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Modeling the Distribution and Shift of Chinese Americans in the United States
--- An Analysis by Trend Surface Expansion

Dissertation

Presented in Partial Fulfillment of the Requirements for the Degree of Philosophy in the Graduate School of The Ohio State University

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CHAPTER I
INTRODUCTION

1.1. Introduction

The Chinese are the largest ethnic group in the world. The United States is the primary destination of Chinese emigrants. In 1990, there were 1,645,472 Chinese Americans living in the United States according to the census data, which accounts for 0.66% of the total population of the United States. Although their immigration to the United States occurred a long time ago, their population didn't increase significantly until the last several decades. It is valuable to explore and model their population's distribution and shift.

Many researchers treated Chinese Americans as only part of their studies. They tended to investigate various phenomena associated with the whole Asian American population instead of only Chinese Americans, and most of their studies are more descriptive than theoretical. They tended to describe detailed information rather than generalize. Some studies focused on only the first generation and some others focused on only new generations. Therefore, the information about the distribution and shift of the Chinese American population in the United States over space and time is not available. This study will focus
on the single ethnic group, the Chinese American, to model its
distribution and shift from 1890 to 1990 at the state level, and to test
several hypotheses concerning its growth rate by using the census data of
1980 and 1990 at the county level.

1.2 The Definition of the Chinese American and the data source

The classification of race and ethnic groups is complex. They can
be classified by blood, culture, religion, etc. There is no single
classification that can meet all requirements. In general, there are
physical, culture, linguistic, and other differences among various large
groups of people and the differences are relatively persistent over time.
These groups have different geographic distributions and different
demographic characteristics, and they are often of interest to national
policy makers. Consequently, such groups are often identified in
demographic statistics (Shryock, 1980). The Chinese American is one of
the ethnic groups identified in the U.S. census data. Most analyses
implemented in this research are based on this data source. Although the
first population census in the United States was in 1790, the population of
the Chinese American was not separated until 1860. Before 1960, the
classification of race was made by the enumerator's observation with
some basic guidelines. Since 1960, self-enumeration has been based
largely on self-identification. People were asked to classify themselves.
Therefore, the definition of the Chinese American used here is broad. It
might not be the same as the definition in hematology. Some people
might be classified as Chinese American at some points in time but as
another group at other points in time. It is assumed that the misclassification is not serious, and it does not cause a serious problem in this study.

The major data source for this research is from the 5th (1890) to the 15th (1990) census. The county data for 1980 and 1990 are directly downloaded from the statistical summary tapes of 1980 and 1990. The software package used for analyses is SPSS on a mainframe.

1.3 Organization of this research

This dissertation is composed of five chapters. Chapter II reviews some literature about the migration of Chinese to the United States and theories concerning population diffusion. In addition, the basic methodology of this research is also discussed.

Chapter III shows the modeling process and its results. Several choropleth maps and histograms are created to show the dynamic of the distribution of Chinese Americans. Some hypotheses for explaining the growth rate of the Chinese American at the county level will also be tested.

Chapter IV summarizes the findings of this research, and discusses some implications and limitations of this research.
CHAPTER II
LITERATURE REVIEW AND METHODOLOGY

The aim of this chapter is to review the migration of the Chinese American to the United States first, and then to review some theories concerning distribution and shift of population. Finally, the methodology of this research will be discussed. From the literature review it can be found that most articles dealing with the distribution of the Chinese American are short of quantitative analyses. Therefore, this research will adopt the quantitative method and expansion method to generalize and model the distribution and shift of the Chinese American in the continental U.S.

2.1 Literature review

2.1.1. The migration of the Chinese to the United States

The total population of Chinese Americans increased from 34,933 in 1860, which accounted for 0.11 percent of the total population of the United States, to 1,645,472 in 1990, which accounted for 0.66% of the total population. This number is small and politically negligible when compared with other racial groups, but in terms of its growth rate and sociological importance, this small population has had an extraordinary influence on American science and diplomacy in recent decades (Wang, 1991).
Although the long-term trend of the population of the Chinese American is increasing, there was a significant decrease or stagnant period from 1880 to 1940. Figure 1 shows the overall growth pattern of the Chinese American population. The Chinese American population increased from 34,933 in 1860 to 105,465 in 1880, a tripling in growth over a period of twenty years. However, from 1880 to 1920 their population decreased significantly, followed by a thirty-year, slightly increasing period. In the last three decades, the Chinese American population increased tremendously; it increased almost sevenfold.

Figure 1: The Population of the Chinese American
Figure 2 offers another insight into the Chinese American population, illustrating that the percentage of the Chinese American in the nation as a whole had the same type of increasing and decreasing trend as shown in Figure 1. It started at 0.11 percent in 1860, dropped to 0.06 percent in 1930, and then increased to 0.66 percent in 1990.

Figure 2: The Percentage of the Chinese American
Clearly, both the population size and the percentage of Chinese Americans had a long period of stagnation or decline, which is exceptional in a natural increasing society. Compared to other races, the changing pattern was special. It differs from not only the major minority, the African American, but also from the Japanese American, another major group of Asian Americans. Figure 3 shows that both the Chinese American population and the Japanese American population were far less than the African American population, and that the gap between the Chinese American and the African American was enlarging rapidly.

Figure 3: The Population of the African American, Japanese American and Chinese American
It is self-evident that the difference between the African American and the Chinese American was significant. However, it is not likely that there was a significant difference between the Japanese American and the Chinese American. Figure 4 shows that the Japanese American population increased considerably from 1890 to 1930, but the Chinese American population decreased significantly in that period. Before 1890, there were few Japanese Americans in the United States; its population was far less than the population of the Chinese American. However, the population of the Japanese American overcame the population of the Chinese American shortly, and its population kept superior to the Chinese American's for over 60 years. In the last two decades, the population of the Chinese American increased dramatically. Its population not only prevailed the population of the Japanese American but also turned out to be the largest Asian group.

Figure 4: The population of the Japanese American and the Chinese American
The history behind these numbers can be discovered by reviewing existing articles. According to Lyman (1986), there are two types of emigration movements. First, migrants permanently separate connections with their own society and seek a new life elsewhere. Second, migrants temporarily abandon their own society to take advantage of opportunities elsewhere. They intend to return home after having made their fortune and to share the fruits of their effort with their families. The early Chinese emigration was considered to be the second type. This kind of emigration is also called the sojourner movement. According to Lyman's estimation (1986), from 1820 to 1892, approximately 360,000 Chinese emigrated to the United States. In the same period, about 270,000 (75%) of the Chinese who had journeyed to the United States returned to China. The motivation of the persons who did not go back might be attributed less to a positive decision to settle abroad, than to a financial inability to return to China. Most of them came to the United States primarily as temporary or seasonal laborers under contract. Most of this kind of movement was fulfilled by push-and-pull forces. Lyman (1986) suggested that the impulse to move out is likely to arise when some event seriously interrupts the everyday lives of a person. The impulse can be natural disasters such as floods or climatic change; or it can be a human catastrophe such as war, economic depression, or religious persecution. The invitation might be the opening of a new frontier, the discovery of natural resources, or the demand for a labor force.

The discovery of gold in California in 1840s served as an important favorable factor drawing the people in southern China to the
United States. The fact that the economy of southern China was poor and it worsened as a result of the Taiping Rebellion served as another important push factor. Almost all the Chinese who immigrated to the United States in the nineteenth century were natives of Kwangtung, a southern Chinese province of about eighty thousand square miles. In addition, other factors were also important to the international migration; for example, the poor natural environment of southern China, a port city, the kinship information, etc. all attributed to the migration. In general, the net flow of migration pointed to the place with favorite conditions, California.

The Chinese immigrants came to the United States long time ago. America has been trading with the Chinese since 1785 and enthusiastically supporting Protestant missionaries in China since 1807 (Miller, 1974). Before the Gold Rush, many Chinese had already lived in America. Based on historical statistics compiled by the U.S. Immigration and Naturalization Service and data from the U.S. Bureau of the Census, only one Chinese person was admitted in 1820. In the next decade, two came. In the following decade, eight arrived. Thirty-five were admitted from 1841 to 1850 (Mangiafico, 1988). Mangiafico (1988) argued that the data might be under-estimated; the real number might be over 4,000. However, compared to 34,933 in 1860, this estimated number might be still low.

There were several common characteristics of those Chinese who immigrated to California at the time of Gold Rush:
1. Most of them worked in the mining industry.
2. They expected to make good money to improve the lives of their families at home.
3. They confined themselves living in Chinatown, in a Chinese style of living.
4. They started at the bottom of the economic ladder.
5. Most of them were male.

The Gold Rush indeed offered a good opportunity for the Chinese immigrants. Even though they only worked on low-yield mining jobs, they still made better livings compared to their original jobs in China. However, after a short, peaceful period of working with other races, the Chinese came to be perceived as a pressure to other people.

According to Mangiafico (1988), immigration into the United States can be divided into five periods: the Colonial Period (1609-1775); the Open Door Period (1776-1881); the Regulation Period (1882-1916); the Restriction Period (1917-1964); and the Liberalization Period (1965 to the present). Obviously, most Chinese came to the United States after the Open Door Period. Even in the Open Door Period, the door was not really opened for the Chinese. Several special regulations were passed to limit the immigration of Chinese to reduce their ability to compete for jobs with others, a situation which was most serious in California. In 1852, the "Coolie Bill," An Act to Enforce Contracts and Obligations to Perform Work and Labor, was passed, which resulted in California refusing to authorize the importation of contract labor (Lyman, 1986). In
1858, the state legislature of California passed a new law, stating that no Chinese or Mongolian could land at any port or be permitted to enter the state unless driven ashore by stress of weather or by an unavoidable accident, superimposing a fine as penalty or imprisonment for those in charge of any ship violating this law. In 1862 a "Police Tax" was imposed on the Chinese and Mongolians. In 1868, although the Burlingame Treaty permitted free immigration of Chinese people to the United States, it denied the right of naturalization to Chinese immigrants (Foner, 1993).

Mangiafico (1988) pointed out that "although Chinese immigrants accounted for only about 10% of California's population among 1860 and 1880, they comprised close to a quarter of the state's work force." The feeling against Chinese became more tense under such circumstances. Many Chinese were robbed, beaten, and murdered. The Chinese were not only subjected to legal discrimination, but also to these kinds of hostilities from the non-Chinese laborers. The Chinese response to these was twofold: first, they tried to go back to their home country, or move to the Northwest or to the East; second, they grouped tightly together in a ethnic neighborhood, Chinatown, to get better protection (Mangiafico, 1988).

When the Gold Rush ended in the early 1860s, many Chinese moved to the jobs of transcontinental railroad construction (Li, 1976), garment making, and cigar making. In the early 1870s, Chinese workers in San Francisco comprised about two-thirds of all garment industry
workers and 90% of the cigar makers (Mangiafico, 1992). Under restrictions, Chinese immigration declined, but the hostility of other laborers to the resident Chinese persisted. Many of them were forced out of manufacturing employment in white-owned firms, and even Chinese-owned cigar and garment manufacturers experienced public pressure to cease operations that were in economic competition with white firms. These pressures left the resident Chinese with few opportunities. They were forced to work in "women's jobs," such as domestic service, laundry work, and work in restaurants and in small retail stores catering principally to other Chinese (Li, 1976).

