	0.51	(1.440)
Of which:				
- Adjacent to pref. city designated as CZ	24	2.17	1.26***	(2.973)
- Adjacent to a county-level city designated as CZ	39	1.26	0.12	(0.327)

*Note:** p<0.1, ** p<0.05, *** p<0.01.

6.5.4 Testing for transboundary pollution

Three variables have been constructed to test for transboundary pollution. Firstly, we follow the literature (Helland and Whitford, 2003; Kahn, 2004; Konisky and Woods, 2010) and construct a dummy variable equal to 1 if the county shares a border with another province, or the sea, and 0 otherwise ($Border\_1$). As explained in Section 6.4, the same free-riding phenomenon is expected to take place in coastal counties. Thus, to capture the whole transboundary pollution effect, we

Table 6.2: Polluting firms in Hebei: border and non-border counties

	N	Nb. of firms per county in 2001	Nb. of firms per county in 2008	% Evolution
(A) Stock of firms in 2001 and 2008				
All counties	172	5.00	6.47	29.40
Border counties	70	4.94	6.74	36.44
Non border counties	102	5.04	6.28	24.60
(B) Plant births from 2002 to 2008	N	Total number of births	Nb. births per county	
All counties	172	253	1.47	
Border counties	70	126	1.80	
Non border counties	102	127	1.25	
Test of diff. between means (border vs non-border) (Ha: diff > 0)			0.55*	

Note: * indicate significance at the 10% level.

create a variable including both coastal and other border counties. However, as can be seen in Figure 6.1, some border counties share a very small part of their border with another province while others share more than half of the total length of their border with another province. To take into account the variability among border counties, we create a second variable equal to the length of the common border with another province (or the sea) divided by the total length of the county's border (*Border_2*). The drawback of the first two variables is that they do not take into account the variability between non-border counties: while some counties are located at the center of the province, others are very close to the borders. For this reason, we create a third variable equal to the distance between the county seat and the closest border (*Distance*). These variables have been constructed with GIS data, using ArcGis 9.2. If transboundary pollution exists, we expect polluting firms to be more likely to set up near borders. Therefore, we would expect the coefficients associated with variables "*Border_1*" and "*Border_2*" to be positive and the coefficient associated with "*Distance*" to be negative.

Table 6.2 gives descriptive statistics on the polluting firms in our sample. Panel A of the table gives the average stock of firms in 2001 and 2008 for all counties, border and non-border. Interestingly, non-border counties had a slightly higher number of polluting firms than border counties in 2001 whereas the opposite was true for 2008.

Panel B of the table gives data on firm births from 2002 to 2008. It clearly indicates that over the recent period, polluting firms have located significantly more frequently in border counties, which tends to validate the transboundary pollution hypothesis. Moreover, the differences observed in the stock of firms between non-border and border counties reflect an evolution in polluting firms' location choices in China. Among the firms identified in the lists, some were created before the 1980s. At that time, a firm's location decision was not based on economic rationale but rather arose from a strategy aimed at protecting industries from potential destructive military conflicts. From 1965 to 1978, three principles determined the location choice of industrial firms: "proximity to mountains, dispersion and concealment" (Wen, 2004). Thus, industrial firms were located far away from the coast. Moreover, an environmental policy did not yet exist in China. Therefore, it should not be a surprise that the stock of firms in 2001 was not higher in border counties than in non-border counties. By contrast, newly created polluting firms choose their location according to economic criteria and certainly take into account the degree of environmental policy implementation. As a result, transboundary pollution is likely to exist and this would explain why, nowadays, polluting firms would locate more in border counties than previously.

Figure 6.1, which shows the positions[25] of the polluting firms created between 2002 and 2008, also gives interesting insights about transboundary pollution. Indeed, firms seem to locate more often in counties close to Tianjin, Shanxi, Henan, and to some extent, to Shandong. This transboundary pollution effect is reinforced by the fact that many firms locate in the capital Shijiazhuang, which is close to the regional border. Surprisingly, Beijing does not appear to significantly attract polluting firms. This could be due to the fact that free-riding is reduced when the neighboring state possesses stringent environmental regulation (Gray and Shadbegian, 2004). Interestingly, there are very few firm births close to Inner Mongolia. As explained in Section 6.4, Inner Mongolia has less stringent environmental regulation than Hebei which, according to the pollution haven hypothesis, would be expected to lead to fewer firm births in counties bordering Inner Mongolia.

6.5.5 Other determinants in a polluting firm's location choice

As control variables, we introduce the traditional determinants of a firm's location, *i.e.* the regional characteristics that may affect the firm's profit. Firstly, a number of variables affect a firm's revenue. On the one hand, firms are attracted to regions with agglomeration economies (Arauzo-Carod *et al.*, 2010), *i.e.* to counties where there is a strong spatial concentration of

[25] The lists published by the MEP and the EPB do not report the geographical coordinates of polluting firms. Following Ma (2010) and Schoolman and Ma (2011), we have collected the geographical coordinates of polluting firms.

economic activity. This enables firms to benefit from good access to intermediate inputs, from market opportunities and from information. On the other hand, firms are more likely to set up in regions that offer significant local market opportunities, measured by the GDP of the own county-level division (Disdier and Mayer, 2004). Following Disdier and Mayer (2004), we also introduce the GDP per capita of the county in order to control for the development level[26]. Furthermore, as regions whose population is well educated are likely to attract firms, we introduce an indicator of the level of education of the county population. We also control for the presence of national and provincial-level Special Economic Zones (SEZ) as regions benefiting from SEZ status attract significantly more firms (Wu, 1999; Cheng and Stough, 2006). We also introduce a dummy indicating whether the county has an international port, to control, to some extent, for international market access.

Furthermore, firms are attracted by regions where production factors are cheap. Thus, we introduce the real wage rate in industry and the population density as a proxy for labor and land price respectively. Note that polluting firms would also prefer areas with low population density where their pollution reaches less people and so, leads to less social discontent. We also introduce a dummy indicating whether the county-level division has been designated as a control-zone area to take into account the level of environmental regulation.

Finally, we introduce a set of indicators for natural endowments. First, the length of rivers running through each county is introduced, given that many plants need to be located close to freshwater (Ma, 2010). Second, as it may be more difficult for a firm to locate in a mountainous area, we control for the topography of the county. Note that the last two control variables are particularly important given that borders are sometimes established by geographical discontinuities (rivers or mountains), which could bias our estimation of the transboundary effect (Holmes, 1998). Lastly, we introduce a dummy variable for districts and county to reflect the nature of the administrative unit (county-level city is the reference category) and year dummies in every specification. All of this data comes from the Hebei Statistical Yearbooks (2003-2009); the definition of variables and descriptive statistics are provided in Appendices 6.C and 6.D[27].

[26]Introducing GDP per capita enables us to control for some variables for which we do not have any information (for example, infrastructures).

[27]The province of Hebei contains 172 county level divisions: 36 districts, 22 county-level cities and 114 counties. For the districts of the 11 prefecture cities where disaggregated data is not available, the districts of a prefecture city are aggregated. Therefore, our sample is constituted of 147 units at the county level.

6.6 Estimation strategy

To investigate the location choices of polluting firms in Hebei province, two types of estimates may be carried out, depending on whether or not a time lag is introduced between the dependent and explanatory variables. Firstly, the number of firms created at year t can be regress on the values of the explanatory variables in t. Secondly, lagged explanatory variables can be used, by regressing the number of firms created at year t on the values of the explanatory variables in $t-1$. In this case, the empirical analysis investigates the creations of polluting firms from 2003 to 2008 in Hebei, using explanatory variables from 2002 to 2007. Using lagged explanatory variables is usually considered as more relevant because this enables both to reduce potential endogeneity and to take into account the time dimension of the decision process[28] (List, 2001; Gabe and Bell, 2004). As a result, in this chapter we will carried out the empirical analysis using lagged explanatory variables. Results obtained with contemporaneous are given in Appendices 6.G and 6.H.

