Farm Dependence and Population Change in China: 1953 to 2005

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Abstract

The existing literature has well documented a negative association between farm dependence and population change in Western countries. A number of theories have also been proposed to explain such an association. The applicability of those findings and theories, however, has rarely been tested in less developed countries, such as China. Using five waves of Chinese Census data and data from *China Statistical Yearbooks*, I investigate the association between farm dependence and population change in China at both the provincial and county levels. I also test the applicability of existing theories to the Chinese society. Findings show that the mechanization thesis, the industry complex theory and the human ecology approach, three major theories used to explain rural population change, are not supported by the Chinese data. Results reveal that the association between farm dependence and population change in China has been greatly impacted by political factors. The effect of farm dependence on population also varies by region; high farm dependence does not necessarily lead to a lower population growth. In China, the negative effect of farm dependence on population growth shown in Western countries is indeed offset by higher fertility in rural regions which is caused by the differential

effect of the one-child policy in rural and urban areas. China's population growth is still heavily driven by rural population growth. This is again a result of the political influence. I thus initiate the political approach to understand the farm dependence and population change relationship in China. The research reminds researchers to re-examine existing population theories when applying them to less developed countries.

Key words: farm dependence, population change, human ecology

Introduction

As the most populous country in the world, China has experienced a dramatic population change during the past few decades. The changing pattern of population, however, has been uneven across subregions of China. Overall, the proportion of agricultural population has been shrinking and the east coast regions and big metropolitan areas have undergone a considerable population increase. Thus far, a number of studies have been conducted to explain the dynamics of population change in China. The majority of them have been focusing on examining the internal migration from rural to urban areas and the "push" and "pull" factors of migration. A few studies (Li 1996; Liang and White 1997; Wu 1994; Yang 1996) have illustrated the role of surplus rural labors on farms in determining population mobility among provinces in China. These studies seem to suggest that regions that heavily depend on farms are more likely to lose population through out-migration than less farm-dependent areas. Thus, there seems to be a positive association between farm dependence and out-migration. The existing literature, however, has rarely shown how farm dependence influences China's population change in the form of *total population growth*.

Prior literature has indeed well documented a negative relationship between farm dependence and population growth in Western countries, especially during the post-mechanization era. Researchers show that in the United States, for instance, coincided with farm mechanization and industrialization, regions with high farm dependence have generally experienced more population loss and lower population growth rates than low-farm-dependence regions (Albrecht 1993; Albrecht 1986; White 2008). Various theories have also been proposed to explain such an association. Those theories, nevertheless, have hardly been tested in less developed countries. In order to fulfill the picture of farm dependence and rural population change in a broader social context that includes less developed nations, in this article, I extend the analysis of farm dependence and population to the social context of China at the provincial and county levels. I test the applicability of previous findings and theories based on Western societies to China. Three most popular theoretical approaches are adopted to explore the dynamics of farm dependence and population change. I believe that research results that are based on a country that is traditionally agricultural and had 77% of its population residing on farms by 2000 (National Bureau of Statistics of China 2001) will take on particular relevance for rural and population policy making in other countries.

The key factor in this article, "farm dependence," refers to the extent to which population in an area depends on agricultural activities. The higher the percentage of population that makes living depending on agricultural activities, the higher the level of farm dependence of a certain region. As already noted, in this research, I examine the influence of farm dependence on population change at provincial and county levels. To do so, I rely on five waves of Chinese Census data to conduct the provincial level analysis. These data allow me to study the longitudinal change of population in 31 provinces of China from 1953 to 2000 and its relation to farm dependence. At the county level, I use data from *China Statistical Yearbooks* 2001-2006 and I cross-sectionally examine the changing pattern of population in counties of several major agricultural provinces from 2000 to 2005. Findings of this research exhibit a unique association between farm dependence and population change in China. Based on those findings, I initiate the political approach to understand the association between farm dependence and population change in China, which enriches existing population theories.

I begin with an introduction of the theoretical framework that guides this current research. This is followed by a discussion of hypotheses, variables, data and methods. I then use the partial correlation and the ordinary least squares (OLS) regression methods to investigate the association between farm dependence and population change in China.

Theoretical Framework

The theoretical framework that guides this current research is rooted from three sociological theories explaining rural population change, namely, farming-manufacturing complex thesis, mechanization and technological innovation theory, and human ecological approach. In this section of the paper, I will review these theoretical approaches and evaluate how these approaches guide this research to understand farm dependence and population change in the Chinese social context.

Farming-Manufacturing Complex Thesis

The main argument of this theory is that alternative employment opportunities in the industrial sector moderate the influence of farm dependence on population change. Friedman's (1978) research provides a good example of how competitive production reduced family labor on farms in the United States and Great Britain. Page and Walker (1991) also observe the mutually interdependent and competing nature between agriculture and manufacturing in the United States. White (2008) further proposes two scenarios explaining the mechanism of farm dependence and population change when nonfarm economic alternative exists. That is, first, the influence of farm dependence on population changes is regulated by the alternative labor market. When family farms are able to reproduce themselves "at a rate on par with wage labor," then the industrial sector is less likely to draw labors away from farms (White 2008: 366). However, when farm income is less than wage labor, people are more likely to switch to the industrial sector though the total population may remain stable. Second, the mutual dependency between agriculture and manufacturing leads to population growth on farms due to the contribution of manufacturing to household income. In this situation, population growth is maintained and is positively moderated by manufacturing. White (2008) argues that the positive association between farm dependence and population change should occur prior to mechanization and the negative relationship turns to be the case after mechanization.