In addition to the discrimination from individuals, and local and state government, Chinese immigration was forbidden by federal laws starting with the Chinese Exclusion Act of 1882, which barred the entry of Chinese laborers for ten years and prohibited the naturalization of Chinese immigrants as U.S. citizens. In 1892, the Geary Act extended these provisions for another ten years. In 1898, the act was extended to Chinese immigrants seeking to enter the Hawaiian Islands. Finally, in 1904, the Chinese Exclusion Act was extended indefinitely (Mangiafico, 1988). The population of Chinese decreased or remained stagnant.

As China was an ally of the United States in the war against Japan, the Chinese Exclusion Acts were repealed in 1943 and Chinese immigrants who were permanent residents of the United States were allowed to apply for naturalization. Although the quota was only 105 persons per year, there were many other special regulations to allow
women to enter America to balance the sex ratio of Chinese (Mangiafico, 1988). For example, in 1946 the Immigration Act was amended and alien wives of citizens were allowed to enter the United States on a non-quota basis (Li, 1976). The impact of World War II was not only to allow more Chinese to enter the United States, but it also offered a nice chance for the upward movement of the Chinese. World War II opened or created a vacuum various professions so the Chinese could get into better jobs and improve their living.

In 1965, the Immigration Act was amended again. Many more Chinese, a total of 40,600 from China, Taiwan, and Hong Kong, were allowed to enter the United States each year. The Immigration Act was amended again in 1979. The annual quota for Hong Kong was raised from 600 to 5,000.

Wang (1991) pointed out that it is extremely difficult to determine the exact number and types of Chinese immigrants to the United States since 1965 because they have come not only from China and Taiwan but also from countries in Southeast Asia and Latin America. In addition, since World War II, the United States has granted over 2.3 million permanent-residence visas under special refugee programs. By September 1988, the most recent large immigrant groups were 486,426 Cubans and 686,540 Indochinese (Jasso & Rosenzweig, 1990). In addition, the Immigration Reform and Control Act of 1986 allowed the undocumented immigrants who had resided continuously in the United States since 1982 to apply for legalization. Although most of these undocumented
immigrants are Mexican, a substantial amount of them should be Chinese. President Bush's protection of over 30,000 Chinese who were allowed to stay in the United States due to the Tiananmen massacre on June 4, 1990, also had a profound impact on the Chinese American population. Obviously, the composition of the newcomers is complex. Many of them are much better educated than the former immigrants, and they came from many different nations, not only limited to the southern China any more. However, on the other hand, many of them are refugees. Their situations are not any better than those of the old immigrants.

The Chinese came to the United States and worked in marginal jobs for a long time. They changed their culture and social status only slightly in the past. However, many significant transformations were reported in the last several decades. For example, Karnow (1992) pointed out that although the original Chinese immigrants were not well educated, the new generations and the new immigrants have changed their status and have achieved better education and income levels than the average native-born White. They had a higher median household income, a higher percentage of college graduates, a higher percentage of technological and scientific positions, a higher percentage of professional and managerial jobs, a lower divorce rate, a lower unemployment rate, and a lower crime rate, so they were called the "Model minority" by William Peterson, a sociologist at Berkeley. Li (1987) pointed out that Chinese Americans are not concentrated only in the upper social scale. He found that Chinese Americans were also heavily distributed at the bottom of the social stratification system, and that the Chinese American
is not in a better financial condition than Blacks or Hispanics if the educational factor is controlled. For example, among those who had a 4-year college education, Chinese Americans have lower average earnings than Blacks and Hispanics.

2.1.2. Theory Review

There is a long history of Chinese settlement in the United States. It is important to know how they distributed and shifted in the United States. The factors affecting distribution and shift of population are very complex. For different population groups, the factors can be completely different. As mentioned in the previous section, Lyman (1986) pointed out that there are two types of emigrations. They are permanent and temporary emigrations. The old Chinese came to the United States as the second type of immigrants. Although they planned to go back to their home country, many of them did stay in the United States. After staying here, the push-and-pull factors changed remarkably. Their moving pattern become unclear. In addition, many newcomers with totally different characteristics should have quite a dissimilar moving pattern. It will not be easy to predict their distribution and shift without any testing. One of the broadest and most precise models for the analysis is the model in Equation 1. It may be used to calculate the total population of an area or of particular classes of the population in an area by age, sex, color, race, nativity, family and marital status, educational attainment, employment status, etc.
\[ P_{t+1} = P_t + B - D + I - O \]  

Where

- \( P_{t+1} \) is the current population
- \( P_t \) is the population at a previous point in time
- \( B \) is the number of births since \( P_t \)
- \( D \) is the number of deaths since \( P_t \)
- \( I \) is the number of immigrants since \( P_t \)
- \( O \) is the number of outmigration since \( P_t \)

This equation is self-evident and is quite easy to understand, but it is not easy to use due to the shortage of available data. In order to get all the data for this model, other methods are usually needed. The birth mortality and fertility can be quite dissimilar in different countries, especially when the countries are in different development stages. However, it should be quite similar for every state or county in the United States. Therefore, they should not be as important as migration in affecting the shift of the Chinese American. Migration has long had the well-deserved reputation of being the most troublesome of the components of population change. Many disciplines are interested in the analyses of migration. They tend to approach this topic in different ways. The major differences between migration studies are in relation to scale, theoretical perspectives, and analytical methods. Demographers treated migration as part of a system of stocks and flows. They show little interest in the spatial perspective as opposed to temporal perspective (Rogers, 1968; Alonso, 1973; Jones, 1990). Economists typically used aggregate data to consider migration as an adjustment to labor market mechanisms. Sociologists and social anthropologists prefer field-survey,
community-based data to explore the relationship between physical and social mobility, and the adoption of migrants to host societies. Geographers show little interest in the analysis of mortality or fertility. They are interested in the spatial structure of migration flow and behavioral investigation, particularly of intra-urban movement (Jones, 1990). However, there has been disciplinary convergence in migration research. It is an interdisciplinary field of investigation now.

Two types of migration models can be identified. The first is the micro-analytical model, which examines an individual migrant's behavior as the expression of decision-making which need not be economically or spatially rational. The second is the macro-analytical model, which looks for rules that are capable of mathematical expression. The models of this type usually have an ecological basis in that migration is measured between areas and is thought to reflect the comparative attraction powers of potential origins and destinations. Therefore, its explanation tends to be based on the environmental and community context of migration flows (Jones, 1990). Since this study will adopt the macro-analytical model, only the theories at this level will be discussed.

The diffusion model should be ideal to explore this study topic. It shows how a phenomenon diffuses temporally and spatially. According to the diffusion model, some phenomena can not only diffuse into their surrounding area but also jump to a place far away from their original points. In other words, some diffusion processes are selective. They tend to diffuse in a hierarchic way. Wheeler (1989) showed that the
information flow in the United States is diffused in that way. They found that a major city tends to create and receive more information. Even though it is far away from another information center, it will still receive more information from that sending point than other nearby small cities.

Several factors might be responsible for the movement of people. DaVanzo (1965) in his book *Why Families Move* had already pointed out many factors. However, one of the most common ways to analyze is from the standpoint of economic opportunity. A place with jobs tends to attract people. In the study period, new jobs were created in different places. Some states had more new jobs than others in some years. There is a long-standing trend for people to concentrate around metropolitan areas or a core area for better living resources. However, in the early 1970s, Beale (1975, 1977) pointed out the phenomenon of counterurbanization, then much attention went to this issue. Since 1970, the metropolitan areas of the United States have grown more slowly than the nation as a whole and substantially less rapidly than non-metropolitan areas, a development that stands in sharp contrast to all preceding decades back to the early 19th century. Casetti & Krakover (1990) successfully demonstrated the shift by examining population growth rate from 1950 to 1985. They identified a major growth area centered in southern California in 1950; the maximum growth moved away from the coastline, shrank, and drifted toward the North, eventually becoming centered in Oregon. At the same time, California gradually turned into a negative growth pole. In addition, the area around the old industrial core and the area centered on the Great Lakes were also being identified as declining areas. On the other hand,
the region centered on Florida was growing at an accelerated pace, and
the southwestern region centered on Texas was also increasing.

Many factors for this shift have been discussed. Some people
treated it as the result of a re-distribution of people and resources from
the Northeast to the South, while the new growth pole theory was
suggested by Sale (1975), Sternlieb & Hughes (1975), Perry & Watkins
(1977), Sawers & Tabb (1983) etc. They thought it resulted from the fact
that many new jobs were created in the southern states, including
positions in the areas of agriculture, defense industries, oil and natural
gas production, real estate and construction, and tourism and leisure.

The shift between the sunbelt and snowbelt combines both natural
increase and migration contributions. The overall impact of natural
increase has declined since the mid-1960s due to the reduction of national
fertility. The deconcentration that resulted in counterurbanization
tendencies of the 1970s mostly results from internal migration. Product
cycle theory suggested that the manufacturing jobs shifted from the core
area to other places due to technical mature and mass production.
Manufacturing jobs had long permitted not only poorly educated people
but also new immigrants access into the mainstream economy. This shift
brought the mismatch hypothesis into existing. This hypothesis argued
that many poorly educated Backs cannot find jobs in metropolitan areas
due to job mismatch, which means there are not enough jobs for poorly
educated people. However, in the declining period of the snowbelt, the
biggest job losers of the seventies were Whites. For example, Whites lost
almost twice as many jobs as the city overall. By contrast, employment among New York Blacks, Hispanics, and Asian immigrants increased by 215%, 64%, and 249%, respectively (Waldinger, 1987). Obviously, the decline in the snowbelt did not stop immigrants. Many cities in the snowbelt were still their principal settlements.

A small number of older urban places in the snowbelt had maintained their controlling role in the nation's economy even through the shift period (Waldinger, 1989). During the last decade, many other cities along the coastal areas revived their economies. The bi-coastal area boom is on the way. Global services, including foreign sales by multinational corporations, research and development expenditures, international banking, loans to large corporate headquarters, and business services, are dominated by cities in this area.

The growth of global services creates a demand for both highly skilled and low-skilled laborers while increasingly excluding workers with middle-level qualifications (Waldinger, 1989). Muller (1985) pointed out that the immigrants of the 1970s had little connection to California's booming service economy, while restructure hypothesis insisted that the new immigrants can offer a cheap labor force to bolster the declining goods production sector and to revive sagging urban economies. Three effects have been identified: (1) immigrants offered plenty of labor so that the wages have declined relative to the national average; (2) immigrants provided a flexible labor force which allowed for more customized production and greater subcontracting; and (3)
immigrants create demand for cheap consumer goods, which can best be served by local producers (Davis, 1987; Sassen, 1988; Soja, 1989; Waldinger, 1989).

It is clear that the economic opportunities shifted in the United States significantly in the past. People with different backgrounds tend to have dissimilar demands for jobs and living environments, so their moving patterns can be quite different. Since the composition of the Chinese American is obscure, it is hard to know their distribution and shift without testing.

2.1.3. The Background of the Research Methodology

From the literature review, it can be seen that many articles have already offered some insights into the distribution and shift of the Chinese American. However, most of them are simply descriptive. Few efforts are made to generalize and model it.

Kuhn (1970) defined science as the constellation of facts, theories, and methods. In order to understand the world, and nature, many methodologies have been employed. They can be simple descriptions, general rules, or rigid models. The general development pattern is from simple description to generalization and modeling, although description is still avail in current society. The movement tended to encourage numerical expression and quantitative analysis (Taaffe & Casetti, 1990). However, only limited variables can be considered in this kind of analysis. The tendency is to increasingly divorce analysis from real world
problems. Reversing this development of generalization, there is a great need for integrative approaches between disciplines and sub-disciplines. No doubt that it is necessary to combine both approaches to understand the complex world. This research will not only adopt the quantitative approach to supplement the shortcoming of existing literature but also try to reduce the conflicts between these two approaches by using Casetti's expansion method.