The dependent variable of the model is the number of polluting firms created in county i at year t. The special nature of the dependent variable (non-negative integers with a high frequency of zeros) has led us to estimate a count-data model. This model estimates how much a 1% change in an explanatory variable x_i affects the probability that a firm sets up in territory i. The probability, $Prob(y_i)$, of a territory i to receive y_i firms is based on a set of characteristics x_i of this territory:

$$Prob(y_i) = f(x_i) \tag{6.3}$$

The most common way to model this probability function is to assume that the variable y_i follows a Poisson distribution. However, the Poisson model is restrictive because it assumes that the conditional mean is equal to the conditional variance of y_i (hypothesis of equi-dispersion). The hypothesis of equi-dispersion is poorly respected with data on firms' location choices, as the conditional variance is often higher than the conditional mean, referred to as "overdispersion". Two phenomena can lead to overdispersion: (i) the presence of unobserved heterogeneity and (ii) an excess of zeros.

Most of the time, overdispersion arises from unobserved heterogeneity. In this case, standard deviations obtained are biased and therefore, statistical inferences are invalid. The standard

[28]Indeed, firms often locate at year t after having observed the county's characteristics in the previous year.

solution consists in assuming that the variable y_i follows a negative binomial distribution instead of a standard poisson distribution.

In addition, overdispersion can also arise from an excess of zeros (or "zero inflation"). This is the case when the dependent variable y_i takes the value zero more times than assumed by the negative binomial distribution, leading to biased estimates. Zero inflation arises when two separate processes lead the dependent variable to take the value zero. In the present study, two processes are likely to explain why some counties did not attract any polluting firms from 2003 to 2008. On the one hand, some counties may not be suitable locations for firms and thus, they will never attract any, whatever the period considered. This could be the case for counties lacking a river, in mountainous areas and where there are no market opportunities. On the other hand, some counties may be suitable locations for firms but did not attract any new firms from 2003 to 2008. To distinguish between these two processes generating a zero outcome, Greene (1994) proposes estimating a zero-inflated model which essentially consists in integrating a binomial (logit or probit) model into the negative binomial regression model. Specifically, a binomial model is first estimated to distinguish those territories that will never attract any firms from the others. In a second-step, the standard negative binomial is estimated. Appendix 6.E proposes a detailed presentation of the mentioned count data models.

Table 6.3 gives some insight about the potential zero inflation problem in our sample. The table represents the frequency and percentage of counties with 0, 1, 2, ... , creations of firms from 2003 to 2008. According to the table, the dependent variable takes the value zero in about 86.17% of the cases. The frequency of zeros in our sample is comparable to those in List (2001) and Roberto (2004) who estimate a zero-inflated model.

Table 6.3: Distribution of firms created

Number of creations	0	1	2	3	> 3
Frequency	760	89	19	7	7
Percentage	86.17	10.09	2.15	0.79	0.79

In terms of the testing procedure, as the negative binomial model and the zero-inflated negative binomial model (ZINB model) are not nested, the Vuong (1989) test is used to test for zero-inflation. Asymptotically, the Vuong test statistic has a standard normal distribution and hence, the test statistic obtained must be compared with the critical value of the normal distribution. A value above 1.96 (below -1.96, respectively) rejects the standard model (zero-inflated model) in favor of the zero-inflated model (standard model).

6.7 Estimation results

6.7.1 Testing for the appropriate model

To determine the model that best fits our data, we (i) test the validity of the equi-dispersion hypothesis and (ii) test for the presence of zero-inflation.

According to Appendix 6.D, the standard deviation of the dependent variable is more than three times its mean, which indicates that the dependant variable suffers from overdispersion. As a result, we test whether overdispersion also arises from an excess of zeros. As already shown in Table 6.3, we are very likely to face a problem of zero-inflation, which could lead to biased estimates. Thus, we further investigate the presence of zero inflation with the Vuong test. The Vuong statistics are reported at the bottom of Table 6.4, which gives the estimation results of the ZINB model using lagged explanatory variables[29]. In estimations (1), (2) and (3), we have introduced a market potential variable for prefecture and county-level cities. Columns (4), (5) and (6) present the estimation results when adding the spatially-lagged environmental regulation variable. In each case, three different equations are estimated, depending on the variable introduced to test for transboundary pollution ($Border1$, $Border2$ and $Distance$). In all cases, the Vuong test rejects the standard model in favor of the zero-inflated model, indicating that zero inflation must be taken into account to obtain consistent estimates. As a consequence, in this chapter, we carry out the analysis by estimating a ZINB model, which enables us to take into account overdispersion arising both from unobserved heterogeneity and from an excess of zeros.

[29]For convergence issues, and following Roberto (2004) and Konisky and Woods (2011), we introduce a subset of the explanatory variables in the first-stage model. Specifically, to differentiate between counties that are unsuitable for firm location and counties that are suitable for firm location, we introduce the following variables in the first-stage model: environmental regulation of the county, agglomeration economy, education, local market, topography and river. We carry out estimations with different subsets of variables and obtain similar results. Appendix 6.F further discusses the choice of specification of the first-step model and gives the estimation results.

6.7.2 Baseline results

Table 6.4 presents the estimation results of the baseline model. First of all, the *Envi.Reg.* variable has a significantly negative impact, indicating that being designated as a control zone significantly reduces the number of firm births. This result is consistent with Tanaka (2010) and Poncet and Hering (2013) who find that the Two Control Zone Policy has led to a reduction in pollution levels in CZ localities. Moreover, this indicates that polluting firms in China are attracted by regions with less stringent environmental regulation. Thus, our results provide evidence of a pollution haven phenomenon at the sub-provincial level in China. This finding is complementary to Dean *et al.* (2009) who find evidence of pollution haven behavior at the provincial level. As polluting firms are significantly attracted by low environmental regulations, there is a high risk for rural areas, where environmental regulations are low and poorly enforced, to suffer from increased levels of pollution.

Turning to the effect of urban proximity, we find that urban effects vary according to the type of cities. Indeed, proximity to a county-level city has no significant impact on the number of firm births whereas proximity to a prefecture-level city leads to a significant increase in the number of firm births. To disentangle whether this effect arises from a simple urban market potential effect and/or from the effect of more stringent environmental regulation in cities, we add to the set of control variables the spatially-lagged environmental regulation indicators in Columns (4), (5) and (6). Interestingly, the higher number of polluting firms setting up in localities close to prefecture-level cities arise both from a market potential effect and from the effect of environmental regulation. Thus, it appears that proximity to a prefecture-level city leads to an increase in pollution not only because of a market potential effect, but also because the more stringent environmental regulation in cities may lead polluting firms to locate in nearby localities in order to escape from the more stringent environmental regulation in prefecture-level cities[30]. It should not be a surprise that prefecture-level cities have a significant effect on their nearby localities while this is not the case for county-level cities. Indeed, prefecture-level cities are bigger and more economically developed than county-level cities and therefore, proximity to a prefecture-level city offers a much larger market potential for firms than proximity to

[30] To explicitly test whether cities lead to a relocation of polluting firms to nearby *rural* areas, we have re-estimated the model by adding an interactive term between the county dummy ($County$) and the spatially-lagged indicators of environmental regulation ($WEnvi.Reg.$). However, the interactive term was not significant, which indicates that being close to a city with a stringent environmental regulation leads to a higher number of polluting firm births not only (or not more significantly) for rural county but more generally for every county-level division.