Prior research on this topic in China has shown mixed results. Researchers find that the existence of industrial sectors outside of farms have caused a considerable gap of living standards of people who work in industry and who work on farms (Leeming 1985). To seek higher living standards in industry, a large amount of rural population abandoned farms and moved to areas with industrial jobs. This pattern became more significant since the 1990s when more and more private- or foreign-owned industrial sectors emerged in China. Those industrial sectors do not require the household registration status of employees at the destination places, which boosted population movement from countryside to urban areas (Liang and White 1996). Findings of those studies have generally supported a negative association between industries outside of farms and farm population change. Some other researchers have also examined the influence of rural enterprises, industries inside of farms, on farm population change. Xiaotong Fei, a pioneer researcher on rural small town development, conducts research on Jiangchun village in Jiangsu province (Fei 1989). He shows that industrial enterprises in rural areas created job opportunities on farms, which absorbed surplus farm laborers. Thus, rural enterprises positively influence population growth in countryside in China and have prevented overpopulation in big and medium sized cities. Results of some more recent studies, however, contradict Fei's findings. For instance, Yang (1996) investigates several rural regions in Zhejiang province and demonstrates that regions with well-developed rural enterprises in fact experienced the most out-migration, which resulted in a rural population loss. Liang and White's (1997) research casts further doubt on the efficiency of rural enterprises absorbing peasants on farms. They find that China's rural enterprises are in fact likely to increase interprovincial migration though they tend to reduce intraprovincial migration. Liang and White contend that rural enterprises seem to absorb only those who have moving potential within rather than between provinces in China. If this is the case, then rural enterprises won't be effective in terms of absorbing migrants who intend to move between provinces. Based on these findings, rural areas with well-developed rural enterprises will eventually experience a population loss through out-migration at the provincial level. To summarize, the majority of prior research on China seems to support the first scenario proposed by White (1997), suggesting a negative influence of industry on farm population change, particularly through population mobility.

Mechanization and Technological Innovation Theory

This theory explains the relationship between agriculture and population dynamics from the changing pattern of technology during the "pre-mechanization" and "post-mechanization" periods. According to the mechanization thesis, a considerable population growth on farms during the pre-mechanization period in Western countries, including in the U.S., was due to a booming agricultural industry (farming industry). This booming farming industry increased the demand for labor, which led to a population growth on farms. During the post-mechanization period, mechanization and technological innovations again played a role in shaping population distribution. This time, however, new technological innovations resulted in a less demand for farm labor, which eventually caused farm population decrease. In the United States, although farm mechanization began far before 1940 (Cochrane 1993), year 1940 is often considered as the landmark of post-mechanization because rapid improvements and adoption of machines occurred after this year. Since 1940, a negative association between farm dependence and population change in the U.S. has been revealed by a number of studies, which provides empirical evidence supporting the mechanization thesis. For example, Albrecht's (1993; 1986) research on population change in the Great Plains in the United States shows a consistent negative association between percentage population employed in farming and county population growth in the Great Plains after WWII. He demonstrates that this negative relationship continued even during the considerable population turnaround of the 1970s. Although White's (2008) recent research slightly alters the mechanization thesis, her results to a large extent echo Albrecht's findings. Researchers also show that in the United States, nonmetropolitan areas with a higher level of farm dependence are likely to experience a lower population growth rate (Johnson 1989; Johnson and Fuguitt 2000), which provides additional support of the mechanization theory. It is believed that farm population decrease in the U.S. after 1940 is partially caused by farm mechanization and technological innovations.

As far as China, farming technique has been basically labor-intensive and has been largely based on traditional technology. According to Tam (1985), China's agricultural mechanization did not start until the early 1950s after the land reform movement. In the mid-1960s, a large scale adoption of modern farm technology began in China, but not until the convention of China's Fourth National People's Congress in 1975, the mechanization of agriculture became the focus of China's agricultural development and made rapid progress since then. Butler (1978: 14) indicates that like other Western countries, mechanization in China did increase "labor power and frees it for other uses," on the other hand, the effect of mechanization on farm dependence and population dynamics in China did not follow the common path of Western countries. In fact, China's population change from the early 1950s to the end of the 1970s was more responsive to Mao's political policies than to farm mechanization. Particularly, the Great Leap Forward Movement (GLFM) that highlighted iron and steel production drew millions of peasants into urban areas, which largely ignored the demand of farm labors. Farm mechanization in China was not able to offset the shortage of farm labors due to the GLFM, which soon caused food shortage and triggered the Great Famine in the early 1960s (Chan 1992). During the Cultural Revolution (1966-1976) and the early 1980s, the political influence on population change was also greater than that of farm mechanization. A large number of college students and intellectuals were sent down to rural China during the Cultural Revolution. The subsequent return migration of students and intellectuals to their original urban residences was a consequence of policy modification as well. In fact, it is since the early 1990s Chinese population change began to be more responsive to market needs than to policy regulations. This change was due to the social system transition and the less restrictive control of the *Hukou* (household) registration system which allows population to move more "freely" as compared to before. A group of studies have indicated the role of China's farm mechanization in shaping population distribution since the 1990s (Chan and Zhang 1999; Ma and Lin 1993; Wu 1994; Zhao 1999). For instance, Li (1996) points out that China's farm mechanization has generated a large amount of surplus rural labors. These surplus labors compose a huge migration stream moving from the countryside to towns and cities. In general, previous analyses support a positive correlation between farm mechanization and out-migration, which leads to a potential farm population loss.