2.1.4. The Expansion Method

Both generalization and empirical study are important. Neither of them can be ignored. However, each of them have their own problems. Mere description cannot accumulate knowledge systematically; an over-generalized model tends to distort the real world. The expansion method is a useful technology and paradigm to bring order to the chaos. It cannot only use a mathematical model to generalize the real world but can also test various contextual contents to clarify various controversies. It can modify a simple model into a more appropriate model to get a better understanding of the complex world.

The expansion method (Casetti, 1972, 1986) can bridge the gap between qualitative and quantitative debate. It also plays an important role in integrating the different disciplines, and makes the methodology not only focus on the specificity context question but also look at "what is particular in what is general" (Jones, 1992, p. 59). The simplified theories and models from typical disciplines represent only a valuable first step in the advancement of knowledge. Complex contextual realities
need to be re-integrated into these models without seriously destroying them in the generalization process, and the expansion method provides the perspectives and the operational routines to implement this integration.

According to Casetti (1986), the expansion method is a technique and a paradigm. It is a technique for creating, modifying, interpreting, and interrelating mathematical models. This method can best be explained by Casetti (1986) himself.

The expansion method is a technique for generating models. It involves the following: 1) an "initial" model in which some or all of the parameters are in non numerical form is selected; 2) some or all of the letter parameters are "expanded" by expansion equations that redefine them as functions of variables and/or of random variables, that may or may not appear in the initial model; and 3) a "terminal" model is generated by replacing the expanded parameters into the initial model (p. 30).

As explained by Casetti, the expansion method treats a mathematical model as a beginning input instead of an end product. Any end product of a mathematical model can serve as a new input for another output. It can change the face of a model according to various situations. Therefore, every end model can be only a beginning point for the expansion method. The expansion method can serve as a tool to integrate concepts or models from different disciplines to create a better product. The integration of complex realities into simple models is a very important task confronting the contemporary social sciences. The
expansion methodology is concerned with how models are created and modified; and how better, more comprehensive, more realistic models can be brought into existence. Jones (1992) stated:

In the language of the realist, the expansion method prompts us to engage in investigations of the varying mechanisms of fundamentally open systems. It shares realism's view of the world as differentiated and stratified (p. 58).

Casetti (1986) pointed out that the expansion method can be used for the following, and each of them are interrelated and cannot entirely be separated from one another.

1. to test hypotheses concerning the drift and/or stability of a model's parameters, and to obtain functional portraits of this drift;
2. to create complex models from simpler ones for specific research purposes;
3. as an organizing scheme within the context of which mathematical models can be classified and related to one other;
4. to interpret complex models in terms of simpler initial model(s) and related expansion equations; and
5. as an artificial intelligence technique allowing model creation by computer programs.

The expansion paradigm suggested that the universal validity (invariance) of models should never be assumed, and that the variation (drift) of models across contexts should be presumed and searched for. To iterate, a model should not be treated as a law, because laws are
invariant. The mathematical models are conceptual tools by which we can examine the real world.

When a un-expanded model is estimated and its contextual expansion is called for, the residuals from this estimated 'initial' model are likely to display 'patterns.' The conventional response to these patterns involves adding independent variables that will cause the regression residuals to become well behaved. In geographic research this situation prompted the adding of contextual variables to the initial model.

The technique procedures can be demonstrated with the following example. Let's assume that Equation 2 is an initial model. X is an independent variable; \( a_0 \) and \( a_1 \) are coefficients. By replacing \( a_0 \) and \( a_1 \) in Equation 3 and Equation 4, respectively, we can get the terminal model Equation 5.

\[
Y = f(X) = a_0 + a_1 X_1 \tag{2}
\]

\[
a_0 = C_{00} + C_{01} Z_1 \tag{3}
\]

\[
a_1 = C_{10} + C_{11} Z_1 \tag{4}
\]

\[
Y = C_{00} + C_{01} Z_1 + C_{10} X_1 + C_{11} X_1 Z_1 \tag{5}
\]

By re-running regression analysis for the terminal model, we can check if variable \( Z_1 \) or variable \( X_1 Z_1 \) is in the final model. If any one of them is, the variable \( Z_1 \) has an effect on the independent variable, and the initial model is expanded. The presence of the variable \( Z \) implies that
variable X is expanded in the contextual content of Z, and at a given value of X, the variable Y will be a function of variable Z.

Casetti (1986) demonstrated that "if a terminal model is generated from a linear initial model by linear expansion equations, there is a second linear initial model and associated linear expansion equations that will yield the same terminal model. In other words, the expansion method can approach a model from two directions so that we can test two hypotheses simultaneously. That is, we can check if the coefficients of variable X₁ are stable in the space of variable Z₁, and if the coefficients of variable Z₁ are stable in the space of variable X₁ at a same time. For example, Equation 9 can be derived by expanding Equation 6, an initial model with the variable Z₁, by Equation 7 and Equation 8 with variable X₁. This terminal Equation will be the same as the Equation 5.

\[ Y = f(Z) = a_0 + a_1Z_1 \]  \hspace{1cm} (6)
\[ a_0 = C_{00} + C_{01}X_1 \]  \hspace{1cm} (7)
\[ a_1 = C_{10} + C_{11}X_1 \]  \hspace{1cm} (8)
\[ Y = C_{00} + C_{01}X_1 + C_{10}Z_1 + C_{11}X_1Z_1 \]  \hspace{1cm} (9)

The expansion method serves an important role in integrating different disciplines in the social science. It also can be used to bridge the gap between different approaches in studying a given phenomenon. "It turns our attention to the contextual specificity of general social scientific statement, and it also provides a way by which such questions
may be answered" (Jones, 1992). Any simple model can be transformed through a series of logical, grounded, and context-sensitive models to better understand the complex social world.

Many theoretical and empirical applications of the expansion method can be found in the literature. Casetti (1986), and Casetti and Jones (1987) have made a thorough review of these applications. In addition, a collection of research using this method was edited by Jones and Casetti in 1992.

Jones (1983) used the expansion method to build temporally and spatially varying parameter regression models with empirical data. He found out the parameters of his initial model, a model identifying the major factors influencing rates of growth in participation in the AFDC program (Aid to Families with Dependent Children), are not stable temporally. After expanding it into a second order polynomial of time, its $R^2$ values increased from 0.241 to 0.541. By comparing the initial model and the terminal model, he found that the spatial autocorrelation of the residuals of the initial model disappears after his expansion. He concluded that "In both analyses reported here, polynomial expansion was able to reduce to non-significant levels of autocorrelation present in residuals."

Casetti and Krakover (1990), in their paper, "Spatial-Temporal Dynamics of The U.S. Population: Estimates and Extrapolations," successfully investigated the dynamic redistribution of the U.S.
population in the period from 1950 to 1985 at the state level. By using temporally expanded trend surfaces, the dynamic of population is modeled, estimated, and extrapolated to the year 2000. This research found that the Northeast and California experienced the most significant decline, while the belt running from Florida through Texas to Oregon experienced the most significant growth. This research used a trend surface as the initial model. "By redefining the parameters of the initial model into functions of time, they are well suited to represent the change of regional trends over time" (Casetti, 1990). In this application a second degree trend surface was used. All its parameters were expanded into a quadratic function of time. This expansion can test two hypotheses. The first is that the parameters of the trend surface drift with respect to time; the second is that the parameters of its dual model drift across geographical space.
2.1.5. The Trend Surface Analysis

Trend surface analysis is an ideal technology to model the spatial distribution of the Chinese American at the state level. Its basic principle is that a mathematical equation with only geographical reference points -- coordinate X, coordinate Y, and their powers and combinations --- can be used to model a spatial distribution of a phenomenon. By fitting observed data into different order polynomials, that phenomena can be modeled. The order of the desired polynomial depends on the properties of the analyzed phenomena. The generic Equation of a trend surface is:

\[ TS = f(X,Y) = \alpha + \beta_1 X + \beta_2 Y + \beta_3 X^2 + \beta_4 XY + \beta_5 Y^2 + \beta_6 X^3 + \beta_7 X^2 Y + \beta_8 XY^2 + \beta_9 Y^3 \] (10)

Where
TS stands for trend surface
X and Y are geographical reference points for a place
The \( \alpha \) and \( \beta_i \) represent coefficients, \( \alpha \) is also called the intercept

If the modeled phenomenon is quite simple, a lower order polynomial might be enough. If it is very complex, a higher order polynomial might be needed. A model with an N order polynomial means there are N-1 curves over the space. For example, if a data set shows that its value increases first then decreases and then increases again, then a third order polynomial might be the right choice. For more detailed discussion about the basic principle and mapping method of the trend surface, the reader can consult the papers by Chorley and Haggett (1965), Agterberg (1984), Unwin (1985), and Yeates (1969).
2.2. Methodology and Research Design

Combining trend surface analysis and the expansion method, it is ideal to examine the distribution of the Chinese American in both spatial and temporal aspects. An original trend surface offers geographical variables for modeling the distribution of the Chinese American. However, the over-simplified model cannot analyze this phenomenon in time space. It should be quite safe to assume that the distribution of the Chinese American changed from time to time. After expanding some or all the coefficients of a trend surface in function of time, the terminal model might be able to contain both spatial and temporal variables and become capable of analyzing the phenomena dynamically both spatially and temporally.

In this study, two levels' census data were collected for different purposes. The first is the data set at the state level; the second is at the county level. The state data are used for modeling the distribution of the Chinese American population at the state level from 1890 to 1990. The county data for 1980 and 1990 is used to test several possible hypotheses for explaining the growth rate of the Chinese American population at the county level.

2.2.1. At the state level

The procedure for these analyses is to create several trend surfaces; one of the trend surfaces will be selected as the initial model and will be expanded by functions of time to get terminal models. A terminal model will be employed to show the dynamic of the distribution of Chinese
Americans. Several maps will be created to show the results. The independent variables for this analysis will be X coordinate, Y coordinates, powers of X and Y, and their combinations of various orders. The centroid of a state will be used to represent the location of that state. The dependent variable, LC, will be the natural logarithm of the location quotient of the Chinese American, a variable defined by the following equations:

\[
S_{it} = \frac{C_{it}}{P_{it}} \\
U_t = \frac{C_t}{P_t} \\
LC_{it} = \ln\left(\frac{S_{it}}{U_t}\right)
\]

Where
- \( C_{it} \): the size of the Chinese American population in state \( i \) at time \( t \)
- \( P_{it} \): the size of the total population in state \( i \) at time \( t \)
- \( S_{it} \): the percentage of the Chinese American population in state \( i \) at time \( t \)
- \( C_t \): the size of the Chinese American population in the United States at time \( t \)
- \( P_t \): the size of the total population in the United States at time \( t \)
- \( U_t \): the percentage of the Chinese American population in the United States at time \( t \)
- \( \ln \): natural logarithm
- \( LC_{it} \): the natural logarithm of the location quotient of the Chinese American population in state \( i \) at time \( t \)

The dependent variable, LC, has the properties such that a positive value means that the percentage of the Chinese American population of that state is higher than the average percentage derived from the whole nation, and a negative value means that the percentage of the Chinese American population of that state is lower than the average, and a zero value means the percentage of the Chinese American population of that
state is the same as the average. With this variable, it is easy to know the
distribution of the Chinese American population, and its changes in the
temporal dimension. If the distribution of the Chinese American
population is quite even, most values of $LC_{it}$ should be close to 0. If its
distribution is highly concentrated in some states, those states will have
large positive values. On the other hand, if some states have a low
percentage of Chinese Americans, their $LC_{it}$ values will be small
negative numbers. Since $LC_{it} = \ln(\frac{S_{it}}{U_t})$, if the $\left( \frac{S_{it}}{U_t} \right) = 0$ then the
value of $LC_{it}$ will be infinite. In the study period, both the $S_{it}$ and $U_t$ are
always greater than 0, so it is not a problem at this level.