Table 6.4: Baseline results

	(1) Border 1	(2) Border 2	(3) Distance	(4) Border 1	(5) Border 2	(6) Distance
Border	0.483**	0.016***	-0.225*	0.541**	0.017***	-0.250**
	(0.045)	(0.001)	(0.061)	(0.019)	(0.000)	(0.048)
Envi. Reg.	-1.128**	-0.956*	-0.998**	-1.405***	-1.208**	-1.234***
	(0.032)	(0.051)	(0.041)	(0.005)	(0.018)	(0.010)
W GDP Pref. Cities	0.002**	0.002**	0.002**	0.002**	0.001	0.001**
	(0.012)	(0.018)	(0.014)	(0.033)	(0.114)	(0.038)
W GDP County-level Cities	-0.002	-0.001	-0.002	-0.001	-3.94E-05	-7.89E-04
	(0.382)	(0.572)	(0.411)	(0.652)	(0.987)	(0.720)
W Envi. Reg. Pref. Cities				0.774**	0.771**	0.758**
				(0.019)	(0.016)	(0.023)
W Envi. Reg. County-level cities				-0.557*	-0.648	-0.508
				(0.099)	(0.189)	(0.140)
Agglo. Eco.	-0.035	0.019	-0.014	-0.085	-0.002	-0.061
	(0.787)	(0.886)	(0.913)	(0.535)	(0.996)	(0.638)
Pop. Density	-0.142	-0.204	-0.236	0.010	-0.051	-0.102
	(0.575)	(0.405)	(0.320)	(0.971)	(0.849)	(0.701)
Wage	-1.290**	-1.603***	-1.445**	-1.123**	-1.416**	-1.300**
	(0.023)	(0.004)	(0.012)	(0.045)	(0.030)	(0.024)
Education	6.294	5.406	5.694	7.452	7.565	6.398
	(0.283)	(0.330)	(0.308)	(0.259)	(0.427)	(0.326)
Local market	0.003***	0.002***	0.003***	0.003***	0.002**	0.003***
	(0.000)	(0.003)	(0.000)	(0.000)	(0.018)	(0.000)
GDP per capita	0.464	0.548*	0.438	0.505*	0.566	0.490
	(0.144)	(0.071)	(0.184)	(0.086)	(0.180)	(0.120)
SEZ	-1.036	-0.967	-1.117	-1.260	-1.214	-1.394
	(0.224)	(0.253)	(0.264)	(0.193)	(0.234)	(0.271)
River	0.010***	0.011***	0.012***	0.010***	0.011***	0.012***
	(0.001)	(0.000)	(0.000)	(0.002)	(0.001)	(0.000)
Port	-1.192	-1.329*	-1.179	-1.232	-1.375	-1.236
	(0.169)	(0.100)	(0.195)	(0.182)	(0.118)	(0.237)
Topography	-0.128	-0.062	-0.096	-0.084	-0.007	-0.052
	(0.661)	(0.822)	(0.723)	(0.757)	(0.978)	(0.849)
Districts	1.543***	1.378**	1.488***	1.820***	1.664**	1.752***
	(0.007)	(0.018)	(0.009)	(0.005)	(0.012)	(0.006)
County	-0.465	-0.436	-0.398	-0.707	-0.683	-0.614
	(0.291)	(0.256)	(0.324)	(0.123)	(0.104)	(0.152)
Constant	11.06*	14.26***	15.57***	8.292	11.13	13.42**
	(0.051)	(0.010)	(0.009)	(0.133)	(0.123)	(0.021)
lnalpha	-2.678	-2.902	-3.003	-2.948	-3.555	-3.334
	(0.109)	(0.152)	(0.163)	(0.109)	(0.340)	(0.173)
Year dummies	Yes	Yes	Yes	Yes	Yes	Yes
N	882	882	882	882	882	882
Log likelihood	-388.304	-385.531	-388.481	-385.371	-382.402	-385.765
Vuong test	2.60	2.68	2.74	2.36	2.43	2.56

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

a county-level city. In addition, the differentiated impact of prefecture and county-level city environmental regulation may arise from the fact that the control zone policy has been more strictly implemented in prefecture-level than in county-level cities. For example, as raised in Section 6.5.3, it is prohibited for new coal burning power plants to locate in the most populated control zone prefecture-level cities. As a result, the more stringent implementation of the policy in prefecture-level cities may have led polluting firms wishing to set up in control zone prefecture-level cities to locate in the vicinity of prefecture-level cities in the absence of better options.

In addition, we find robust evidence that polluting firms locate disproportionately in border counties as the *Border* and *Distance* variables have the expected sign and are statistically significant in every case. Counties that share a (larger part of their) border with another province or with the sea have a higher probability of polluting firms locating there. By the same token, the farther the county seat is from the boundary, the lower the probability of polluting firms settling there. These results provide evidence of transboundary pollution problems in China. While this has already been demonstrated for the U.S. case, to our knowledge, we are the first to demonstrate this phenomenon in China.

Regarding the control variables, on the whole their signs are consistent and confirm that the location choices of Chinese firms nowadays are based on economic factors. For example, the larger the local market, the higher the number of firm births. Conversely, the higher the labor costs, the lower the number of firm births. Moreover, polluting firms locate more frequently in counties where fresh water is available and in urban districts. On the other hand, education, population density, agglomeration economies and topography do not significantly impact the location choices of polluting firms.

6.7.3 Robustness checks

To check the robustness of our results, we use the share of environmental staff in total employees as our indicator of environmental regulation (instead of the control zone status) to construct the spatially-lagged environmental regulation variable ($WEnviReg$). As this variable is only available for prefecture-level cities, we have created a new spatially-lagged indicator of environmental regulation only for prefecture-level cities ($WEnvi.Reg.Pref.Cities$). Thus, the $Envi.Reg.$ and $WEnvi.Reg.County - levelCities$ variables are created using information on control zones, as in the previous estimates. Results are reported in Columns (1), (2) and (3) of

Table 6.5. According to these new estimates, while the market potential effect of prefecture-level cities remains significant, the newly created spatially-lagged environmental regulation variable is only significant at the 10% level. Moreover, it is not significant when using contemporaneous variables (see Appendix 6.H).

In our opinion, while the lack of robustness of the impact of the $WEnvi.Reg.Pref.Cities$ variable may arise from a lack of robustness, it may also arise from the fact that the share of environmental staff out of total employees does not adequately capture the stringency of environmental regulation. Indeed, as China's environmental policy is decentralized, city governments are not responsible for creating environmental standards but for enforcing them. In this context, in CZ cities, where environmental standards are stringent, a higher share of environmental staff is likely to lead to better enforcement of environmental standards. In this case, the share of environmental staff out of total employees may thus be considered as a good proxy for environmental stringency. On the contrary, in non-CZ cities, where the environmental standards to be enforced are very low, environmental regulation will be low whatever the share of environmental staff out of total employees. In this case, the share of environmental staff out of total employees is not likely to be a good proxy for environmental stringency. As a result, we expect that a higher share of environmental staff in total employees will lead to a higher level of environmental regulation only in CZ cities, which have high environmental standards to enforce. To test for this, we have further disaggregated the spatially-lagged indicator of environmental regulation for prefecture-level cities ($WEnvi.Reg.Pref.Cities$) into two components: a spatially-lagged indicator for CZ cities and a spatially-lagged indicator for non-CZ cities (respectively $WEnvi.Reg.CZPref.Cities$ and $WEnvi.Reg.Non-CZPref.Cities$). Results are reported in Columns (4), (5) and (6) of Table 6.5. According to our estimates, in CZ prefecture-level cities, the higher the share of environmental staff out of total employees, the higher the number of polluting firms in nearby localities. On the other hand, consistently, the number of environmental staff in non-CZ prefecture-level cities has no impact on the number of firm births in nearby localities. Moreover, this last result is robust when using as indicator of environmental regulation the number of environmental staff per inhabitant rather than the share of environmental staff out of total employees, as shown in Columns (7), (8) and (9).