Human Ecological Approach

The third theoretical approach that guides this study is the human ecological approach. The mechanization theory can be considered as drawn from the human ecological theory because technological development is one of the four rubrics of the human ecological approach. Human ecological theory argues that there are four dimensions (rubrics) of the ecosystem, which are population, organization, environment and technology (POET). From the perspective of sociological human ecology, population change is the major mechanism of social change and adaptability for human populations. Human populations redistribute themselves so to approach an equilibrium between their overall size and the surrounding ecosystem which includes environment, organization and technology. These factors determine the life chances available to population. Migration is viewed as the principal mechanism for effecting this adjustment (Poston and Frisbie 2005).

The interrelationships among and between these four dimensions inform one's understanding of population change patterns, as follows: all populations must necessarily adapt to their environments, and these adaptations vary among populations on the basis of their social and sustenance organization, their technology, and the size, composition, and distribution of their population. The environment per se is comprised of both social and physical factors which tend to set constraints on the population and the form and characteristics of its organization. The technology that the population has at its disposal sets in an important way the boundaries for the form and type of environmental adaptation the population may assume. These may well change, however, as new and/or different technologies are introduced, allowing its relationship with the environment to change, and resulting also in changes or adjustments in the population's organization, and in its population size (Hawley 1950).

The efficiency of the human ecological approach in explaining population change in the United States has been approved by multiple empirical studies (Micklin and Poston 1997; Poston, Zhang, Gotcher, and Gu 2009; Sly and Tayman 1977). Environment and organization have been proved to play a decisive role in determining population size. Research on the Great Plains and the twentieth-century agricultural transition concentrates primarily on technological innovations accompanied with organizational changes in shaping farm population growth. When technology, in particular, is taken into consideration, Friedman's (1978) research implies a negative impact of technology on farm population growth. He claims that the adoption of farm technology by the family farm is a central source for successful competition. Mechanization characterized by adopting new technology makes competitive production possible for family farms by reducing labor input but at the same time maintain acreage expansion. In this sense, new technology affects farm population growth negatively. As far as China, through exploring the influence of human ecological factors on population change in the form of migration streams among 31 provinces during 1995 to 2000, Poston and Zhang (2008) show that the human ecological model has a strong capability explaining population mobility in China. The population, organizational, environmental as well as technological factors all played a role in determining population mobility. Particularly, coastal provinces with relatively lower percentages of farm population and greater foreign investments attracted a considerable number of migrants from provinces in the North and the West. These findings seem to suggest that high farm dependence may result in a lower population growth rate due to out-migration.

In this research, I will base my theoretical rationale, modeling and operationalization on the above three theoretical approaches to test my hypotheses. I turn now to introducing the data, variables, hypotheses and methods of the paper.

Data, Variables, Hypotheses and Methods

Data

As already noted, the main sources of data are the five waves of Chinese Census data and six volumes of *China's Statistical Yearbooks* 2001-2006. The five waves of Chinese Census data were collected on June 30th of 1953, June 30th of 1964, July 1st of 1982, July 1st of 1990 and November 1st of 2000, respectively. The five waves of Chinese Census data and data from the 2006 *China's Statistical Yearbook* allow me to examine provincial population change in 31 subregions of China during five periods: July 1st of 1953-June 30th of 1964, June 30th of 1964-July 1st of 1982, July 1st of 1982 to July 1st of 1990, July 1st of 1990 to November 1st of 2000, and November 1st of 2000 to December 31st of 2005. The 31 subregions in China include four municipalities (Beijing, Tianjin, Shanghai and Chongqing), five autonomous regions (Tibet, Qinghai, Xinjiang , Ningxia and Inner Mongolia) and 22 provinces, namely, Hebei, Shanxi, Gansu, Liaoning, Jilin, Heilongjiang, Jiangsu, Zhejiang, Anhui, Fujian, Jiangxi, Shandong, Henan, Hubei, Hunan, Guangdong, Hainan, Sichuan, Guizhou, Yunnan, Shaanxi and Qinghai (see Figure 1). The five autonomous regions and the four municipalities are governmental equivalents of provinces, and are referred to and treated here as provinces.

[Figure 1 about here]

At the county level, I analyze China's Fifth National Census Data and data from *China's Statistical Yearbooks* 2001-2006 to investigate population change in counties of selected provinces from November 1st 2000 to December 31st 2005. The selected provinces are Shandong, Henan, Hunan, Sichuan, Guizhou and Shaanxi, which are considered as major agricultural provinces and are located in Central and West China where are heavily represented by traditional agricultural regions. These six provinces contain a total number of 594 counties according to China's political administrative designation. These 594 counties are units of the county level analysis. The focus of this research is at the county level.