2.2.2. At the county level

This section is designed to explore the growth pattern of the
Chinese American population at the county level from 1980 to 1990.
Since a place with a large ethnic population tends to attract more people
of that race, this section will start from the initial model with only one
independent variable, the Size of the Chinese American population in the
middle ($C$), to test its relationship with the Growth Rate of the Chinese
American population ($GC$), the dependent variable. Equation 14 is used
to calculate the dependent variable for each county, assuming that the
population of the Chinese American is increasing or decreasing by an
exponentially compounded rate over a given period of time.

$$C_{t+1} = C_t \times e^{rn} \quad (14)$$

Where
$C_t$: the population of the Chinese American in time $t$ (i.e. 1980)
In order to get the growth rate \( r \) (GC), Equation 14 can be transformed to Equation 15. All the growth rates for each county can be calculated with this Equation.

\[
\begin{align*}
  r &= \frac{\ln(C_{t+1}/C_t)}{n} = \frac{\ln(C_{t+1}) - \ln(C_t)}{10} = GC
\end{align*}
\]

Where: \( \ln \) is the natural logarithm

The independent variable is derived by simply averaging the population of the Chinese American from 1980 to 1990 after taking the natural logarithm (Equation 16). This variable is used to represent the population of the Chinese American in the middle of 1980 and 1990 for a county.

\[
C = \frac{(\ln(C_{t+1}) + \ln(C_t))}{2}
\]

For some calculations infinite values will occur due to the taking of natural logarithms for a county not containing any Chinese Americans. In addition, counties with a small number of Chinese Americans tend to introduce noise into analysis. Therefore, only those counties with more than 50 Chinese Americans are considered for analysis. For some other
variables, if an infinite value occurs, that record will be set as system missing data.

As discussed earlier, an over-simplified model distorts reality seriously, so the expansion method will be adopted again to test and integrate some contextual contents. The early Chinese immigrants were poorly educated and worked on low skill, low paying jobs; the new generations have improved their social and economic conditions remarkably. Although some new immigrants are refugees, most of them should have better social and economic status than the old immigrants. For such a long naturalization period, we can assume that the overall status of the Chinese American is getting better. They integrate into the society much better than they used to. Therefore, their movement should be similar to the that of the Whites to some extent. It is suggested that poorly educated poor people tend to live in big cities near central business districts (CBDs), while highly educated rich people tend to have higher mobility and tend to widely disperse to sub-urban areas over the nation. Therefore, four hypotheses are made for the growth rate of the Chinese American. They are:

1. A county with a higher Average Per Capita Income tends to have a higher growth rate.

2. A county with a higher growth rate of Average Per Capita Income tends to have a higher growth rate.

3. A county with a larger total population tends to have a lower growth rate.
4. A county with a higher growth rate of total population tends to have a lower growth rate.

These hypotheses will not only be tested individually but also serve as the contextual contents to test the stability of the initial model one by one.
CHAPTER III
RESULTS

This chapter is composed of two parts. The first part will show the results of the analyses at state level. Two sets of maps and some histograms will be created to display the distribution of the Chinese American in the continental states of the United States geographically and temporally. The second part will test some hypotheses to explain the growth rate of the Chinese American population from 1980 to 1990 by county data.

3.1. Modeling the Distribution of the Chinese American at the State Level

Several trend surface analyses at the state level were employed to get an initial model (a trend surface) to explore the distribution of the Chinese American population. In order to get the initial model, all data blocks are pooled together. In other words, the data set contains 48 states and 11 time blocks. This research starts from the first order polynomial, and ends at the fifth order polynomial. The values of the $R$, $R^2$, and the change of $R^2$ for these analyses are listed in Table 1. Most correlation coefficients of these polynomials are high. They are between 0.73 and 0.78 except for the first one with the value 0.54. The Determinism ($R^2$) of the first order polynomial is only 0.30, the second is 0.54, and the rest
are a little bit higher than 0.60. Both values of the $R$ and $R^2$ increase quite a lot from the first order polynomial to the second order polynomial. Obviously, the first order polynomial is not the right choice for the initial model.

Table 1 shows that a higher order polynomial tends to have higher values of $R$ and $R^2$. The differences between the second order polynomial and the third order polynomial are small but the changes are still significant at the 0.1 level. For the other higher order polynomials, although the values of their $R$ and $R^2$ are higher than those of the third order polynomial, their changes are not significant at the 0.1 level. Therefore, the third order polynomial is taken as the initial model, which implies that the distribution of the Chinese American population is not very complex over the continental states. The results of this model are listed in Table 3. There are only two regions showing a high concentration of the Chinese American population. Based on the literature review, it is safe to conclude that the two high concentration regions should be along the bi-coastal areas.

In order to get a better model with both spatial and temporal variables, the initial model is expanded in the function of time. All the coefficients of the initial model are expanded from the first order polynomial to the fifth order polynomial of time, and the results of these expansions are listed in Table 3, which shows that all expansions result in better models. In other words, all the values of the $R$ and $R^2$ of these expansions are higher than the initial model's. The range of the $R$ values
of the expanded models is from 0.87 to 0.89, and the $R^2$ ranges from 0.76 to 0.78. Compared to the initial model, the value of $R$ increases by 0.11, and the $R^2$ increases by 0.17. The significant increases suggest that the distribution of the Chinese American population shifted temporally and geographically during the study period, and that a model with both spatial and temporal variables can explain the distribution of the Chinese American population much better than a model with only spatial or temporal variables.
Table 1: The List of the Values of $R$ and $R^2$ and Change of $R^2$

<table>
<thead>
<tr>
<th></th>
<th>$R$</th>
<th>$R^2$</th>
<th>$\Delta R^2$</th>
<th>$\Delta F$</th>
<th>Sig. F Change</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0.54290</td>
<td>0.29474</td>
<td></td>
<td>109.7022</td>
<td>0.0000</td>
</tr>
<tr>
<td>2</td>
<td>0.73463</td>
<td>0.53968</td>
<td>0.24494</td>
<td>92.5864</td>
<td>0.0000</td>
</tr>
<tr>
<td>3</td>
<td>0.77961</td>
<td>0.60780</td>
<td>0.06812</td>
<td>22.4912</td>
<td>0.0102</td>
</tr>
<tr>
<td>4</td>
<td>0.78177</td>
<td>0.61116</td>
<td>0.00336</td>
<td>1.48728</td>
<td>0.2171</td>
</tr>
<tr>
<td>5</td>
<td>0.78292</td>
<td>0.61297</td>
<td>0.00181</td>
<td>2.39640</td>
<td>0.1222</td>
</tr>
</tbody>
</table>

Table 2: The Results of the Initial Model

<table>
<thead>
<tr>
<th>Variable</th>
<th>$B$</th>
<th>SE B</th>
<th>Beta</th>
<th>$T$</th>
<th>Sig T</th>
</tr>
</thead>
<tbody>
<tr>
<td>$Y^3$</td>
<td>-1.98643E-09</td>
<td>2.3693E-10</td>
<td>-8.940207</td>
<td>-8.384</td>
<td>.0000</td>
</tr>
<tr>
<td>$XY^2$</td>
<td>-7.65444E-10</td>
<td>1.2430E-10</td>
<td>-3.474903</td>
<td>-6.158</td>
<td>.0000</td>
</tr>
<tr>
<td>$X^2$</td>
<td>8.79499E-07</td>
<td>1.6768E-07</td>
<td>.856950</td>
<td>5.245</td>
<td>.0000</td>
</tr>
<tr>
<td>$X$</td>
<td>-.004283</td>
<td>5.1596E-04</td>
<td>-3.658309</td>
<td>-8.302</td>
<td>.0000</td>
</tr>
<tr>
<td>$X^3$</td>
<td>-4.07750E-11</td>
<td>3.5942E-11</td>
<td>-.106924</td>
<td>-1.134</td>
<td>.2571</td>
</tr>
<tr>
<td>$Y$</td>
<td>-.020788</td>
<td>.002370</td>
<td>-8.109414</td>
<td>-8.770</td>
<td>.0000</td>
</tr>
<tr>
<td>$X^2Y$</td>
<td>-1.43623E-10</td>
<td>7.6035E-11</td>
<td>-.347629</td>
<td>-1.889</td>
<td>.0595</td>
</tr>
<tr>
<td>$XY$</td>
<td>3.40911E-06</td>
<td>5.1778E-07</td>
<td>6.455272</td>
<td>6.584</td>
<td>.0000</td>
</tr>
<tr>
<td>$Y^2$</td>
<td>1.14397E-05</td>
<td>1.3212E-06</td>
<td>16.818062</td>
<td>8.658</td>
<td>.0000</td>
</tr>
<tr>
<td>(Constant)</td>
<td>9.925702</td>
<td>1.358039</td>
<td>7.309</td>
<td>.0000</td>
<td></td>
</tr>
</tbody>
</table>

$R = 0.77961$  \quad R^2 = 0.60780$
Although the expansion of the initial model by a higher order polynomial tends to obtain higher values of R and \( R^2 \), the expansion by the fifth order polynomial improves nothing, so that expansion is not appropriate. The values of the R and \( R^2 \) of the expansion by the fourth order polynomial are 0.88485 and 0.78297, respectively; they are a little bit higher than those of 0.88458 and 0.78247, respectively, from the expansion by the third order polynomial. However, the differences between these two expansions are not significant at the 0.1 level, so the third order polynomial of the time function is selected as the expansion function. Its function is \( \alpha T + \beta T^2 + \delta T^3 \). Again, this expansion reveals that the distribution of the Chinese American population indeed shifted temporally.