Table 6.5: Robustness checks

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
			% envi staff in employees					Envi. Staff per inhab.	
	Border 1	Border 2	Distance	Border 1	Border 2	Distance	Border 1	Border 2	Distance
Border	0.400*	0.015***	-0.176	0.441**	0.015***	-0.194	0.463**	0.015***	-0.210*
	(0.082)	(0.002)	(0.148)	(0.048)	(0.001)	(0.121)	(0.041)	(0.001)	(0.094)
Envi. Reg.	-1.229**	-1.063**	-1.095**	-1.480***	-1.282**	-1.326***	-1.481***	-1.272**	-1.316**
	(0.013)	(0.033)	(0.025)	(0.003)	(0.014)	(0.010)	(0.003)	(0.016)	(0.010)
W GDP Pref. Cities	0.002***	0.002***	0.002***	0.002**	0.001**	0.002**	0.002**	0.001**	0.002**
	(0.008)	(0.006)	(0.008)	(0.020)	(0.027)	(0.022)	(0.025)	(0.033)	(0.028)
W GDP County-level Cities	-0.003	-0.002	-0.002	-0.002	-0.001	-0.002	-0.002	-0.001	-0.002
	(0.271)	(0.417)	(0.294)	(0.465)	(0.653)	(0.504)	(0.415)	(0.583)	(0.439)
W Envi. Reg. Pref. Cities	0.215*	0.199*	0.211*						
	(0.069)	(0.090)	(0.089)						
W Envi. Reg. CZ Pref. Cities				0.508**	0.463**	0.495**	0.505**	0.465**	0.494**
				(0.015)	(0.025)	(0.020)	(0.013)	(0.020)	(0.016)
W Envi. Reg. Non-CZ Pref. Cities				0.159	0.153	0.158	0.873	0.902	0.904
				(0.217)	(0.228)	(0.243)	(0.203)	(0.181)	(0.199)
W Envi. Reg. County-level cities	-0.400	-0.433	-0.363	-0.564	-0.584	-0.524	-0.526	-0.547	-0.479
	(0.237)	(0.209)	(0.291)	(0.106)	(0.105)	(0.146)	(0.128)	(0.125)	(0.179)
Agglo. Eco.	-0.059	-0.007	-0.039	-0.075	-0.015	-0.053	-0.076	-0.016	-0.054
	(0.646)	(0.958)	(0.751)	(0.576)	(0.912)	(0.677)	(0.569)	(0.908)	(0.668)
Pop. Density	-0.095	-0.135	-0.186	-0.088	-0.140	-0.183	-0.089	-0.143	-0.187
	(0.724)	(0.622)	(0.469)	(0.739)	(0.610)	(0.478)	(0.736)	(0.601)	(0.467)
Wage	-1.231**	-1.515***	-1.359**	-1.103**	-1.415***	-1.241**	-1.116**	-1.439***	-1.268**
	(0.031)	(0.006)	(0.018)	(0.046)	(0.009)	(0.029)	(0.042)	(0.007)	(0.024)
Education	9.442	8.778	8.531	10.77*	10.01	9.926	10.66*	9.898	9.814
	(0.151)	(0.195)	(0.197)	(0.080)	(0.125)	(0.118)	(0.079)	(0.124)	(0.117)
Local market	0.003***	0.003***	0.003***	0.003***	0.003***	0.003***	0.003***	0.003***	0.003***
	(0.000)	(0.001)	(0.000)	(0.000)	(0.001)	(0.000)	(0.000)	(0.000)	(0.000)
GDP per capita	0.384	0.440	0.378	0.407	0.481	0.397	0.435	0.511*	0.419
	(0.222)	(0.164)	(0.256)	(0.165)	(0.103)	(0.198)	(0.140)	(0.080)	(0.179)
SEZ	-1.004	-0.971	-1.055	-1.117	-1.054	-1.190	-1.114	-1.040	-1.201
	(0.262)	(0.270)	(0.285)	(0.264)	(0.274)	(0.280)	(0.267)	(0.281)	(0.279)
River	0.010***	0.011***	0.012***	0.009***	0.010***	0.011***	0.009***	0.010***	0.011***
	(0.000)	(0.000)	(0.000)	(0.002)	(0.001)	(0.000)	(0.002)	(0.001)	(0.000)
Port	-1.232	-1.376	-1.216	-1.423	-1.527*	-1.401	-1.443	-1.547*	-1.418
	(0.165)	(0.103)	(0.191)	(0.126)	(0.087)	(0.160)	(0.114)	(0.078)	(0.150)
Topography	-0.089	-0.015	-0.065	-0.129	-0.054	-0.103	-0.148	-0.069	-0.119
	(0.753)	(0.958)	(0.821)	(0.621)	(0.845)	(0.706)	(0.571)	(0.805)	(0.665)
Districts	1.826***	1.651***	1.778***	1.844***	1.659***	1.788***	1.824***	1.644***	1.772***
	(0.002)	(0.007)	(0.002)	(0.003)	(0.009)	(0.003)	(0.002)	(0.008)	(0.002)
County	-0.495	-0.485	-0.420	-0.673	-0.626	-0.587	-0.671	-0.612	-0.580
	(0.243)	(0.216)	(0.285)	(0.121)	(0.135)	(0.170)	(0.126)	(0.149)	(0.184)
Constant	9.865*	12.61**	13.58**	8.814	11.86**	12.81**	8.986	12.14**	13.29**
	(0.085)	(0.022)	(0.022)	(0.115)	(0.028)	(0.031)	(0.105)	(0.023)	(0.024)
lnalpha	-15.25***	-17.63***	-15.83***	-17.31***	-16.56***	-114.4***	-16.12***	-16.65***	-23.53***
	(0.004)	(0.000)	(0.001)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Year dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	882	882	882	882	882	882	882	882	882
Log likelihood	-386.823	-383.920	-387.128	-385.033	-382.438	-385.466	-385.029	-382.370	-385.405
Vuong test	4.44	4.42	4.48	4.76	4.81	4.81	4.80	4.83	4.83

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

6.8 Conclusion

This chapter provides a comprehensive study of the effect of proximity to cities and regional borders on the location choices of polluting firms in China. To achieve this, we estimate whether polluting firms are more likely to locate in counties close to cities and regional borders in Hebei province. Our estimation results suggest that being close to a prefecture-level city significantly increases the probability of attracting polluting firms. Interestingly, this effect arises both from a "pure urban market effect" and from the deliberate intention on the part of polluting firms to avoid more stringent urban environmental regulations. In addition, the closer a county is to the provincial border, the higher the probability of its attracting polluting firms. Thus, there is a risk that people in counties close to cities and to regional borders suffer disproportionately from pollution.

In our opinion, the present work contributes to the literature on urban effects by going beyond the study of the simple economic impact of cities on nearby areas. In the literature, and in the two previous chapters of this thesis, it has been found that urban proximity may enhance economic performance in nearby rural places. On the other hand, the present chapter demonstrates that urban proximity may also heavily deteriorate rural development by significantly increasing pollution.

The results obtained from this chapter may also lead us to discuss the relevance of a decentralized environmental policy in China. Indeed, it seems that the decentralized environmental policy may result in strong differences in the implementation of environmental laws across China, leading some people to disproportionately suffer from pollution. If such problems are often put forward by opponents of decentralization, our results do not suggest that a centralized policy would be optimal. Indeed, a decentralized policy offers compelling advantages for a country as heterogeneous as China. While a centralized policy would consist in applying uniform rules across the country, a decentralized policy allows for adaption to the local conditions and thus, is more efficient. It is unclear whether a decentralized or a centralized policy would lead to higher social welfare in our case. Thus, as suggested by Sigman (2005) in the case of the United States, the optimal policy might be to provide targeted solutions to transboundary pollution problems within the framework of a decentralized policy. In the specific case of China, increasing fiscal transfert towards poorest areas could help them in better enforcing environmental laws. Moreover, the recent creation of the six major regional centers (see Section 6.2) could be a way to reduce transboundary pollution. For the moment, the creation of these centers is too recent and their power is still too limited to have measurable impact. It could be interesting to study the location choices of firms in the period to come, to test whether the creation of these intermediate poles, between central government and regional governments, may offer a solution to the transboundary pollution problem.

Finally, some provinces have recently released data on pollution emissions for each facility on the list published by the MEP and the provincial EPB. Thus, Schoolman and Ma (2011) combine data on sources of pollution and pollution emissions data on every source for Jiangsu province. It would be interesting to further test for transboundary pollution and for urban proximity by using this actual pollution data rather than the counting of firms. This would enable us to more precisely investigate whether population at borders are disproportionately exposed to pollution.