Dependent Variables

The dependent variable used to operationalize population change is *percentage population change* from Time 1 to Time 2, in this case, during each specific time frame. This measure describes the population growth pattern and is applied to both the provincial and individual level analyses. In my preliminary analysis, I used the natural logged form $\ln[1+(P_{time2}-P_{time1})/P_{time1}]$ to normalize the distribution of percent population change. P_{time1} and P_{time2} in the formula represent number of population at Time 1 and Time2, respectively. Results show that the natural logged form of percent population change does not significantly alter the results as compared to the raw form, which indicates a relatively normal distribution of this dependent variable. As a result, I decided to apply the raw form of the *percent population change* variable rather than its natural logged form in the analysis. The migration measure is not selected to represent population change for several reasons. First, measures of migration are not consistently available at the provincial level. Second, the Chinese census datasets report population mobility within a five year time period. Thus, the migration measure does not control return migration or multiple migration that occurred in the same five-year period. I therefore prefer using other measures rather than the migration measure. Moreover, the existing studies have the tradition of studying overall population size change instead of population change due to migration. Lastly, when it comes to the social context of China, prior literature has already documented a negative association between farm dependence and net migration, whereas the correlation between farm dependence and overall population growth has largely eluded researchers. In this study, I intend to fill the gap of previous analyses by studying overall population change and farm dependence.

The descriptive statistics for dependent variables are shown in Table 1. As it can be seen, at the provincial level, the dependent variable *percent total population change* shows a decreasing pattern over time since year 1982. The most dramatic population increase occurred during the 1953 to 1964 and 1964 to 1982 periods. During these time frames, the 31 provinces had an average total population increase rate of 37.1% and 47.7%, respectively. The population growth pattern during 1953 to 1964 can be described as: population grew unevenly across provinces; the fastest population growth occurred in large cities, especially the three municipalities-Beijing, Shanghai and Tianjin. Data show that among the 31 provinces, Beijing had the highest population growth rate of 173.4% and Anhui had the lowest population growth rate of 3.0% (results are not shown in table but available from the author upon request). During 1964 to 1982, the population growth pattern seemed to be reversed. Provinces in the North and the West with higher levels of farm dependence showed faster population growth rates than those more urbanized provinces. Shanghai, one of the most urbanized sub-regions in China, experienced the lowest population growth rate of 9.6%. As already noted, such a reverse pattern could be due to Mao's "sending down" policy that encouraged youths and intellectuals moving to rural areas. Since year 1982, provincial population growth rates slowed down considerably with less variation among provinces. Municipalities and coastal provinces again experienced faster population growth than other provinces, with Beijing showing the highest population growth rate (13.4%) during years 2000 to 2005 among the 31 provinces. If the political influence is controlled, then the descriptive results seem to suggest that more urbanized regions did grow faster than rural-based provinces.

At the county level, I address population change by having either declined, grown, or remained stable in the five year period from 2000 to 2005. A county population is considered as stable if the difference between two time points shows no increase or decrease by more than 5% of its value in year 2000. Results show that 54.4% of the 594 counties grew during 2000 to 2005. About 42% counties were stable and the rest about 4% counties experienced a population loss. Xinxiang county in Henan province had the highest population decrease rate (-25.0%) and Gushi county in the same province reported the highest population increase rate of 35.5%. Overall, the 594 counties had an average population increase rate of 6.4%, with a standard deviation of 7.0. Thus, the general patterns of population growth in counties studied are either growing or remaining stable during the 1995 to 2000 period.

Independent Variables

The key independent variable is *farm dependence*, which is measured by *proportion of rural population*, that is, population that resides on farms in Time z. Since the Census Bureau of China applied different criteria identifying rural population, measures of the independent variable *farm dependence* also reflects this variation. Measures based on the 1990 and 2000 Censuses are *percentage of agricultural population* and measures for the rest of the years are *percentage of rural population*. As it is suggested in Table 1, the proportion of rural population in China has always been relatively high. By year 2000, China still had an average over 70% of its population residing on farms. Since year 2000, there is a dramatic decline of rural population.

Year 2005 seems to represent a milestone of Chinese urban-rural population distribution-for the first time, around 50% of the whole nation's population resided in cities in that year.

As far as farm population distribution at the county level, 87.6% of county population resided on farms by year 2000. This percentage is higher than the average national percentage of 71.9% mainly because counties studied are chosen from several primary agricultural provinces which contain higher percentages of rural population. Yima county in Henan and Shuicheng county in Guizhou had the lowest (29.4%) and highest (97.6%) percentages of agricultural population, respectively.

Besides this key independent variable, I also include a series of other independent variables that are based on the theoretical framework presented earlier. I need to draw the reader's attention that these independent variables are not applicable to the provincial level analysis due to data unavailability and the limited number of observations at the provincial level. The OLS assumptions would not be met if including too many independent variables in the regression models when only analyzing 31 cases. So the other independent variables discussed here are restricted to the county level analysis. These variables represent the industrial, mechanization, technological, organizational and environmental dimensions of the 594 counties in year 2000 or earlier years. Since the dependent variables are measured with data for the time period of 2000 to 2005, it is theoretically appropriate to posit temporally the independent variables before the onset of the dependent variables.

Two variables are used to represent the industry alternatives, namely, *proportion employed in manufacturing* and *number of industrial enterprises above designated size.*[*] They are included to measure the effect of non-agricultural labor market alternatives. The 594 counties

[*] The Statistical Yearbooks of China did not specify the threshold for designated size.

reported an average proportion of 4.4% population being employed in manufacturing. The highest percentage of manufacturing population (23.3%) occurs in Jimo county in Shandong province and the lowest (0.04%) in Yajiang county in Sichuan province. In terms of the second measure, number of industrial enterprises, overall, counties in the East and Central regions of China, such as in Shandong and Henan provinces, reported greater average numbers of industrial enterprises than counties in the South and the North West, such as in Guizhou, Sichuan and Shaanxi provinces. This pattern could be due to the effect of the "open door" policy that first started absorbing foreign investments to build industrial enterprises in the East coast; it then gradually moved to the South and the West.