After deciding the order of the time function, three expansion methods are used in this study to expand the initial model. The first expands only the constant (intercept). The second expands all the coefficients but the intercept. The third expands all the coefficients. The coefficients of the three expanded models are summarized in Table 4, 5, and 6. In addition, the values of the R, \( R^2 \), and change of \( R^2 \) of these expansions are summarized in Table 7.
Table 3: The Summary Table of the Time Order Testing

<table>
<thead>
<tr>
<th>Order</th>
<th>R</th>
<th>ΔR</th>
<th>R²</th>
<th>ΔR²</th>
<th>F change</th>
<th>Sig. F Change</th>
</tr>
</thead>
<tbody>
<tr>
<td>Initial Model</td>
<td>.77961</td>
<td>.60780</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1st Order</td>
<td>.87136</td>
<td>.09175</td>
<td>.75926</td>
<td>.15146</td>
<td>89.18632</td>
<td>.0000</td>
</tr>
<tr>
<td>2nd Order</td>
<td>.87850</td>
<td>.09889</td>
<td>.77177</td>
<td>.16396</td>
<td>3.43156</td>
<td>.0007</td>
</tr>
<tr>
<td>3rd Order</td>
<td>.88458</td>
<td>.10497</td>
<td>.78247</td>
<td>.17467</td>
<td>4.88078</td>
<td>.0002</td>
</tr>
<tr>
<td>4th Order</td>
<td>.88485</td>
<td>.10524</td>
<td>.78297</td>
<td>.17517</td>
<td>1.12923</td>
<td>.2885</td>
</tr>
<tr>
<td>5th Order</td>
<td>.88485</td>
<td>.10524</td>
<td>.78297</td>
<td>.17517</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 4: The Results of the Terminal Model with Intercept Expanded

<table>
<thead>
<tr>
<th>Variable</th>
<th>B</th>
<th>SE B</th>
<th>Beta</th>
<th>T</th>
<th>Sig T</th>
</tr>
</thead>
<tbody>
<tr>
<td>T³</td>
<td>.005546</td>
<td>.001626</td>
<td>1.260734</td>
<td>3.410</td>
<td>.0007</td>
</tr>
<tr>
<td>Y³</td>
<td>-1.98643E-09</td>
<td>2.3366E-10</td>
<td>-8.940207</td>
<td>-8.501</td>
<td>.0000</td>
</tr>
<tr>
<td>XY²</td>
<td>-7.65444E-10</td>
<td>1.2259E-10</td>
<td>-3.474903</td>
<td>-6.244</td>
<td>.0000</td>
</tr>
<tr>
<td>X²</td>
<td>8.79499E-07</td>
<td>1.6537E-07</td>
<td>.856950</td>
<td>5.318</td>
<td>.0000</td>
</tr>
<tr>
<td>T</td>
<td>.423451</td>
<td>.103465</td>
<td>.942939</td>
<td>4.093</td>
<td>.0000</td>
</tr>
<tr>
<td>X</td>
<td>.004283</td>
<td>5.0885E-04</td>
<td>-3.658309</td>
<td>-8.418</td>
<td>.0000</td>
</tr>
<tr>
<td>X³</td>
<td>-4.07750E-11</td>
<td>3.5447E-11</td>
<td>-.106924</td>
<td>-1.150</td>
<td>.2505</td>
</tr>
<tr>
<td>Y</td>
<td>-.020788</td>
<td>.002338</td>
<td>-8.109414</td>
<td>-8.892</td>
<td>.0000</td>
</tr>
<tr>
<td>X²Y</td>
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<td>7.4987E-11</td>
<td>-3.47629</td>
<td>-1.915</td>
<td>.0560</td>
</tr>
<tr>
<td>T²</td>
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<td>.024780</td>
<td>-2.132945</td>
<td>-3.723</td>
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R = 0.78787
R² = 0.62074
Table 5: The Results of the Terminal Model with all Coefficients
Expanded but Intercept

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<th>Variable</th>
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<th>Beta</th>
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<th>Sig T</th>
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R = 0.88392       \quad R^2 = 0.78131
Table 6: The Results of the Terminal Model with All Coefficients Expanded

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<th>Beta</th>
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<th>Sig T</th>
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R = 0.88384   R² = 0.78117
Table 7: The Summary Table of the Values of $R$ and $R^2$

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<th>$R^2$</th>
<th>$\Delta R^2$</th>
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<td>0.88384</td>
<td>0.10423</td>
<td>0.78117</td>
<td>0.17337</td>
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</table>
The first expansion changes both values of R and $R^2$ slightly; They increase by 0.00826 and 0.01294, respectively. The small amount of changes shows that the intercept drifts a little bit over time. Many variables with the time component show up in the second and third expanded models. For both expansions, the R value increases from 0.77 to 0.88, and $R^2$ increases from 0.62 to 0.78. The increases are 0.10 and 0.17, respectively. Clearly, the expansions not only improve the correlation coefficient a lot, but also significantly improve the ability for the terminal models to explain the total variance of the data set. To be more specific, the original model can only explain 62% of the total variance, while the terminal models can explain 78%. Since the results of the second and the third expansion are quite similar, the last one is taken arbitrarily as the final model. The LC values for each state were calculated from the final model. Several choropleth maps were created according to these values to show the distribution of the Chinese American population every 20 years from 1890 to 1990. They are shown in Figure 5 through Figure 10. All of these maps were created by dividing the 48 states into three groups, according to their LC values in descending order. They are the high LC value group (group H), the middle LC value group (group M), and the low LC value group (group L). The criteria for these groups are:

Group H: the values of LC > 1
Group M: -1 ≤ the values of LC ≤ 1
Group L: the values of LC < -1
Group M is composed of the states with a moderate share of the population of Chinese Americans. A state in this category should have a share closer to the average share of Chinese Americans in the whole United States. Group H consists of those states with a high share of Chinese Americans; Group L contains the states with a low share of Chinese Americans.
Figure 5: The Distribution of the Chinese American in 1890

Figure 6: The Distribution of the Chinese American in 1910
Figure 7: The Distribution of the Chinese American in 1930

Figure 8: The Distribution of the Chinese American in 1950
Figure 9: The Distribution of the Chinese American in 1970

Figure 10: The Distribution of the Chinese American in 1990
In 1890, all the states in Group H were on the west coastal area; all the states in Group L were on the east coastal area and the central United States. There was a narrow transition zone between them. The transition zone was located east of the Rocky Mountains. As mentioned earlier, California was the major destination of the Chinese immigrants in middle 19th century. They went there for the Gold Rush. As an entry port, the west coast still served as the favorite area for the Chinese Americans in 1890. According to diffusion theory, the area near the diffusion source should have higher opportunity to receive arrivals and migrants. The existence of the transition zone gave the theory powerful support.

The territory of Group H along the west coastal area has shrunk constantly since 1890. Only one state still fell into this category in 1970; this Group totally disappeared in 1990. This decline suggested that the western states were losing their leading role. Their share of the Chinese American population is relatively much lower than previously. The states in the central United States fell into Group L constantly. They did not change much from 1890 to 1930. After that, Group L expanded its territory westerly a little bit, which resulted from that some states around the Rocky Mountains changed their category from Group M to Group L. At the same time, when Group L was expanding its territory into the West, Group M started to show up in the Northeast and to expand its territory into the Great Lakes area. It can be found that 5 states fell into this category in 1890, 11 in 1950, and 19 in 1990. Although this number was not always increasing in the study period, the overall pattern showed that more and more states fell into this group. It can be observed that
most states that fell in this category resulted from either the decline in the West or an increase in the Northeast. No any states in the Northeast fell into Group M until 1910. However, most states in this area had already changed their category from Group L to this group in 1990.

Obviously, the distribution of the Chinese American in the study area was becoming more even throughout the past 100 years. In 1890, the Chinese American population was highly concentrated in the west coastal area. In 1990, the leading role of this area was lesser than it used to be. On the other hand, the northeastern area increased its LC values substantially. It has already turned out to be another new concentration center. As for the states in the central United States, most of them still remained in Group L, although their LC values were increasing constantly.

In short, the distribution of the Chinese American is becoming more even throughout the past 100 years. The differential between states is decreasing. If this trend continues, the new distributions for the following decades can be calculated from the terminal model. Figure 11 through Figure 14 show the extrapolated distributions for the next four decades. The factors affecting the distribution are complicated and cannot be assumed to be unchanged so the extrapolated distribution cannot be warranted. However, they are ideal to show the dynamic of the redistribution. According to these maps, Group H is still absent in 2000, but it shows up in the Northeast in 2010, and then more states in this region begin to fall into this group. Figure 20 shows that the northeastern part of
the United States will be dominated by this group to form a highly concentrated core in 2030, and that some states in the South and Northwest will also turn out to be high LC states. The sequence of the extrapolated maps shows that the states in Group L will be fewer and fewer and totally disappear in 2030, and then most states will have shares closer to that of the average share of the whole nation.
Figure 11: The Extrapolated Distribution of the Chinese American in 2000

Figure 12: The Extrapolated Distribution of the Chinese American in 2010
Figure 13: The Extrapolated Distribution of the Chinese American in 2020

Figure 14: The Extrapolated Distribution of the Chinese American in 2030
The re-distribution patterns of the Chinese American have been pointed out in Figures 5 to 14. They show the distribution of the Chinese American is becoming more even, but they cannot to show many detailed textures of the changes. For example, Figure 9 shows only two groups of states; it is hard to compare the relative importance for the states in same category. Therefore, the states will be re-classified in another way to show details. By ranking 48 states in descending order according to their LC values, the upper 1/3 states were classified as Group $H$, the lower 1/3 states as Group $L$, and the remaining 1/3 states as Group $M$. The states in Group $H$ are the top 16 states with the highest LC values, while the states in Group $L$ are the bottom 16 states with the lowest LC values. The remaining 16 states have LC values between those two groups. The results are shown in Figures 15 to 24. Three things can be observed from this set of Figures.

First, most states in Group $H$ were located in the western portion of the United States, Texas, and New England in 1890. Compared with Figure 5, many states on the northeastern portion fell into either Group $H$ or Group $M$ in Figure 15, but all the states fell in Group L in Figure 5, which shows that although the LC values of the states in this area were far less than the average share of the whole nation, they were relatively higher than many others, suggesting another concentration center. According to the first set of Figures, this concentration center is revealed much later than 1890.
Second, the western states were losing their leading position. The territory of Group $H$ had been changed a lot since 1890. Its western portion kept shrinking, while the Middle Atlantic was enlarging slightly. Figure 20 shows that only five states in the West were still in this group in 1990. If this trend continues, the number will decrease to one state in 2030. On the other hand, there were eight in the northeast portion in the 1990 and fifteen in 2030. This shift revealed that the northeast portion of the United States was emerging as the prime area having a high percentage of Chinese Americans, while the western portion of the United States was losing its leading position. In 2030, all the states in Group $H$ but one will be located in the new center. However, there is a long history of Chinese Americans living in the western states, so most of these states will still stay in Group $M$ in the following decades. By comparing these two sets of maps, it can be found that the shift between the western and northeast portions is suggested, but their rates of shift were different. The second set reveals the growth in the northeast portion much earlier than the first set does. In addition, the second set also shows a slower declination tendency for the states in the West than the first set does. The different results from those of the first set uses absolute LC values while the second set uses the relative orders of LC values.

Third, there were two transition zones right outside of the concentration centers. Identified earlier, the northeastern and the western states were two concentration centers. They were about equally important in 1990, although the western part might lose its leading position soon. By examining these Figures, it can be concluded that most states outside
the two poles fell and will fall into Group $M$, while the states far away from them fell into Group $L$. This distribution is perfectly coincident with the situation suggested by diffusion theory.
Figure 15: The Distribution of the Chinese American in 1890

Figure 16: The Distribution of the Chinese American in 1910
Figure 17: The Distribution of the Chinese American in 1930

Figure 18: The Distribution of the Chinese American in 1950
Figure 19: The Distribution of the Chinese American in 1970

Figure 20: The Distribution of the Chinese American in 1990
Figure 21: The Extrapolated Distribution of the Chinese American in 2000

Figure 22: The Extrapolated Distribution of the Chinese American in 2010
Figure 23: The Extrapolated Distribution of the Chinese American in 2020

Figure 24: The Extrapolated Distribution of the Chinese American in 2030
In short, two major types of movement of the Chinese American population can be seen in the past 100 years. First, the Chinese American spread out from several port states into inland states. The distribution of the Chinese American population was becoming more even. Table 8 lists the maximum and minimum values of the LC values, and their ranges from both the census data and the predicted data. They both show that the range between the largest and smallest value for each decade decreased significantly from 1890 to 1990. According to the predicted values, in 1890, the maximum was 3.7, the minimum was -4, and the range was 7.7. In 1990, however, the maximum was 0.72, the minimum was -2.16, and its range was 2.88. The decrease of the range shows that the distribution of the Chinese American population was becoming more even.