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Appendix to Chapter 6

6.A Environmental regulation in Hebei province compared with its neighbors

Table 6.6: Environmental regulation in Hebei province compared with its neighbors

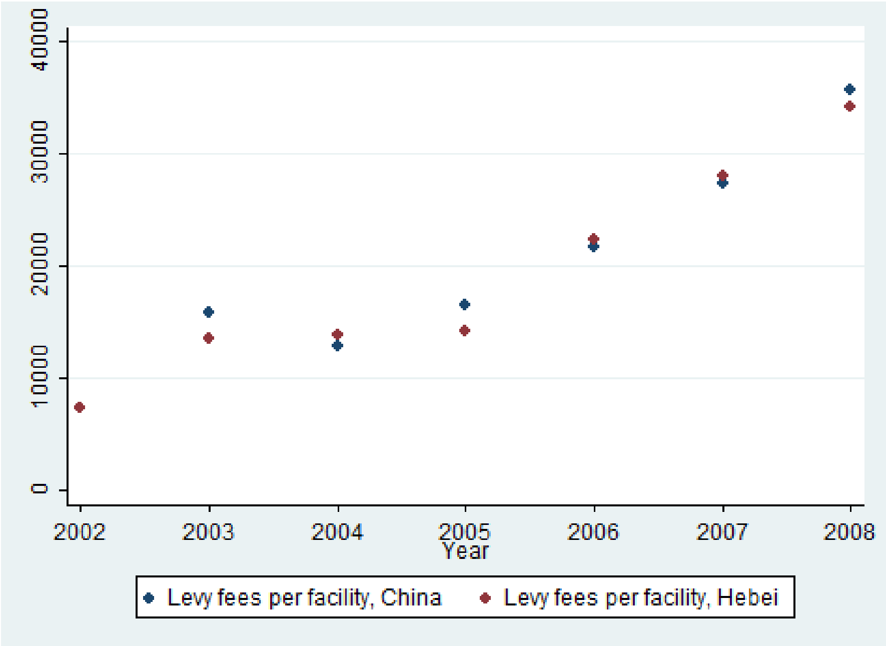
Indicator 1†		**Indicator 2**‡	
Ranking of provinces	Indicator value	Ranking of provinces	Indicator value
Inner Mongolia	196.51	Inner Mongolia	0.43
Hebei	262.06	Hebei	0.73
Liaoning	280.31	Tianjin	0.89
Henan	312.66	Shanxi	0.90
Beijing	315.42	Henan	0.92
Shanxi	417.77	Liaoning	1.11
Shandong	484.24	Shandong	1.47
Tianjin	610.59	Beijing	1.89

† Refers to the share of industrial pollution treatment investment in innovation investment

‡ Refers to levy fees divided by the number of charged organizations

6.B Tightening of the environmental policy in Hebei and China

Figure 6.3: Tightening of the environmental policy in Hebei and China



Data source: Authors' calculations using data from the Ministry of Environmental Protection and Hebei Environmental Protection Bureau.

6.C Variables definitions

Table 6.7: Variables definitions

Variable	Definition	Unit
Creation of firms	Number of creations of polluting firms	Creation
Envi. Reg.	Dummy equal to 1 if the county-level division has been designated as a control zone, 0 otherwise	-
W GDP	Real GDP (2002 prices) of neighboring cities weighted by distance between the county-level division and neighboring cities	-
W Env. Reg.	Environmental regulation of neighboring cities weighted by distance between the county-level division and neighboring cities	-
Border 1	Dummy equal to 1 if the county-level division shares a border with the sea or another province, 0 otherwise	-
Border 2	Length of the common border (with another province or the sea) divided by the total length of the county-level division's border	%
Distance	Distance between the county seat (county capital) and the closest border (with another province or the sea). The geographical coordinates of the county seat are used to calculate the distance.	Meter
Agglo. Eco.	Number of employees in industry per km^2	Employees per km^2
Population density	Population per km^2	Person per km^2
Wage	Average real wage in industry (2002 prices)	Yuan
Education	Share of secondary students in the total population	%
Local market	Real GDP (2002 prices)	100 million yuan
GDP per capita	Real GDP per capita (2002 prices)	10,000 yuan
SEZ	Number of Special Economic Zones (national level)	SEZ
River	Length of the rivers running through the county-level division	Meters
Port	Dummy equal to 1 if the county-level division has an international port	-
Topography	Variable equal to 1 if the county-level division is located on a plain, 2 if in a hilly area and 3 if in a mountainous area	-
District	Dummy equal to 1 if district, 0 otherwise	-
County	Dummy equal to 1 if county, 0 otherwise	-

6.D Descriptive statistics

Table 6.8: Descriptive statistics

Variable	**Obs.**	**Mean**	**Std. Dev.**	**Min**	**Max**
Creation of firms	1029	0.25	0.86	0	17
Envi. Reg.	1029	0.14	0.35	0	1
W GDP Pref. Cities	1029	12.30	29.76	0	462.69
W GDP County-level Cities	1029	8.33	6.09	0	35.22
W Envi. Reg. Pref. Cities	1029	0.03	0.09	0	1.13
W Envi. Reg. County-level cities	1029	0.05	0.04	0	0.22
Border 1	1029	0.45	0.50	0	1
Border 2	1029	14.36	20.59	0	74.28
Distance	1029	40631.43	25710.47	354.40	110647.60
Agglo. Eco.	1029	29.18	97.09	0.05	694
Population density	1029	683.22	846.61	43.37	8890
Wage	1029	11634.60	3782.49	2624.00	31432.60
Education	1029	7.11	1.85	1.35	13.65
Local market	1029	67.73	111.15	4.12	1473.47
GDP per capita	1029	12210.33	7337.96	3775.31	37620.39
SEZ	1029	0.30	0.62	0	5
River	1029	42438.00	50765.16	0	327997.10
Port	1029	0.03	0.16	0	1
Topography	1029	1.50	0.79	1	3
District	1029	0.07	0.26	0	1
County	1029	0.78	0.42	0	1

6.E Count data models

The standard count data model is the Poisson model. In this case, the probability for a region i to receive y_i firms is given by:

$$Prob(Y = y_i|x_i) = \frac{e^{-\lambda_i}\lambda_i^{y_i}}{y_i!}, y = 0, 1, 2, ..., n \text{ and } \ln(\lambda_i) = \beta' X_i$$

The vector of coefficients β is estimated by the method of the maximum likelihood.

In the case of overdispersion caused by unobserved heterogeneity, a negative binomial model is usually estimated. It is obtained by introducing heterogeneity in the Poisson parameter:

$$\ln(\lambda_i) = \beta' X_i + \varepsilon_i$$

with ε_i following a gamma distribution with mean 1 and variance α. In this model, which is a mixture of Poisson and Gamma distributions, the probability $Prob(y_i)$ of a territory i to receive a number y_i of firms is given by:

$$Prob(Y = y_i) = \frac{\theta^\theta \lambda_i^{y_i}}{\Gamma(y_i + 1)\Gamma(\theta)} \frac{\Gamma(y_i + \theta)}{(\lambda_i + \theta)^{y_i+\theta}}$$

where Γ is the gamma function and $\theta = 1/\alpha$, with α the over-dispersion parameter. When $\alpha = 0$, there is equi-dispersion and the negative binomial model is equivalent to the Poisson model (the two models are nested).

In addition, if overdispersion also arises from an excess of zeros, a zero-inflated negative binomial model is estimated. Specifically, this two-regime model takes the following form:

$$y_i = 0 \text{ with probability } P_i$$

$$y_i \rightsquigarrow \text{negative binomial model with probability } 1 - P_i$$

Therefore, the overall probability of a zero outcome is:

$$Prob[Y_i = 0] = P_i + [1 - P_i]R_i(0)$$

and

$$Prob[Y_i = y_i | Y > 0] = [1 - P_i] R_i(\text{not } 0)$$

where P_i is the state probability and R_i the negative binomial distribution for the variable y_i. The probability P_i can follow a normal or a logistic distribution.

6.F First-step results of the ZIP model

To deal with zero-inflation, the standard solution consists in estimating a zero-inflated model, as suggested by Greene (1994). In our case however, as we have data on the stock of firms, we have an alternative to the zero-inflated model. Given that we have stock data, we may be able to differentiate between, on the one hand, counties that are unsuitable for firm' locations ($stock = 0$) and, on the other hand, counties suitable for firms' location ($stock > 0$) but in which no polluting firms were established during the sample period. Thus, an alternative to the zero-inflated model could be to exclude from the analysis counties in which there are no polluting firms at all ($stock = 0$). After that, we could run a standard count data model on the remaining counties (for which $stock > 0$).

Between these two solutions, we have decided to estimate the zero-inflated model, which is, in our view, much more flexible than the other option. Indeed, we feel that the stock of polluting firms does not provide fully accurate information necessary to determine whether or not a county is a suitable location for firms (and thus, whether or not it should be excluded from the analysis). This is due to two reasons.

Firstly, in 2002, there were no polluting firms at all in fifteen counties ($stock = 0$). In 2008, there were no polluting firms at all in only eleven counties. Thus, it is likely that in the following years, new firms will locate in these eleven remaining counties. In this context, excluding them from our analysis would be very restrictive.