Farm mechanization is measured by *total agricultural machinery power* in thousand kilowatts. This variable accounts for the impact of farm mechanization and technology on population change. Counties in the East and Central provinces again demonstrated higher levels of farm mechanization than counties in the South and the West.

In terms of the human ecological factors, I have chosen the independent variable *sex ratio* to represent the population rubric. It considers the influence of excess males on population change. Variable *foreign capital investment* in 10,000 yuan captures the organizational structure of the county. It is assumed that the more feasible the organizational structure, the more likely the county possesses a greater value of foreign capital investment. The environmental dimension of the human ecological model is measured by the *climate index*. Due to data constraint, the climate index is calculated as the average daily temperature in January in the capital city of the province divided by the average daily temperature in July in the capital city. These temperatures are 30 year averages covering the years 1951–1980 and are calculated in Centigrade units. Thus, countries in the same province would have the same climate index, which is considered as the proxy of the climate measure for each county. Such an index is based on the assumption that most persons prefer to avoid exposure to bitter and cold winters, and excessively hot and humid summers. The resulting index is lowered if it is cold in the winter or hot in the summer. The technological measure is omitted here because the variable *total machinery power* that measures farm mechanization can be considered as a predictor of technology.

Additional controls, such as the birth, death and migration effects on population growth, are also included in the analysis. The crude birth rate (CBR) is applied as the measure of birth rate. It is replaced by the total fertility rate (TFR) if the TFR information is available. The death rate is measured by the crude death rate (CDR). The net migration rate (NMR) is used as a measure of the migration effect. It is calculated as follows: NMR = [(number of in-migrants to county_j – number of out-migrants of county_j)/mid-year county total population] *1,000. Including this measure controls the migration effect on overall population growth, considering migration has become a major component of population growth in many areas. Due to data constraint, the provincial level analysis does not have the migration effect controlled for the most study periods. Detailed descriptive results for all independent variables are presented in Table 1, expressed in their raw versions.

[Table 1 about here]

Hypotheses

The hypotheses may now be summarized. According to previous findings, my hypotheses regarding farm dependence and population change are as follows:

1. A higher proportion of rural population leads to a lower population growth rate, controlling for the effects of other independent variables.

The remaining hypotheses pertain to the theoretical explanations of rural population change:

2. Given that industrial alternatives in rural China promotes out-migration, a higher percentage of population being employed in manufacturing should cause an overall farm population loss due to out-migration.
3. Similarly, a greater number of industrial enterprises is also likely to result in a population loss, net the effects of other factors.
4. The value of total agricultural machinery power should be negatively associated with population growth since mechanization frees rural labors, which eventually causes a population decline.
5. Since the sex ratio measures excess males in the population, a higher sex ratio represents excess males in the population and an unbalanced sex composition, which results in a lower population growth rate.
6. The more foreign capital investments in a certain region, the more feasible the organizational structure. Thus, the higher the population growth rate.
7. The higher the value of the climate variable, i.e., the more favorable the climate, the higher the population growth rate, controlling for other factors.

Methods

To test the above hypotheses, I use the descriptive analysis, the partial correlation technique and the ordinary least squares (OLS) regression models to explore the association between farm dependence and population change.

Findings

Table 2 presents the partial correlation coefficients of population change and farm dependence when controlling for the birth, death and migration effects at the provincial level. The partial correlation rather than the OLS regression is used due to the limited number of observations (31 cases) at the provincial level. As stated earlier, the assumptions of the OLS regression may not be met based on 31 observations. Results in Table 2 show that besides the study periods of 1964 to 1982 and 1982 to 1990, farm dependence does have a negative effect on population change, controlling for the effects of birth, death and migration. The negative effect was especially significant during the 1953 to 1964 period when the most dramatic population growth occurred in municipalities, such as Beijing (173.4%), Tianjin (133.9%) and Shanghai (74.3%). Such a negative association supports the general finding of previous literature that a higher level of farm dependence leads to a lower population growth rate.

[Table 2 about here]

The positive but non-significant effect of farm dependence on percent population change during 1964 to 1982 could be due to Mao's "sending down" policy which redistributed youths and intellectuals to rural areas. As a consequence, areas with a high level of farm dependence even showed a positive effect on population change. From 1982 to 1990, farm dependence hardly showed any effect on population change. This is an interesting finding because, theoretically speaking, the return migration of youths and intellectuals to urban dwellings coupled with surplus rural labors moving from the countryside to metropolitan areas should have led to a negative rather than a positive effect of farm dependence on population change. The data, however, show that there is indeed a trivial correlation between farm dependence and population during this time period. Then how to resolve this discrepancy? The significant, strong and positive associations between percent population change and CBR may be an explanation. In the late 1970s and the early 1980s, China launched the "one-child" policy to regulate its population growth, which first started in urban areas and gradually became effective in rural settings. Years 1982 to 1990 are about the first decade after the "one-child" policy began to play a role in replacing natural fertility to controlled fertility. More restrict fertility policies in urban areas in turn caused a more rapid fertility decline in urban than in rural areas. As a consequence, we observe a positive association between percent rural and percent population change. Thus, the influence of return migration and farm dependence on population growth is likely to be offset by the effect of fertility. Farm dependence therefore shows a minor influence on population growth (see Table 2). These results highlight that the political force may be the key to understand the farm dependence and population change relationship at the provincial level. Since year 1990, population mobility has become more "free" of political influence. Provinces with higher levels of farm dependence again demonstrated slower population growth rates considering the negative partial correlation coefficients. Nevertheless, such a negative correlation is not statistically significant. The non-significant correlation may be due to a limited sample size. In order to further test the key hypothesis, a finer analysis at the county level is necessary.