Second, the share of the Chinese American population in the bi-coastal areas is increasing again, especially in the northeast portion. Table 9 shows the extrapolated LC values for the next forty years. The range for each decade will increase again. It will increase from 2.70 in 2000 to 6.66 in 2030, so the differential between states will increase again. The northeast part of the United States and some states in the South and Northwest will be the largest concentration centers. California will still not grow quickly, although it had been staying in the leading place for quite a long time.

Third, there is a shift between the western and northeastern portions of the United States. The prime concentration center is moving from the western portion to the northeastern portion.
Table 8: The Ranges of the LCs

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
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<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Census Max.</td>
<td>3.59</td>
<td>3.3</td>
<td>2.98</td>
<td>2.73</td>
<td>2.38</td>
<td>2.28</td>
<td>1.95</td>
<td>1.53</td>
<td>1.39</td>
<td>1.35</td>
<td>1.28</td>
</tr>
<tr>
<td>Census Min.</td>
<td>-4.74</td>
<td>-3.8</td>
<td>-4.41</td>
<td>-3.17</td>
<td>-3.44</td>
<td>-3.72</td>
<td>-2.79</td>
<td>-2.99</td>
<td>-3.16</td>
<td>-2.52</td>
<td>-2.48</td>
</tr>
<tr>
<td>Range</td>
<td>8.33</td>
<td>7.1</td>
<td>7.39</td>
<td>5.9</td>
<td>5.82</td>
<td>6</td>
<td>4.74</td>
<td>4.52</td>
<td>4.55</td>
<td>3.87</td>
<td>3.76</td>
</tr>
</tbody>
</table>

Table 9: The Ranges of the Extrapolated LCs

<table>
<thead>
<tr>
<th>LC</th>
<th>2000</th>
<th>2010</th>
<th>2020</th>
<th>2030</th>
</tr>
</thead>
<tbody>
<tr>
<td>Predicted Max.</td>
<td>0.72</td>
<td>0.99</td>
<td>3.75</td>
<td>6.06</td>
</tr>
<tr>
<td>Predicted Min.</td>
<td>-1.98</td>
<td>-1.63</td>
<td>-1.10</td>
<td>-0.60</td>
</tr>
<tr>
<td>Range</td>
<td>2.70</td>
<td>3.63</td>
<td>4.85</td>
<td>6.66</td>
</tr>
</tbody>
</table>


Proven by Casetti, whenever a terminal model is created it can be interpreted as a dual model. It can be used to test drifts from either aspect (Casetti, 1986). In this case, it can be said that the distribution of the Chinese American drifted temporally at a given place or the distribution of the Chinese Americans drifted spatially at a given time point. The first aspect of the terminal model has already been discussed. Six states (New York, Florida, Illinois, Texas, Washington, and California) are chosen to show the second aspect of the dual model. The locations of the selected states are shown in Figure 25. The temporal differences of the selected states are shown in Figures 26 to Figure 31. Each selected state can be a representative for its nearby states.

New York (Figure 26) can be a representative of the Middle Atlantic area. Its LC values increased first, remained almost at the same level for a long time, then increased remarkably again in the last several decades. According to the extrapolated data, its LC value will be 3.4 in 2030, which implies that the Chinese American population will be highly concentrated in this state then. This example demonstrates the growth pace of the states in the northeast portion of the United States. It also shows how the area moves from a low LC value area into a new leading position.

Florida (Figure 27), Illinois (Figure 28), and Texas (Figure 29) have similar growth patterns as New York. They all increased their LC values before 1920, had small amounts of changes from 1920 to 1990, and will increase clearly from 1990 to 2030. The differences between
them are the absolute values of the variable LC. As an another entry port state, Texas always has higher LC values than others. Illinois, as an inland state, has an LC value that was the lowest in 1890, but it will be a little bit higher than Florida's in 2030 as a result of the fact that it is closer to the new concentration center. Florida does not change its LC values too dramatically, but it did get more Chinese Americans. As a state in sunbelt, Florida increased its population significantly, but the growth rate of its Chinese Americans is not as high as others in the northeastern area. During the past several decades, many older people move to this state. In addition, many new immigrants also moved there. Jasso and Rosenzweig (1990) pointed out that Florida has a long history as an important Spanish colony, as the home of Cuban and other Spanish-speaking immigrants. Therefore, it is a highly concentrated center for Cubans and Hispanics, although it is not for Chinese Americans.

Washington (Figure 30) and California (Figure 31) are the examples for decreasing states. California decreased its LC values entirely. Its decreasing rate remained quite constant from 1890 to 1990. However, according to the extrapolated values, its decreasing tendency will slow down and its LC values will be still positive in 2030. Before 1990, Washington had very similar decreasing experience to California's. The only difference is that its LC values were always smaller than California's. However, the LC values of Washington will increase dramatically after 1990. In 2030, its LC value will have overcome California's and it will have become another concentration pole. This
concentration center coincides with the finding by Casetti (1990) that the maximum growth center moved northward from California to Oregon.

Figure 25: The Locations of the Selected Six States
Figure 26: The LC Values in the State of New York

Figure 27: The LC Values in the State of Florida
Figure 28: The LC Values in the State of Illinois

Figure 29: The LC Values in the State of Texas
Figure 30: The LC Values in the State of Washington

Figure 31: The LC Values in the State of California
The Chinese American population for the selected six states is showed in Figure 32. California was the only state that decreased its Chinese American population significantly from 1890 to 1920. However, the overall situation was that all the states increased their Chinese American population from 1890 to 1990. During the last several decades, their population increased remarkably. The states of New York and California always had large Chinese American population; their Chinese American population were much larger than other states'. Although the California decreased its LC values all the way down, its Chinese American population were still much larger than any other single state's and were still increasing significantly. In 1990, the Chinese American population of New York was less than half of California's, although New York had the second largest Chinese American population. In other words, the growth rate of other racial groups was faster than the growth rate of the Chinese Americans in California, so its LC values decreased although its population increased tremendously.

The shares of Chinese American population in the selected states are showed in Figure 33. In 1890, over 67% of Chinese Americans lived in California, and less than 4% lived in the state of New York; the shares of other states were less than 5%. During the study period, the California decreased its share from 67% to 43% , while the state of New York increased its share from 3% to 17%. Roughly speaking, about 60% of Chinese Americans lived in either the state of California or the state of New York during the study period. Therefore, the Chinese Americans were highly concentrated. In order to check if any other states also had
large share of Chinese Americans, Table 10 was created. This Table shows the top five leading states according to their shares of Chinese Americans. The state of New York increased its share from 3% in 1890, to 7% in 1910, and to 17% in 1990. It has been in the second position since 1930. The state of California was always in the first place, although its share was decreasing, in general. Except these two states, no any single state had a percentage greater than five. More precisely, the Chinese Americans was highly concentrated in two states, California and New York. In 1890, all other three leading states - Oregon, Washington, and Nevada - were in the western portion of the United States. However, in 1990, they turned out as Texas, New Jersey and Massachusetts. None of them is in the western portion of the United States. Instead, two of them were in the northeastern portion of the United States. That the Chinese American population shifted from the western portion of the United States to the northeastern portion was also proved by the real data.
Figure 32: The Chinese American Population in the Selected States

Figure 33: The Percentages of Chinese American Population in Selected States
Table 10: The Leading States with the Largest Chinese American Population

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>67%</td>
<td>51%</td>
<td>50%</td>
<td>50%</td>
<td>39%</td>
<td>43%</td>
</tr>
<tr>
<td>2</td>
<td>Oregon (9%)</td>
<td>Oregon (10%)</td>
<td>New York (13%)</td>
<td>New York (17%)</td>
<td>New York (19%)</td>
<td>New York (17%)</td>
</tr>
<tr>
<td>3</td>
<td>Washington (3%)</td>
<td>New York (7%)</td>
<td>Illinois (4%)</td>
<td>Illinois (4%)</td>
<td>Illinois (3%)</td>
<td>Texas (4%)</td>
</tr>
<tr>
<td>4</td>
<td>New York (3%)</td>
<td>Washington (4%)</td>
<td>Massachusetts (4%)</td>
<td>Massachusetts (3%)</td>
<td>Massachusetts (3%)</td>
<td>New Jersey (4%)</td>
</tr>
<tr>
<td>5</td>
<td>Nevada (3%)</td>
<td>Massachusetts (4%)</td>
<td>Pennsylvania (3%)</td>
<td>Washington (3%)</td>
<td>Washington (2%)</td>
<td>Massachusetts (3%)</td>
</tr>
<tr>
<td>Sum</td>
<td>85%</td>
<td>76%</td>
<td>74%</td>
<td>76%</td>
<td>67%</td>
<td>71%</td>
</tr>
</tbody>
</table>
3.2. The Explanations of the Distribution and Shift of the Chinese American

Both sets of maps are derived from the terminal model. Figure 5 to 24 show the spatial aspect of the model. They show that different states tend to have different LC values at a given time point. Figures 25 to 31 show the temporal aspect of the model. They demonstrate that a state tends to have different LC values at different time points. They clearly show that the distribution of the Chinese American shifted temporally and spatially.

The mechanism affecting the distribution and shift of the Chinese American can be very complicated. The pull-push theory offers a very nice explanation for the Chinese immigration to the United States. The poor Chinese who suffered from rebellions in China were forced to leave their homeland. California, the state with the Gold Rush in the 1840s, offered an attractive opportunity for those people, so California became their major destination. This high concentration can still be observed 30 years later in Figure 5 and Figure 15, the first time point used in this study. Although Figure 5 shows that the northeast portion of the United States was classified as Group L, many states in this area have middle to high LC values according to Figure 15, a result of the fact that this area was another entrance point for Chinese immigrants. Texas, another port state, also had a high concentration in 1890. Frey (1989) offered an explanation for the concentration in these port states. He said that the destination selections of immigrants are less responsive to the kinds of economic forces and environmental attractions that affect internal
migrants' choices. Many immigrants tend to locate in areas near their "entry port" cities or in areas where earlier immigrants from their country of origin have settled." In short, these concentration areas were the major port states from which the original Chinese immigrants came to the United States and from which the Chinese Americans dispersed into other states.

According to diffusion theory, there are two types of diffusion processes. The first type states that a phenomenon disperses to its surrounding area little by little. The second type states that a phenomenon jumps into another(other) point(s) far away from it, and then from the new point(s) disperse(s) to its(their) surrounding area(s). In order to observe the real diffusion process of the Chinese American, further research is needed. However, by comparing maps, both types of diffusion processes should present.

The first type of diffusion process can be observed in Figures 5 to 14. They show that the states in the central portion of the United States always had the lowest LC values, a result of these states being far away from the entrance ports and only a few of Chinese Americans moving into these states as a consequence. During the last two decades, many states below the Great Lakes changed their category from Group L to Group M. The states near New York City, the new concentration center, changed their category earlier than those far away from it, which shows the diffusion center expanded its territory into inland states gradually.
The diffusion processes will continue so the Group L will totally disappear in 2030.

The second type of diffusion process can best be shown in Figures 15 to 24. These maps clearly show the trend of the high concentration area shift from the west coastal area to the Northeast. In 1890, all states in Group $H$ were in the west coastal area but one; in 1990 only four of the western states still were in Group $H$ and many states in the northeast portion had already changed their category to Group $H$; in 2030 all the states in Group $H$ will be in the northeast portion but one. The relative growth rate of the Chinese American population in the northeast portion is faster than in either the western or southern portion. This trend might indicate that the traditional core area is the favored area for the Chinese Americans. Some articles suggested that the bi-coastal areas are experiencing high population growth again recently due to the booming of international business. For the Chinese American, the growth can be observed in the northeast coastal area, but not in the West. In fact, the shift between the West and the northeast does not necessarily mean that the Chinese American moved from western states to northeastern states. It can result from many people of other ethnic groups moving out of northeastern states or moving into western states, or result from international migration.