Secondly, as detailed in Section 6.5.4, China's industrial strategy has evolved over time. Many firms on the list locate in counties during the 1950s-1960s. These counties, which were mostly in mountainous and remote areas, were suitable location for firms when the country was trying to protect industry from potential destructive military conflicts (Wen, 2004). Nowadays, by contrast, these remote counties are no longer suitable locations for firms. Thus, it would be an error to consider these counties as suitable locations, even if they have a positive stock of polluting firms ($stock > 0$).

Because of these reasons, we have chosen not to use the stock criteria to exclude several counties from the analysis. Instead, we have decided to estimate a zero-inflated model, which offers a much more flexible way (thanks to the first-step model) to differentiate between counties that are unsuitable locations for firms from the others.

Table 6.9: Estimation results of the first-step model

	(1) Border 1	(2) Border 2	(3) Distance	(4) Border 1	(5) Border 2	(6) Distance
Envi. Reg.	-16.56***	-15.30***	-15.00***	-14.57***	-4.141	-14.72***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.583)	(0.000)
Agglo. Eco.	0.168	0.228	0.231	0.239	0.596	0.299
	(0.751)	(0.662)	(0.650)	(0.628)	(0.714)	(0.527)
Education	19.99**	18.19*	18.85**	22.16**	21.75*	20.60**
	(0.026)	(0.060)	(0.041)	(0.013)	(0.063)	(0.034)
Local market	-0.017	-0.021	-0.023	-0.016	-0.022	-0.022
	(0.342)	(0.269)	(0.239)	(0.298)	(0.327)	(0.222)
Topography	-0.132	-0.018	-0.118	-0.178	-0.035	-0.144
	(0.817)	(0.975)	(0.819)	(0.746)	(0.953)	(0.775)
River	0.016***	0.017***	0.016***	0.017***	0.018**	0.017***
	(0.001)	(0.001)	(0.002)	(0.002)	(0.029)	(0.003)
Constant	-3.264**	-3.123*	-2.822	-3.708**	-3.852*	-3.196*
	(0.039)	(0.083)	(0.102)	(0.019)	(0.052)	(0.084)
N	882	882	882	882	882	882

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

6.G Baseline results using contemporaneous variables

Table 6.10: Baseline results using contemporaneous variables

	(1) Border 1	(2) Border 2	(3) Distance	(4) Border 1	(5) Border 2	(6) Distance
Border	0.358*	0.010**	-0.185*	0.391**	0.011**	-0.211*
	(0.074)	(0.042)	(0.076)	(0.048)	(0.014)	(0.053)
Envi. Reg.	-0.902**	-0.804**	-0.830**	-1.172***	-1.079***	-1.103***
	(0.013)	(0.028)	(0.023)	(0.004)	(0.008)	(0.006)
W GDP pref. cities	0.002***	0.001***	0.002***	0.001**	0.001*	0.001**
	(0.006)	(0.009)	(0.005)	(0.026)	(0.052)	(0.025)
W GDP county-level cities	-0.001	-0.001	-0.001	-0.001	-8.45E-05	-6.35E-04
	(0.553)	(0.780)	(0.572)	(0.671)	(0.960)	(0.703)
W Envi. Reg. pref. cities				0.623**	0.658**	0.641**
				(0.026)	(0.016)	(0.022)
W Envi. Reg. County-level cities				-0.363	-0.407	-0.333
				(0.164)	(0.112)	(0.199)
Agglo. Eco.	0.005	0.024	0.014	-0.020	0.001	-0.014
	(0.965)	(0.836)	(0.903)	(0.851)	(0.991)	(0.898)
Pop. Density	-0.144	-0.192	-0.211	-0.032	-0.078	-0.106
	(0.558)	(0.445)	(0.371)	(0.898)	(0.761)	(0.667)
Wage	-1.499***	-1.696***	-1.561***	-1.401***	-1.623***	-1.480***
	(0.000)	(0.000)	(0.000)	(0.001)	(0.000)	(0.002)
Education	5.816	5.873	6.015	5.077	5.274	5.106
	(0.135)	(0.115)	(0.106)	(0.218)	(0.174)	(0.194)
Local market	0.003***	0.002***	0.003***	0.003***	0.002***	0.003***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
GDP per capita	0.548**	0.662***	0.573**	0.607**	0.733***	0.640**
	(0.038)	(0.010)	(0.029)	(0.020)	(0.004)	(0.014)
SEZ	-0.957	-0.923	-1.085	-1.142	-1.150	-1.353
	(0.146)	(0.180)	(0.169)	(0.118)	(0.148)	(0.156)
River	0.007**	0.006**	0.008***	0.007***	0.007**	0.008***
	(0.015)	(0.036)	(0.004)	(0.006)	(0.017)	(0.001)
Port	-0.893	-0.973*	-0.941	-0.942	-1.035*	-1.005
	(0.102)	(0.075)	(0.118)	(0.113)	(0.081)	(0.141)
Topography	-0.007	-0.001	-0.008	0.022	0.034	0.015
	(0.974)	(0.998)	(0.968)	(0.918)	(0.878)	(0.943)
Districts	1.421***	1.329***	1.391***	1.569***	1.477***	1.546***
	(0.001)	(0.002)	(0.001)	(0.001)	(0.002)	(0.001)
County	-0.396	-0.352	-0.363	-0.607*	-0.581	-0.584
	(0.228)	(0.269)	(0.266)	(0.096)	(0.103)	(0.110)
Constant	12.75***	14.81***	15.71***	11.25***	13.50***	14.70***
	(0.002)	(0.000)	(0.000)	(0.007)	(0.001)	(0.002)
lnalpha	-2.588*	-2.495*	-2.702	-2.931	-2.939	-3.290
	(0.097)	(0.089)	(0.107)	(0.151)	(0.146)	(0.231)
Year dummies	Yes	Yes	Yes	Yes	Yes	Yes
N	1029	1029	1029	1029	1029	1029
Log likelihood	-490.570	-489.872	-490.524	-488.002	-486.890	-487.884
Vuong test	2.54	2.44	2.58	2.56	2.46	2.64