[Place Table 3 here]

The county level results are presented in Table 3. Considering the variation among counties, I not only study the 594 counties as a whole but also examine these counties as several sub-groups based upon their geographic locations. In this research, counties are classified into four sub-groups: Eastern counties, Central and Southern counties, Southwestern counties and Northwestern counties. The Eastern counties include counties in Shandong province, Central and Southern counties are those in Henan and Hunan provinces, the Southwestern counties are counties in Sichuan and Guizhou provinces, and counties in Shaanxi are classified as Northwestern counties. Results shown in Table 3 are the OLS regression results of percent population change on farm dependence, controlling for other independent and control variables. As the results show, farm dependence only showed a significantly negative effect on population change among counties located in Central and Southern China. It corroborates hypothesis 1, suggesting that the higher the proportion of rural population, the lower the county population growth rate. Standardized coefficients (β 's) presented in column 3 in the table inform us that fertility has the strongest relative effect on population change, followed by the farm dependence variable. Such results indicate a relatively strong influence of farm dependence on population change. The effect of the farm dependence variable, however, turns to be significantly positive when only Southwestern counties are examined. If the analysis is restricted to Northwestern counties or is extended to all 594 counties, then the effect of the farm dependence variable which is measured by percent agricultural population becomes non-significant. These results challenge my key hypothesis on farm dependence and population change. Since the significant level may be affected by sample sizes and standard errors, I decided to use the Z-test strategy to further compare these coefficients and determine the effect of farm dependence on population change.

Paternoster and colleagues (1998) have recommended the following formula for contrasting the effects of two regression coefficients:

$$Z = \frac{b_1 - b_2}{\sqrt{SEb_1^2 + SEb_2^2}}$$

where b_1 is the regression coefficient of independent variable X for group 1 (for instance, the Eastern counties), b_2 is the regression coefficient of the same variable X for group 2 (for example, the Southwest counties), and SEb_1 and SEb_2 are the coefficient variances associated with the first and second groups respectively.

The calculated Z test values for the farm dependence variable in the five regression models are presented in Table 4. If the value of Z for any one variable is less than 1.96, this indicates that we accept the null hypothesis that the coefficient in one regression model is the same as the coefficient in another model. If the Z test value is greater than 1.96, the null hypothesis is rejected, signifying that the coefficient in the equation predicting the dependent variable is significantly different from the coefficient in the equation predicting the other. A rejection of the null hypothesis for a particular independent variable that its coefficients are the same in two regression models is also indicated by "No." An acceptance of the null hypothesis that the coefficients are the same is indicated by "Yes."

[Place Table 4 about here]

It is shown in Table 4 that among nine comparison groups, coefficients for only three comparison groups are significantly different from each other. Those groups are: all counties versus Eastern counties, all counties versus Central and Southern counties, and Eastern counties versus Central and Southern counties. These findings suggest that the Eastern counties and Central and Southern counties stand out as compared to the rest of the other counties in the relationship between farm dependence and population change. In Central and Southern counties (counties in Henan and Hunan provinces), a higher percentage of agricultural population has resulted in a lower population growth rate. However, in Eastern counties of Shandong province, a higher percentage of agricultural population has led to a slower population growth. For the rest of the other counties, farm dependence appears to be a minor factor influencing counties' total population growth. Thus, at the county level, my hypothesis regarding farm dependence and population change is only partially supported by empirical evidence, meaning the correlation between these two variables varies by counties' geographic location.

I turn now to testing of the remaining hypotheses that pertain to the theoretical explanations of rural population change. The farming-manufacturing complex thesis expects industrial alternatives to be negatively associated with rural population growth. The coefficients of the two industrial alternative variables, namely, *proportion population being employed in manufacturing* and *number of industrial enterprises*, did not show significant effects on the dependent variable in either group of analysis. These results oppose hypotheses 2 and 3. As noted by hypothesis 4, mechanization and technological innovation theory expects variable *total agricultural machinery power* to have a negative influence on population growth. This hypothesis is based on the rationale that mechanization frees rural labors, which may cause population decrease through out-migration of free labors or a lowered fertility. Results of this current research contradict this hypothesis by showing a significantly positive effect on the dependent variable (see column 1). Of the three human ecological variables, the climate index and the foreign investment variable that represent the organization and environment dimensions respectively, show negative impacts on population growth. Since I expected counties with feasible environmental and organizational features to experience a booming rather than declining population pattern, such empirical results obviously oppose hypotheses 6 and 7. My hypothesis 5 on sex ratio and population change is supported by results when examining the Northwestern counties (counties in Shaanxi province). My rationale is that areas with higher sex ratios represent a un-equilibrium of the population dimension, which is likely to cause a population loss or decrease. The sex ratio effect, nevertheless, turns to be significant and positive when all 594 counties are consider, which challenges hypothesis 5. The Z-test is thus applied to re-examine the sex ratio effect. Result shows that the differences indeed exist between coefficients of two sets of groups. The findings again demonstrate drastic variation among counties in China, which moderates directions of the hypothesized relationships.