During the shift between the sunbelt and snowbelt, many people moved to the South or the West. Many of those people are in the middle of the ladder of the social and economic structure. However, most
Chinese Americans are distributed in both ends. They are either poorly educated or highly educated persons. There is no problem for them in finding jobs in the snow belt. Therefore, they are not likely to move as the Whites do. In this case, the LC values of these states tended to
increase. If both internal migration and international migration are considered too, further increases can be introduced. Frey (1989) pointed out that immigrants tend to locate disproportionally in large metropolitan areas, particularly on the eastern and western seabords. Therefore, even though there is a shift between the sunbelt and snowbelt, the continued rise in immigrants from Latin American and Asia not only serves to reinforce metropolitan growth in the South but also serves to counter the impact of deconcentration related to internal migration processes in the North.

3.3. Testing Hypotheses at the County Level

The purposes of this section are to test hypotheses and explore factors that can explain the growth rate of the Chinese American population at the county level. The last section has already showed how the distribution of the Chinese American shifted in the United States from 1890 to 1990. However, it gives no answers for how Chinese Americans distributed and shifted within a state. This section will go a little bit further to explore this issue by using the last two census' data, 1980 and 1990 at the county level.

Figure 34 was created by the county data of 1990. All the 3141 counties were divided into two groups. The first group includes the counties with at least 20 Chinese Americans; the second group includes the counties with less than 20 Chinese Americans. This Figure shows that the Chinese Americans were highly concentrated in the western coastal area. Most counties in California, Arizona and Washington states fell into
the first Group. The northeastern portion of the United States, and Florida also had higher concentration. For most other states, Chinese Americans tended to lived in only few counties. In order to know how the Chinese Americans shifted, the expansion method is employed again.

Figure 34: The Distribution of the Chinese American at the County Level in 1990
The initial model for the analyses contains only one independent variable, the size of the Chinese American population, and one dependent variable, the Growth Rate of the Chinese American population. Their relation can be expressed as Equation 17. Although both values of R (R = 0.51) and R² (R² = 0.26) of the model are not high, their relationship is still significant at the 0.1 level. This initial model confirms that a county with a larger Chinese American population tends to have a higher growth rate. Although the Chinese have already been in the United States for a long time, they still tend to cluster together. The independent variable C itself can explain 26% of the variance of the data set, so it is an important variable and an ideal point at which to start.

\[ GC = -0.070770 + 0.014517 \times C \]
\[ R = 0.51009 \quad R^2 = 0.26019 \quad (17) \]

Several hypotheses in explaining the Growth Rate of the Chinese American population at the county level had been made in Chapter II. They are:

1. A county with a higher Average Per Capita Income (I) tends to have a higher growth rate.
2. A county with a higher growth rate of Average Per Capita Income (GI) tends to have a higher growth rate.
3. A county with a higher total population (P) tends to have a lower growth rate. and
4. A county with a higher growth rate of total population (GP) tends to have a lower growth rate.
Equations 18 to 22 are used to define the variables for testing these hypotheses. Equations 20 and 22 assume that the growth rate of these variables was increasing or decreasing by an exponentially compounded rate over the study period. Each hypothesis is tested individually by running the "enter regression" procedure with GC as the dependent variable, and then expanding the initial model by these independent variables individually to test the contextual contents. This section will be divided into the four tests below.

\[
I = \frac{(\ln(I_{t+1}) + \ln(I_t))}{2} \quad (18)
\]
\[
GI = \frac{(\ln(I_{t+1}) - \ln(I_t))}{10} \quad (19)
\]
\[
P = \frac{(\ln(P_{t+1}) + \ln(P_t))}{2} \quad (20)
\]
\[
GP = \frac{(\ln(P_{t+1}) - \ln(P_t))}{10} \quad (21)
\]

where
\[
(I_{t+1}) = \text{Average Per Capital Income for a county in 1990}
\]
\[
(I_t) = \text{Average Per Capital Income for a county in 1980}
\]
\[
(P_{t+1}) = \text{Total Population of a County in 1990}
\]
\[
(P_t) = \text{Total Population of a County in 1980}
\]
Test 1:

The relationship between variable GC and variable I is listed in Table 11. This regression shows that a county with a higher average per capital income tends to have a higher Growth Rate of the Chinese American population. This relationship is significant at the 0.1 level, although both values of $R$ ($R = 0.29358$) and $R^2$ ($R^2 = 0.08619$) are not high. By expanding all the parameters of the initial model by the linear equation of variable I, the results can be shown in Table 12. The Table shows that variable I and variable C*I are not significant at the 0.1 level, which means that they did not significantly affect the growth rate of the Chinese American population and the coefficients of the initial model are stable in the space of average Per Capital Income. In other words, if two counties have same amount of Chinese Americans and different average Per Capital Incomes, they still will tend to have similar growth rate. Therefore, when the variable C is controlled, the variable I makes no significant difference in variable GC. If only average income and size of the Chinese American population are compared, the size is still much more important than the income in affecting the growth rate.
Table 11: The Regression model of GC and I

<table>
<thead>
<tr>
<th>Variable</th>
<th>B</th>
<th>SE B</th>
<th>Beta</th>
<th>T</th>
<th>Sig T</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>.058583</td>
<td>.008626</td>
<td>.293578</td>
<td>6.791</td>
<td>.0000</td>
</tr>
<tr>
<td>(Constant)</td>
<td>-.757247</td>
<td>.120684</td>
<td>-6.275</td>
<td>.0000</td>
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</tbody>
</table>

R = .29358  R² = .08619

Table 12: The Expansion by Average Per Capita Income

<table>
<thead>
<tr>
<th>Variable</th>
<th>B</th>
<th>SE B</th>
<th>Beta</th>
<th>T</th>
<th>Sig T</th>
</tr>
</thead>
<tbody>
<tr>
<td>C</td>
<td>.014517</td>
<td>.001107</td>
<td>.510088</td>
<td>13.114</td>
<td>.0000</td>
</tr>
<tr>
<td>(Constant)</td>
<td>-.070770</td>
<td>.010419</td>
<td>-6.792</td>
<td>.0000</td>
<td></td>
</tr>
<tr>
<td>I</td>
<td>.043958</td>
<td>.043901</td>
<td>.737904</td>
<td>.971</td>
<td>.3322</td>
</tr>
<tr>
<td>C*I</td>
<td>.245863</td>
<td>.022346</td>
<td>.006111</td>
<td>.494</td>
<td>.6217</td>
</tr>
</tbody>
</table>

R = 0.51009  R² = 0.26019
Test 2:

The regression model for the variables GC and GI is listed in Table 13. It confirms that the county with a higher Growth Rate of Average Per Capital Income tends to have a higher Growth Rate of the Chinese American population. Both values of $R$ ($R = 0.31462$) and $R^2$ ($R^2 = 0.09899$) in this regression are not high, but they are significant at the 0.1 level. The results of this expansion are summarized in Table 14. The Table shows that the variable GI and variable $C*GI$ are not significant at the 0.1 level, which means that they did not significantly affect the growth rate of the Chinese American population, and the coefficients of the initial model are stable in the space of the Growth Rate of Average Per Capital Income. In other words, if two counties have the same amount of Chinese Americans and different Growth Rates of Average Per Capital Income, they will still tend to have similar GC values. Variable GI can only explain 9.9% of the total variance of the data set, which is much lower than the variable C.
### Table 13: The Regression model of GC and GI

<table>
<thead>
<tr>
<th>Variable</th>
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<th>Beta</th>
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<tr>
<td>GI</td>
<td>.091290</td>
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<td>-.728125</td>
<td>.107853</td>
<td>-6.751</td>
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</table>

R = .31462  \( R^2 = .09899 \)

### Table 14: The Expansion by Average Growth Rate of Per Capita Income

<table>
<thead>
<tr>
<th>Variable</th>
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<th>Beta</th>
<th>T</th>
<th>Sig T</th>
</tr>
</thead>
<tbody>
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<td>.001107</td>
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<td>13.114</td>
<td>.0000</td>
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<tr>
<td>(Constant)</td>
<td>-.070770</td>
<td>.010419</td>
<td>-6.792</td>
<td>.0000</td>
<td></td>
</tr>
<tr>
<td>GI</td>
<td>.070261</td>
<td>.069988</td>
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<td>1.550</td>
<td>.1218</td>
</tr>
<tr>
<td>C*GI</td>
<td>.460834</td>
<td>.046298</td>
<td>.007467</td>
<td>1.024</td>
<td>.3064</td>
</tr>
</tbody>
</table>

R = 0.51009  \( R^2 = 0.26019 \)
Test 3:

The regression model for variable GC and variable P is listed in Table 15, and the model is significant at the 0.1 level. The values of its R and $R^2$ are 0.38873 and 0.1511, respectively. It shows that the county with a higher total population tends to have a higher Growth Rate of the Chinese American population, which is not coincident with the hypothesis. However, two variables, P and C*P, are significant in the expanded model (Table 16). The original variable C turned out to be insignificant. Therefore, the interactive effect of the new variable P*C is more important than the variable C itself. Equation 22 is the expanded regression model, which can be transformed into Equations 23 and 25. The coefficients of the initial model can be expressed in the function of variable P. They are shown in Equations 25 and 27.

\[
GC = 0.084290 + 0.001191(C*P) - 0.012891P \tag{22}
\]

\[
GC = 0.84290 - 0.012891 * P + (0.01191 * P) * C \tag{23}
\]

\[
GC = 0.84290 + (0.01191 * C - 0.012891) * P \tag{24}
\]

\[
\alpha(P) = 0.84290 - 0.012891 * P \tag{25}
\]

\[
\beta(P) = 0.01191 * P \tag{26}
\]

Equation 25 indicates that the intercept decreases as variable P increases, while Equation 26 indicates coefficient $\beta$ increases as variable P increases. Therefore, Variable P has a different effect on the coefficients. However, since both values of P and C are always greater
than 5 in this study, the net effect of variable P is positive, which can be observed more easily in Equation 24. The net effect implies that a county with a higher total population tends to have a higher growth rate of the Chinese American population when the size of the Chinese American population is controlled, and that a county with larger Chinese American population tends to have a higher growth rate of the Chinese American population when the total population is controlled. The interactive effect means that a county with a large Chinese American population and total population tends to attract Chinese Americans.
Table 15: The Regression model of GC and P

<table>
<thead>
<tr>
<th>Variable</th>
<th>B</th>
<th>SE B</th>
<th>Beta</th>
<th>T</th>
<th>Sig T</th>
</tr>
</thead>
<tbody>
<tr>
<td>P</td>
<td>0.023742</td>
<td>0.002545</td>
<td>0.388734</td>
<td>9.330</td>
<td>0.0000</td>
</tr>
<tr>
<td>(Constant)</td>
<td>-0.226903</td>
<td>0.031089</td>
<td></td>
<td>-7.299</td>
<td>0.0000</td>
</tr>
<tr>
<td>R = .38873</td>
<td>R^2 = .1511</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 16: The Expansion by Total Population