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

6.H Robustness checks using contemporaneous variables

Table 6.11: Robustness checks using contemporaneous variables

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
			% envi staff in employees					Envi. Staff per inhab.	
	Border 1	Border 2	Distance	Border 1	Border 2	Distance	Border 1	Border 2	Distance
Border	0.341*	0.010**	-0.175	0.371*	0.010**	-0.197*	0.363*	0.010**	-0.189*
	(0.094)	(0.046)	(0.112)	(0.059)	(0.028)	(0.074)	(0.064)	(0.029)	(0.076)
Envi. Reg.	-0.896**	-0.801**	-0.826**	-1.095***	-0.993***	-1.022***	-1.083***	-0.979**	-1.009***
	(0.014)	(0.028)	(0.023)	(0.003)	(0.009)	(0.006)	(0.004)	(0.010)	(0.008)
W GDP pref. cities	0.002***	0.001***	0.002***	0.001**	0.001**	0.001**	0.001**	0.001**	0.001**
	(0.005)	(0.007)	(0.004)	(0.020)	(0.035)	(0.019)	(0.023)	(0.039)	(0.022)
W GDP county-level cities	-0.001	-0.001	-0.001	-0.001	-8.91E-05	-4.78E-04	-0.001	-3.03E04	-0.001
	(0.517)	(0.727)	(0.554)	(0.724)	(0.958)	(0.778)	(0.657)	(0.860)	(0.685)
W Envi. Reg. pref. cities	0.034	0.042	0.022						
	(0.765)	(0.703)	(0.846)						
W Envi. Reg. CZ pref. cities				0.334*	0.343*	0.323*	0.371**	0.386**	0.373**
				(0.065)	(0.051)	(0.070)	(0.043)	(0.031)	(0.038)
W Envi. Reg. Non-CZ pref. cities				-0.017	-0.002	-0.031	0.156	0.275	0.170
				(0.904)	(0.988)	(0.818)	(0.829)	(0.691)	(0.813)
W Envi. Reg. County-level cities	-0.196	-0.232	-0.170	-0.344	-0.378	-0.313	-0.343	-0.373	-0.315
	(0.421)	(0.336)	(0.487)	(0.188)	(0.138)	(0.231)	(0.192)	(0.145)	(0.229)
Agglo. Eco.	0.004	0.022	0.014	-0.014	0.004	-0.005	-0.020	-0.004	-0.012
	(0.969)	(0.853)	(0.897)	(0.896)	(0.975)	(0.961)	(0.854)	(0.974)	(0.907)
Pop. Density	-0.107	-0.144	-0.179	-0.073	-0.118	-0.146	-0.078	-0.122	-0.152
	(0.675)	(0.583)	(0.464)	(0.769)	(0.645)	(0.547)	(0.752)	(0.633)	(0.527)
Wage	-1.512***	-1.711***	-1.567***	-1.456***	-1.668***	-1.527***	-1.470***	-1.686***	-1.541***
	(0.000)	(0.000)	(0.000)	(0.001)	(0.000)	(0.001)	(0.001)	(0.000)	(0.001)
Education	6.491	6.673*	6.551*	6.015	6.293*	6.092	6.140	6.422*	6.269*
	(0.102)	(0.078)	(0.084)	(0.128)	(0.090)	(0.103)	(0.118)	(0.082)	(0.093)
Local market	0.003***	0.003***	0.003***	0.003***	0.003***	0.003***	0.003***	0.003***	0.003***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
GDP per capita	0.537**	0.640**	0.567**	0.553**	0.665***	0.579**	0.557**	0.669***	0.584**
	(0.042)	(0.012)	(0.031)	(0.032)	(0.008)	(0.025)	(0.033)	(0.008)	(0.025)
SEZ	-0.938	-0.914	-1.058	-1.105	-1.092	-1.292	-1.083	-1.066	-1.246
	(0.159)	(0.190)	(0.183)	(0.125)	(0.158)	(0.159)	(0.132)	(0.164)	(0.163)
River	0.007**	0.006**	0.008***	0.006**	0.006*	0.007***	0.006**	0.006*	0.007***
	(0.018)	(0.045)	(0.005)	(0.025)	(0.059)	(0.009)	(0.026)	(0.062)	(0.010)
Port	-0.934*	-1.023*	-0.976	-0.923	-1.003*	-0.981	-0.921	-1.006*	-0.974
	(0.094)	(0.066)	(0.111)	(0.118)	(0.088)	(0.144)	(0.116)	(0.083)	(0.139)
Topography	0.035	0.052	0.026	0.033	0.046	0.026	0.032	0.046	0.025
	(0.870)	(0.813)	(0.902)	(0.877)	(0.834)	(0.901)	(0.881)	(0.837)	(0.906)
Districts	1.436***	1.363***	1.391***	1.529***	1.458***	1.480***	1.594***	1.536***	1.569***
	(0.002)	(0.005)	(0.003)	(0.001)	(0.002)	(0.001)	(0.001)	(0.001)	(0.001)
County	-0.388	-0.349	-0.357	-0.558*	-0.516	-0.531	-0.542	-0.497	-0.510
	(0.240)	(0.274)	(0.276)	(0.095)	(0.115)	(0.113)	(0.110)	(0.134)	(0.134)
Constant	12.55***	14.53***	15.38***	12.17***	14.31***	15.40***	12.29***	14.45***	15.43***
	(0.003)	(0.001)	(0.001)	(0.005)	(0.001)	(0.001)	(0.004)	(0.001)	(0.001)
lnalpha	-2.550*	-2.480*	-2.646*	-2.600**	-2.571**	-2.805**	-2.521**	-2.490**	-2.675**
	(0.085)	(0.085)	(0.094)	(0.031)	(0.034)	(0.043)	(0.024)	(0.025)	(0.028)
Year dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	1029	1029	1029	1029	1029	1029	1029	1029	1029
Log likelihood	-490.291	-489.469	-490.328	-487.852	-487.057	-487.820	-487.838	-486.992	-487.819
Vuong test	2.52	2.42	2.54	2.55	2.42	2.58	2.52	2.38	2.55

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

Chapter 7

General Conclusion
What could be a good rural development strategy for China?

Since the early 2000s, the Chinese government has defined a series of measures to enhance rural development. Among the different strategies implemented, one of them consists in promoting cities as growth poles for nearby rural areas. Thus, "100 km economic zones" are progressively appearing across the country in order to link rural areas to urban centers. The creation of these economic zones has been accompanied by huge investments in rural infrastructures in order to enhance linkages between urban and rural areas within the zones. However, while the number of these economic zones is increasing, very little is known about the effective impact of cities on nearby rural areas in the specific Chinese context. Can cities enhance rural development or, on the contrary, would it be preferable to rely on other strategies to develop rural areas? This dissertation seeks to understand whether or not cities may enhance development in nearby rural areas in China.

Main results

In Chapter 2, we have defined what we mean by "urban" and "rural" areas in China. We have explained why, because of the implementation of several administrative measures, the "city" concept has progressively lost relevance over the reform period. While the "city" very relevantly covered the city proper in the pre-reform era, nowadays the UAA of city is likely to over-bound cities because recent increases in UAA reflect not only the urbanization process but also administrative arrangements. In the light of this discussion, we have wondered about the relevant scale of analysis to empirically assess urban influence on rural economic development in China. We have concluded that the more relevant consisted in providing both county and village-level analyses.

Chapter 3 contains a review of the literature on the role of cities in rural development. This has enabled us to describe the different potential mechanisms by which cities may enhance, or on the contrary hinder, rural development. However, as most studies have been carried out in the context of developed countries, we have also provided a critical analysis of this analytical framework in order to examine the relevancy of the different mechanisms in the Chinese context. Thus, we have highlighted that, as for developed countries, cities may produce a number of positive effects on nearby rural areas. However, we have emphasized that cities may produce additional negative effects on rural areas in China, because the country is at a lower stage of economic development and because of some specific institutional arrangements. As a result, while recent empirical studies on developed countries have often concluded that cities enhance rural development, their impact is much more uncertain in China. Finally, we have wondered about the relevant measure of urban proximity to empirically assess whether cities affect rural areas in China.

In the following three chapters of the dissertation, we carried out empirical analyses in order to understand whether urban proximity had a positive or negative effect on rural development. Each chapter was conceived in order to shed light on a set of fundamental issues: to what extent are cities and nearby rural areas interdependent? What is the effect of urban areas on the different economic sectors of rural areas (agricultural and non-agricultural sectors)? Beyond their economic impact, do cities enhance rural development? Are urban effects on rural areas homogeneous across Chinese regions? Do different cities produce different effects on rural areas?

Chapter 4 began by testing the effect of cities on the agricultural sector of rural counties. While agriculture remains a key component of the rural economy, very few studies have investigated the impact of cities on the agricultural sector of nearby rural areas. Specifically, we have tested whether urban proximity enhances the agricultural technical efficiency level of nearby rural counties, which is a key determinant of long-term economic growth. Our empirical analysis has provided three main results. First, it appears that cities significantly influence rural areas in China. As a result, it is not possible to understand rural development without taking into account nearby urban centers. Studying rural development without taking the surrounding regional economy into account would result in incorrect policy recommendations. Second, we have found that cities strongly enhance the level of agricultural efficiency of nearby counties in the most developed region, that is to say Eastern China. However, cities enhance agricultural efficiency much less significantly in the less developed Central region and have no significant effect in Western provinces. Third, it appears that spillover effects also vary across the urban hierarchy. On the one hand, provincial-level cities, which are favored by the Central government, are found to produce significant backwash effects on counties. On the other hand, prefecture-level cities, and to some extent county-level ones, produce spread effects on counties in almost every region. Thus, this last result confirmed our expectations: while cities may enhance rural development in China, their effect is much less positive than what is usually estimated for developed countries.