With respect to the control variables, measures of fertility and mortality both show significant and positive effects on population change for all groups. If we take a closer look at the standardized regression coefficients, we may see that fertility has the strongest effect on population growth among all three control variables. Even when all variables are concerned, the fertility effect on population change remains relatively strong. Net migration rate (NMR) for all groups generally exhibits a negative influence on population change, which suggests that the more people moving to a certain area, the lower the population growth rate. This is contradictory to the common sense. I am not sure how to interpret this result. If there is no data error, then I would suspect that fertility may be the key here that explains the situation. I ran a correlation between the TFRs and the NMRs among 594 counties and found there is a negative association between these two factors. Counties with higher fertility levels are likely to experience a lower net migration fertility rates and vice versa. Social and economic development may elucidates the mechanism here. Counties with higher fertility rates are likely to be less developed areas in China, and thus, to experience a lower or even negative net migration. Similarly, counties that have attracted a considerable number of migrants tend to be more socioeconomically developed areas and therefore reported lower birth rates. As already noted, fertility is the factor that has the strongest promoting effect on population growth. Then fertility is likely to be the medicating factor in the relationship between net migration and population growth. Since fertility levels in most regions of China are largely determined by regulations of the one-child policy, the county level analysis again shows the impact of the political force in the association between farm dependence and population change at the county level.

Conclusion and Discussion

In this article, I have examined the relationship between farm dependence and population change in China at both provincial and county levels. At the provincial level, I have investigated population change in 31 provinces from 1953 to 2005. My county level analysis focuses on population change during 2000 to 2005 in counties of several major agricultural provinces, which are located in the East, Central and South, and Southwest of China where historically concentrate the highest percentages of agricultural population.

Results from the provincial level analysis show that the proposed negative correlation between farm dependence and population change suggested by previous literature is overly simplistic and requires re-examination. The findings exhibit that the correlation between farm dependence and population change in China is heavily influenced by political forces and social movements. From 1953 to 1964, Mao's Great Leap Forward movement drew millions of farm labors to urban areas to promote China's heavy industry. Thus, the rapid population growth in less farm-dependent regions, such as Beijing and Shanghai, benefited largely from the political movement. From 1964 to 1982, Mao's "sending down" policy during the Cultural Revolution redistributed Chinese intellectuals and youths to the countryside, which reshaped the farm dependence and population growth association to a positive direction. Moving to 1982 to 1990, China's one-child policy began to play a considerable role in regulating population growth by dropping down urban fertility to a much lower level than rural fertility. As a consequence, the advantage of farm-dependence in slowing down rural population growth, which is repeatedly shown in the U.S. and other industrialized countries, did not occur in China. Since 1990, China transformed from planned economy to market-oriented economy. Policies on population mobility became less restrictive as compared to before. Thus, population change in China after 1990 began to be more "free" of political control as compared to previous decades. Under such circumstances, as the empirical results show, farm dependence seems to be negatively associated with population growth. Its effect, however, is not significant.

The provincial level analysis is beneficial in the sense that it depicts the general pattern of population change in China, which is demonstrated in Table 1. Additionally, the provincial level analysis allows us to see how the magnitudes of some covariates on population growth have been shifted over time. Besides farm dependence, we see that the influence of mortality has been gradually reduced whereas the impact of fertility on population growth has increased since the 1990s. The finding suggests that when a country, such as China, is experiencing the demographic transition from high mortality and high fertility to lower mortality and lower fertility, fertility is likely to be a more decisive factor determining population growth than mortality.

In order to examine the subject in a finer manner, I have extended the analysis to the county level. I find that during 2000 to 2005, the level of farm dependence only shows a negative influence on population change in Central and Southern counties. In some counties, high farm dependency in fact led to a faster population growth. These findings suggest that farm-dependent counties did not generally experience a population loss or a slower population growth than less farm-dependent counties during 2000 to 2005. I argue that fertility associated with farm dependence is the mediating factor in the farm dependence and population change relationship.

The results further show that the proposed negative association between farm dependence and population change at the county level also varies across counties of China. The industry complex thesis and the human ecology approach have received very little support from the empirical analysis. The mechanization thesis has also been challenged by empirical data. I thus initiate the political approach to explain to the correlation between farm dependence and population change. In China, population policies rather than urbanization may have been the most effective way regulating rural population growth.

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Fig. 1. The 31 Provinces, Autonomous Regions, and Municipalities of China


Shanxi
Heilongjiang
Shaanxi
Jilin
Ningxia
Liaoning
Xinjiang
Gansu
Inner Mongolia
Beijing
Tianjin
Shandong
Qinghai
Henan
Tibet
Jiangsu
Shanghai
Hubei
Anhui
Hunan
Zhejiang
Jiangxi
Sichuan
Yunnan
Fujian
Guangdong
Guizhou
Hainan
Chongqing
Guangxi