<table>
<thead>
<tr>
<th>Variable</th>
<th>B</th>
<th>SE B</th>
<th>Beta</th>
<th>T</th>
<th>Sig T</th>
</tr>
</thead>
<tbody>
<tr>
<td>C*P</td>
<td>0.001191</td>
<td>1.3841E-04</td>
<td>0.686671</td>
<td>8.602</td>
<td>0.0000</td>
</tr>
<tr>
<td>P</td>
<td>-0.012891</td>
<td>0.004876</td>
<td>-0.211058</td>
<td>-2.644</td>
<td>0.0085</td>
</tr>
<tr>
<td>(Constant)</td>
<td>0.084290</td>
<td>0.046365</td>
<td></td>
<td>1.818</td>
<td>0.0697</td>
</tr>
<tr>
<td>C</td>
<td>0.026945</td>
<td>0.002827</td>
<td>0.005106</td>
<td>0.062</td>
<td>0.9503</td>
</tr>
<tr>
<td>R = .51272</td>
<td>R^2 = .26288</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Test 4:

The regression model for variables GC and GP is listed in Table 17. The model shows that a county with a higher growth rate of population tends to have a higher Growth Rate of the Chinese American population, which also differs from the hypothesis. The values of R ($R = 0.30228$) and $R^2$ ($R^2 = 0.09137$) for this regression are still low, but again they are significant at the 0.1 level. The results of the expansion are summarized in Table 18. The interactive effect of the variable C*GP is not significant, but both variables C and GP are significant. They have a positive relationship with the dependent variable. Their relationship can be expressed in Equation 27. Equation 28 shows that the intercept of the terminal model increases as the growth rate of the total population increases, and that the $\beta$ is stable to the growth rate of the total population. Therefore, the growth rate of the Chinese American population increases if the growth rate of the total population increases.

$$GC = -0.073372 + 1.007086 \times GP + 0.13550 \times C \quad (27)$$

$$\alpha(GP) = -0.073372 + 1.007086 \times GP \quad (28)$$
Table 17: The Regression model of GC and GP

<table>
<thead>
<tr>
<th>Variable</th>
<th>B</th>
<th>SE B</th>
<th>Beta</th>
<th>T</th>
<th>Sig T</th>
</tr>
</thead>
<tbody>
<tr>
<td>GP</td>
<td>1.307770</td>
<td>.186495</td>
<td>.302275</td>
<td>7.012</td>
<td>.0000</td>
</tr>
<tr>
<td>(Constant)</td>
<td>.047271</td>
<td>.003414</td>
<td></td>
<td>13.846</td>
<td>.0000</td>
</tr>
<tr>
<td>R = .30228</td>
<td>R^2 = .09137</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 18: The Expansion by Growth Rate of Total Population

<table>
<thead>
<tr>
<th>Variable</th>
<th>B</th>
<th>SE B</th>
<th>Beta</th>
<th>T</th>
<th>Sig T</th>
</tr>
</thead>
<tbody>
<tr>
<td>C</td>
<td>.013550</td>
<td>.001079</td>
<td>.476109</td>
<td>12.555</td>
<td>.0000</td>
</tr>
<tr>
<td>GP</td>
<td>1.007086</td>
<td>.164061</td>
<td>.232776</td>
<td>6.138</td>
<td>.0000</td>
</tr>
<tr>
<td>(Constant)</td>
<td>-.073372</td>
<td>.010058</td>
<td></td>
<td>-7.295</td>
<td>.0000</td>
</tr>
<tr>
<td>C*GP</td>
<td>-.120149</td>
<td>-.031277</td>
<td>.046540</td>
<td>-.691</td>
<td>.4902</td>
</tr>
<tr>
<td>R = .55966</td>
<td>R^2 = .31322</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Based on these analyses in this section, we can get some insights into the growth rate of the Chinese American population at the county level. Three things can be concluded.

1. The size of the Chinese American population is best able to explain the growth rate of the Chinese American population among the variables used, if only one independent variable is considered. It always has a positive relationship with the dependent variable, no matter what variable is used to expand the initial model. This situation indicates that Chinese Americans still tend to live close to one another.

2. Variables I, GI, P, and GP also have a positive relationship with the dependent variable. The Chinese American population tends to move to places with nice economic opportunities, which implies that they are improving their economic condition. In addition, they also tend to move to places with large populations or places with high growth rates of total population, which shows that they tend to live in metropolitan areas with high population growth rates. In other words, although they are improving their economic conditions, ruralization processes are still not significant for this racial group.

3. The interactive effect of the variables C and P are significant. When the initial model is expanded in the function of variable P, the variable C itself turns out as insignificant. However, variable P itself can only explain 15% of the total variance, which is much lower than variable C did (25%). Therefore, the interactive effect suggests that a favored
county to attract the Chinese American population needs to possess both a large Chinese American population and a large total population.
CHAPTER IV
CONCLUSION AND DISCUSSIONS

4.1 Conclusion

The Chinese American is one of the racial groups in the melting pot. They have been coming to the United States for a long time, but their population did not increase significantly until the last several decades. The original Chinese immigrants came to the nation for the Gold Rush in 1840s in California. Most of them were from the Southern province, Kwangtung. They used to work on low-paying mining jobs and confined themselves to living in Chinatown. Today, they have not only improved their social and economic status but have also earned much respect from others. The "model immigrants" can be found in many metropolitan areas and small counties. Many previous researchers adopted a qualitative approach to discuss various phenomena associated with this group. They offered many detailed insights to this group, but most of them did not generalize its overall distribution pattern and shift. This research adopts a quantitative approach to supplement earlier research to model its changing pattern at a highly generalized level.

By expanding a third order trend surface in a third order time polynomial, the changing pattern of the Chinese American population in both spatial and temporal aspects can be well modeled; the values of the
The west coastal area was the major concentration area for the Chinese American population during the past 100 years. Its leading position results from its Gold Rush and its role as a major entrance port. Many Chinese came into the United States from here and dispersed into other states. Its dominant situation has been decreasing significantly. Although it is still in the leading position today, it might lose its position to the northeast portion of the United States soon. The northeast portion of the United States is another concentration area. Many Chinese immigrants moved to this region as a result of both internal migration and international migration. As another entrance port area and the base of many global services, it offers many jobs for both low-skilled laborers and professional laborers, so its population of Chinese Americans has increased dramatically over the past several decades. In the near future, further concentration still can be expected, so it might turn out to be the major leading area soon. The inland states have always had the lowest population of Chinese Americans, which is a result of the fact that they are far away from the entry port areas. In general, the states closer to the concentration centers increase their LC values faster than the states far away from them.
From the temporal aspect, two changing patterns can be observed. First, the states on the west coast decreased their LC values constantly. Recently, the decline stopped and a slight increase can be observed. Second, most states increased their LC values from 1890 to 1920, increased or decreased a little bit from 1920 to 1990, and might grow fast again from 1990 to 2030.

After understanding the distribution and shift of the Chinese American population at the state level, more detailed data are used to test some hypotheses to explain the growth rate of the Chinese American population at the county level. This study shows that the growth rate of Chinese American population of a county from 1980 to 1990 tends to be higher when that county has a large Chinese American population, a higher Average Per Capita Income, a higher growth rate of the Average Per Capita Income, a higher total population, or a higher growth rate of total population. In addition, the interactive effect of the size of the Chinese American population and the total population also has a positive relationship with the growth rate of the Chinese American population. Although the growth rate of the Chinese American is

4.2 Discussions and Limitations

This research has demonstrated that the distribution and shift of the Chinese American population can be well modeled by combining the trend surface analyses and the expansion method. It not only generalizes a complex phenomenon, but also offers a model for prediction. It is much
This research also reveals some interesting things. Although there are no enough data for further analysis, some points might be relevant to those issues.

1. The growth pattern of the Chinese American population was different from the growth pattern of the Japanese American. The difference might resulted from several factors. First, the Chinese came to the United States much earlier than the Japanese did, so there were much more Chinese Americans than Japanese Americans before 1880. Second, from 1882 to 1943, the Chinese Exclusion Act harmed seriously to the Chinese but not to the Japanese. The population of the Japanese American became bigger than the population of the Chinese American. During the World War II, the Japanese American population decreased slightly. Third, the repeal of the Chinese Exclusion Act in 1943 gave an opportunity for the population of Chinese Americans to grow dramatically. The Chinese had been moved to many other countries. The Chinese immigrants might from any one of them. They were not necessary from either China or Taiwan. However, Japanese were not widely distributed as Chinese did. In addition, it was possible that more Chinese than Japanese moved into the United States through illegal or undocumented immigrations.
2. This study uses a location quotient as the dependent variable for the state data, a variable which shows the relative share of Chinese Americans of that state to the average share of the whole nation. For a state with many Chinese Americans and a large population, its LC value might still be low. In contrast, if a state has a moderate amount of Chinese Americans and small total population, its LC value might be relatively high. If a state decreases its LC value, it does not necessary mean that the size of its Chinese American population is decreasing. It might be a result of a lot of other ethnic people moving in. Although this variable is not ideal to show the sizes of the Chinese American population, it is nice to show the differences between ethnic groups. By changing the components in Function (13), this variable will be ideal to compare various ethnic groups.

3. The analysis at the state level shows that the range of the LC values is decreasing. After examining the absolute numbers of the Chinese American population, it can be found that the total population of Chinese Americans increase in the inland states. The analysis at the county level shows that Chinese Americans still tend to move to a place with large population. These two situations suggest that although Chinese Americans still tend to live in metropolitan area, certain amount of them also move into inland states and small counties. For example, in 1980, Chinese American residents can be found in 44% of counties in the study area; in 1990, they can be found in 47% of counties. This situation might also implies that many Chinese Americans moved out metropolitan areas after improving their social and economic situations. Their leaving, in sequence,
offered many opportunities for new comers. Of course, for the highly educated new comers, they might spread into small towns directly. Further research for their migration should be valuable. The fact that many counties have small Chinese population might suggest that Chinese Americans integrate well into the White society. The Chinatown is not the only favorite place to live.

4. The shift of the high LC values area from California to the northeastern portion of the United States and Washington state might suggest the existence of a two step migration for Chinese. Under various constraints, Chinese can not immigrate to the United States easily. Some of them might choose the Canada as their first destination. Many Chinese can be found in Toronto or Vancouver today. For a while staying in the Canada, they might move down to the states closer to their first destination.

5. Most Chinese Americans live in either the state of California or the state of New York. These two states offered the best places for various research on Chinese Americans. The research about how Chinese Americans distribute and shift inside these two states should be carried out.

Although this research can offer many benefits to the understanding of the distribution and shift of the Chinese American population, there are some limitations. They are:

1. This research uses a quantitative method to model the distribution and shift of the Chinese American population, a methodology which tends to sacrifice accuracy resulting in some detailed information being lost.
Since the distribution of the Chinese American population is highly concentrated in some states, the predicted values for these states might be quite off their real values.

2. This research focuses on only the 48 continental states. Some other important states and a district, namely, Hawaii, Alaska, and Washington, D.C. are not included. Because many Chinese Americans live there, they should be carefully examined in order to acquire a better understanding.

3. The model for explaining the growth rate of the Chinese American population at the county level has low values for both $R$ and $R^2$ so that more hypotheses and useful variables are needed for a better explanation.

4. A mathematical model is supposed to have the ability to predict, but the world might change dramatically so that the reality might be far away from prediction, especially when the predicted time is far away from the modeled period. The predicted values for the years from 1890 to 1990 should be much more dependable than the extrapolated values.

5. Most of the data used in this study are from the Census. Many Chinese, especially illegal immigrants, might not be included, so this study should not be treated as a thorough examination of this ethnic group. In fact, many illegal immigrants might live in California and New York, so these states' real LC values might be higher.
REFERENCES