Chapter 5 has shed additional light on the role of urban centers in rural development by investigating their impact on rural non-agricultural employment. Specifically, we have estimated whether workers living in villages close to cities and towns get access to better paid non-agricultural jobs. This issue is of utmost importance as non-agricultural earnings are a major determinant of the level of earnings of rural households. By carrying out a micro-level analysis, we have reached three potentially interesting conclusions. First, this study has confirmed that urban areas significantly affect rural development. In this chapter we have found that urban areas have a particularly positive impact on the non-agricultural sector of nearby rural areas. Indeed, it appears that rural workers close to cities not only benefit from higher opportunities to diversify locally but also from higher non-agricultural wages. Second, interestingly, we have managed to disentangle the different transmission channels at work. According to our estimates, workers close to cities benefit from higher wages thanks to the combined effects of market potential -resulting in higher wages in villages close to cities- and of commuting. Third, this chapter has confirmed that urban effects vary a great deal according to regions and city type. Once again, we have estimated that cities produce a significantly more positive impact on rural areas in Eastern China than in the less developed interior provinces. Moreover, we have found that wages are the highest close to the largest cities, which is consistent with previous findings on developed countries.

While the first two empirical analyses have tested the impact of cities on the economic performance of rural areas, Chapter 6 focused on a more developmental issue: environmental quality. Specifically, we tested whether a higher number of polluting firms choose to establish themselves in rural counties close to cities. Clearly, this issue has been largely ignored by the literature on urban effects which has overwhelmingly focused on the role of cities on rural economic performance. In this last chapter, we have reached three main results. First, polluting firms have a significantly higher probability to settle in counties close to prefecture-level cities. Thus, while cities may enhance rural economic performance, they may also seriously deteriorate the quality of life. As a result, focusing exclusively on the role of cities on rural economic performance may lead to over-estimate the positive impact of cities on rural areas. Second, we estimated that polluting firms are significantly more likely to establish themselves close to prefecture-level cities for two reasons: (i) a “pure market effect” and (ii) a deliberate intention on the part of polluting firms to avoid more stringent urban environmental regulations. Finally, it appears that counties close to county-level cities do not suffer more from a higher level of pollution. Thus, once again, this confirms that urban effects vary according to the city type.

Policy implications

The results of this dissertation naturally lead us to wonder what would be a good rural development strategy for China.

A regional approach to rural development close to cities

The main result of this dissertation is that urban centers interact with their nearby rural areas. Nowadays, there is a blurring of the boundaries between urban and rural areas and thus, it does not seem relevant to implement separated policies in urban centers and in their surrounding rural areas. In other words, the best policy for rural areas close to cities would be a regional policy that explicitly recognizes that urban and rural areas are interdependent.

On the whole, we have found that cities enhance the economic performance of their neighboring rural areas, both in the agricultural and non-agricultural sectors. Previous studies on developed countries have suggested implementing several different policies in the case where urban centers generate positive effects on nearby rural areas. On the one hand, the best rural development policy could consist in an urban policy promoting urban growth (Schmitt and Henry, 2000; Partridge *et al.*, 2007). However, in our opinion, such a recommendation cannot be formulated for China where urban locations have been continuously favored for decades, at the expense of rural areas. In other words, a good rural development strategy in China cannot consist in favoring cities and waiting for urban growth to trickle down to rural areas. On the other hand, enhancing urban and rural linkages through transportation and communication policies, without favoring urban growth, could also be a good rural development strategy, as it would result in increased urban spread effects (Barkley *et al.*, 1996; Henry *et al.*, 1997; Partridge *et al.*, 2007). For example, developing the infrastructure network is expected to facilitate commuting and the relocation of urban firms to nearby rural areas. In our opinion, this second option seems much more viable in the Chinese context. Thus, a good development strategy for rural areas surrounding urban centers could be a regional policy, consisting in leaving cities to prosper while strengthening ties between prosperous urban areas and their surrounding nearby rural areas.

However, one additional result in this dissertation is that urban effects vary a great deal according to regions and city type. First, cities stimulate significantly more rural economic performance in Eastern China than in the rest of the country. Indeed, congestion costs have appeared in Eastern cities and the service sector develops much more rapidly there, leading to a significant relocation of urban firms to nearby rural areas. On the contrary, in less developed provinces, cities are at a lower stage of development and are more likely to compete with nearby rural areas. Therefore, while enhancing urban-rural ties could be particularly effective in Eastern China, where spread effects prevail, we can seriously question the effectiveness of this policy in the less developed provinces. Indeed, in less developed provinces, this policy could result in increased competition between cities and their nearby rural areas, and thus in backwash effects. Secondly, we have found that different cities produce different effects on their nearby rural areas. In the specific case of agriculture, we have found that provincial cities have a negative impact on their nearby rural areas. This result leads us to examine the relevance of the current Chinese urban policy, which strongly favors higher-ranked cities. In addition, from an empirical point of view, the high heterogeneity of urban effects indicates that it is crucial to distinguish the effect of different cities, in different regions, when assessing their effect on rural development. Otherwise, this may lead to skewed and overly simplistic policy recommendations. As highlighted by Partridge (2012), testing for urban effects without taking into account the potential heterogeneous effect of different cities may lead to wrongly state that urbanization, and integration to urban areas, is "good for all".

Finally, close to cities, a regional approach is desirable not only to enhance the positive impact of cities on rural economic performance, but also to manage the negative effects of cities on rural areas, in terms of pollution for example. As estimated in this dissertation, while cities may significantly enhance the economic performance of nearby rural areas, they are also likely to produce a significant negative impact on the environmental quality of their neighboring rural areas. Thus, a regional approach to rural development is necessary to plan and manage a number of developmental issues, such as land issues or pollution, which occur at the level of the city region. In other words, a regional approach is a necessary condition to create sustainable regions (McGee, 2008).

Heterogeneity of rural policies and community-specific policies in remote areas

While strengthening urban and rural integration could be an effective policy to enhance development close to cities, we can seriously question the effectiveness of this approach in isolated areas. According to the World Bank (2009), the most efficient way to develop lagged regions would be to enhance integration between lagged and dynamic regions, in particular by liberalizing factors' mobility so that resources may move from unproductive to productive places. However, the actual effects of this kind of policy on remote areas remain uncertain. In fact, an increased integration can result in a greater marginalization of lagged regions. Indeed, a number of empirical studies have highlighted that infrastructure investment in remote regions often leads capital and workers to increasingly agglomerate in productive regions, widening the regional development gap (Barca *et al.*, 2012). Thus, while enhancing integration between urban and rural areas may reinforce spread effects close to cities, it may also reinforce backwash effects in remote areas (Barkley *et al.*, 1996).

This leads us to conclude that heterogeneity is a major component of a good rural development strategy for China. Indeed, it clearly appears that rural places face a different regional context, in particular according to their location: while cities generate positive economic benefits on their nearby rural areas, they have a much less positive impact on areas located further away. As a result, a good rural development policy must take into account these differences and thus, different policies might be undertaken in different contexts. While this recommendation may seem quite trivial, it is of great importance in China, where different local governments tend to implement very similar development policies, a situation referred to as the "isomorphism of local development policy" (Chien, 2008).

If increasing integration is not a good development strategy for remote areas, then what could be a good development strategy for remote regions[1]? For remote areas, which do not benefit from positive urban effects, the best solution could consist in implementing place-based policies, as already pointed out in the literature on developed countries (Barkley *et al.*, 1996; Roberts, 2000). For example, the government may provide tax incentives to industries to encourage non-agricultural employment growth. It is worth noting that place-based policies have been criticized, especially by the World Bank (2009). According to its detractors, the place-based approach would divert resources from productive to unproductive places, undermining national

[1] As highlighted by Polèse and Shearmur (2003) development strategies based on the growth pole theory can be effective in enhancing the development of all regions in countries such as France, where almost every area is close to a city. However, given that urban effects have a limited geographical scope, relying on cities is very unlikely to stimulate development of peripheral regions in vast and sparsely populated territories such as Canada. In our opinion, the same conclusion can be drawn for China: relying on cities cannot enhance development in remote rural areas in China.

economic growth. However, these approaches often wrongly assume that economic development is not possible in every territory. Yet, this is not supported by empirical works, as several studies have highlighted that place-based policies targeting remote regions resulted in significant growth, both at the local and national levels (Barca *et al.*, 2012). Indeed, place-based policies may be particularly effective to reduce rural poverty in remote areas (Partridge and Rickman, 2008). Specifically, as commuting and migration to remote areas is very limited, local employment growth in remote areas benefit almost exclusively the local residents, resulting in a significant reduction in poverty. While this result has been found to be true for the U.S., we can reasonably assume that place-based policies could be even more effective in reducing poverty in Chinese remote rural areas, given that mobility to remote areas is much more limited than in the U.S.

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