Table 1. Descriptive Statistics of Dependent and Independent Variables, China

Variable	Mean	Standard Deviation	Minimum Value	Maximum Value
At the provincial level (n=31)				
Dependent variable: percent total pop. change (%)				
1953-1964	37.1	38.1	3.0	173.4
1964-1982	47.7	9.6	9.6	84.8
1982-1990	12.8	6.0	6.0	19.5
1990-2000	12.1	3.0	3.0	37.7
2000-2005	4.3	0.3	0.3	13.4
Independent variables				
Farm dependence: % rural (agricultural)				
1953	79.9	22.6	9.2	95.3
1964	83.4	13.5	36.7	93.3
1982	75.4	15.5	31.3	90.4
1990	75.4	14.6	34.0	87.7
2000	71.9	13.6	36.9	87.2
2005	54.6	15.4	10.9	73.4
Control variables				
Crude birth rate (CBR)				
1953	33.0	10.9	10.9	58.8
1964	32.9	11.2	5.1	46.9
1982	16.9	6.5	4.9	26.9
1990	16.5	6.5	4.9	26.9
2000 (TFR)	1.3	0.3	0.6	2.2
Crude death rate (CDR)				
1953	16.7	9.9	7.2	44.2
1964	16.5	13.5	6.1	49.4
1982	9.6	6.6	4.6	28.9
1990	11.0	7.2	5.7	24.7
2000	5.8	0.7	4.5	7.3
At the county level (n=594)				
Dependent variable:				
Percent total pop. Change (%)	6.4	7.0	-25.0	35.5
Independent variables				
Farm dependence: % agricultural	87.6	6.2	29.4	97.6
Proportion employed in manufacturing	4.4	4.0	0.04	23.3
# of industrial enterprises above designated size	38.3	43.8	1	436
Agricultural machinery power (in 1,000 kilowatts)	26.5	28.4	0	195.4
Sex ratio	107.5	4.5	92.4	124.7
Foreign capital investment (in 10,000 yuan)	945.4	2024.9	0	14139
Climate index	0.09	0.12	-0.05	0.21
Control variables				
Total fertility rate (TFR)	1497.5	472.2	678.5	3366.5
Crude death rate (CDR)	6.7	1.1	3.4	12.1
The net migration rate (per 1,000 pop.)	5.1	7.8	0.1	83.4

Sources: five waves of Chinese Census data and China Statistical Yearbook 2006.
Note: 1 yuan is equivalent to 0.14 US dollar.

Table 2. Partial Correlation Coefficients of Percent Population Change with Farm Dependence Variable and Other Control Variables: 31 Provinces in China, 1953-2005

Variables	53-64	64-82	82-90	90-2000	2000-05
Farm dependence variable					
% rural/agriculture	-0.81***	0.34	0.02	-0.19	-0.19
Control variables					
CDR	0.38*	0.54**	0.52**	0.29	-0.19
CBR/TFR	0.36	0.29	0.40*	0.22	0.51**
Net migration rate	-	-	-	-	0.33

Sources: derived from five waves of Chinese Census data and the 2001-2006 China's Statistical Yearbooks.
Note: * p<.05, **p<.01, ***<p<.001, two-tailed test.

Table 3. OLS Regression of Percent Population Change on Farm Dependence Variable and Other Independent and Control Variables: China, 2000-2005

Variables	All Counties (1)		Eastern Counties (2)		Central and Southern Counties (3)		Southwestern Counties (4)		Northwestern Counties (5)	
	b	β	b	β	b	β	B	β	b	β
Key Independent variable										
(1) Percent agriculture	0.03	0.01	0.28***	0.28	-0.27**	-0.27	0.23*	0.19	0.12	0.10
Other independent variables										
(2) Proportion employed in manufacturing	-0.11	-0.07	-		-0.30	-0.15	0.32	0.12	-0.13	-0.06
(3) # of industrial enterprises	-0.01	-0.08	-0.01	-0.09	-0.01	-0.03	-0.04	-0.10	-0.06	-0.09
(4) Agricultural machinery power	0.02*	0.06	0.01	0.10	-0.01	-0.01	0.05	0.06	-0.05	-0.09
(5) Sex ratio	0.20**	0.13	-0.02	-0.01	0.25	0.13	0.20	0.11	-0.53**	-0.43
(6) Foreign capital investment	-		-0.01*	-0.16	-		-		-	
(7) Climate index	-4.22	-0.07	-		-7.46	0.13	-4.21***	-0.28	-	
Control variables										
Total fertility rate (TFR)	0.01***	0.38	0.01***	0.28	0.01***	0.29	0.01*	0.22	0.01*	0.20
Crude death rate (CDR)	0.88***	0.13	1.55*	0.20	1.38*	0.14	1.18**	0.18	2.17***	0.49
The net migration rate (NMR)	-0.13***	-0.14	-0.14*	-0.29	-0.41*	-0.19	-0.03	-0.04	-0.17	-0.11
Constant	–28.50*		-39.26*		–13.10		41.16		35.50	
N	589		88		198		213		86	
Adjusted R^2	0.29		0.64		0.17		0.44		0.33	

Sources: derived from five waves of Chinese Census data and the 2001-2006 China's Statistical Yearbooks.
Note: * p<.05, **p<.01, ***<p<.001, two-tailed test. "- " means that the variable is dropped due to limited number of observations or collinearity.

Table 4. Z -Tests to Determine if Regression Coefficient for One Sub-group is Significantly Different from Coefficient for the Other Sub-group: China, 2000-2005

Comparison groups	Z Value	$b_1=b_2$ (Coefs are the same)
1) All counties vs. Eastern counties	2.43	No
2) All counties vs. Central & Southern counties	2.37	No
3) All counties vs. Southwestern counties	1.85	Yes
4) All counties vs. Northwestern counties	0.58	Yes
5) Eastern counties vs. Central and Southern counties	4.37	No
6) Eastern counties vs. Southwestern counties	0.38	Yes
7) Eastern counties vs. Northwestern counties	0.93	Yes
8) Central and Southern counties vs. Southwestern counties	1.26	Yes
9) Southwestern counties vs. Northwestern counties	0.63	Yes

Note: H_0: b_1 for sub-group 1 = b_2 for sub-group 2