The Determinants of County Growth in Virginia

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(ABSTRACT)

Counties and cities in Virginia exhibit distinct regional patterns of growth. While some regions are amongst the fastest growing of any in the nation, other regions have experienced slow or even negative rates of growth in recent decades. To better understand growth in Virginia in recent decades, this thesis presents and estimates an empirical model that will help determine which factors have had the greatest influence on the various components of growth. These components include migration, natural increase (births minus deaths) and employment growth. The results suggest that overall growth was most positively associated with areas of diffuse but high population, as found in many peri-urban localities. Results also indicate that high property taxes have had a strong negative influence upon growth in recent decades. For policy makers and planners in rapidly growing regions, these results indicate that development ordinances that restrict growth to more densely populated areas could effectively slow rates of rapid growth. For slow growth regions, these results indicate that maintenance of low living costs to attract migrants and a diversified employment base may be an effective means to stimulate growth.

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Chapter 1: Introduction

1.1 Problem Statement

Rapid population growth, where it occurs, can lead to increasing income and employment opportunities for current residents and new in-migrants, as well as higher tax bases. Higher population densities may increase the efficiency of the distribution of goods and services in society, and the productivity of the economy (Marshall, 1920). Often, however, population growth is associated with problems of congestion, crime, and environmental degradation. Rapid population growth may also cause financial stress for residents and local governments who must provide services and infrastructure to accommodate new residents. Regions experiencing slow or negative growth in population may suffer stagnant or falling wages and employment opportunities, but avoid the social strains associated with congestion. Counties and cities in Virginia (see Figure 1-1) exhibit distinct regional patterns of growth. The peri–urban fringes of the Washington D.C. metropolitan region have experienced rapid growth. The independent city of Manassas saw the nation's 20th highest average annual growth rate from 1980 to 1992 (U.S. Census *City and County Data Book 1994*), while Fairfax County experienced the nation's 16th highest rate of net population growth. Meanwhile, numerous counties in the southwestern portion of the state show declines or very sluggish rates of population growth. For example, Dickenson County has shown an estimated population decrease of 2.9 percent from 1991 to 1996 (Weldon Cooper 1997).

At the most basic level, local population growth equals the sum of in-migration minus out-migration plus births minus deaths. In this equation, migration rates are generally the most important determinant of differential growth. Migration will also vary widely by age cohort and other socio-demographic factors. Certain housing or labor market conditions may be attractive to one age group while discouraging in-migration of another. Younger individuals are most likely to relocate in search of greater employment and earnings opportunities, whereas older, retired individuals may prefer to reside in low cost, but economically sluggish regions. Areas which younger individuals are leaving

and older ones are moving into often experience additional population decline due to lower birth rates and higher death rates typically found among older populations.

Management of growth, especially in areas of rapid increase, has become an important and controversial issue in recent times. Often, restrictions must be placed on where people and employers may locate themselves if the negative consequences of rapid growth are to be managed. These decisions will infringe upon the rights of individuals and corporations in ways that will anger many. This anger may result in judicial or political action by those whose interests are at stake. Numerous conflicts occur throughout the state each year over development issues. In 1998, amidst local controversy, Loudoun County officials narrowly approved a plan by World-com to locate a large facility in the county, despite the promise of thousands of new high technology jobs.

Areas in other parts of the state, which have seen slow growth or declining populations and economic activity are actively seeking firms and new jobs. For example, Halifax County and South Boston, in the southeastern portion of the state, offer a joint enterprise zone with an ordinance exempting certified pollution control facilities and equipment from real and personal property taxes. Control of out-migration in negative growth regions may be an even more difficult task than control and management of in-migration in rapidly growing regions. Areas in decline are generally non-metropolitan[1] and are, or have been, dependent upon just a few major industries. For example, Buchanan County, in the southwest is heavily dependent upon the coal mining industry. In 1980, 5,397 people were employed in mining jobs, or about 14 percent of the county labor force. By 1989, only 3,871 workers remained (representing a 28 percent decrease) in the industry, with an associated loss in population of 6,656 persons. Maintenance of populations in such areas will require diversification and development of new firms or growth in existing ones. If appropriate action is not taken, continued out-migration and population decline may be inevitable.

[1] Metropolitan is defined as one or more entire counties having a city or population cluster of 50,000 people or more and a total metropolitan area population of at least 100,000.

Given the myriad of factors influencing growth, sound local planning requires an understanding of recent growth trends and the factors that influence them. The body of knowledge concerning growth and factors affecting growth in Virginia is small. Present decision-makers must rely primarily on the conventional wisdom of curtailing rapid growth through zoning, and of fostering growth through pursuit of industry, or "smokestack chasing". To help officials better decide where to focus their development resources, this study seeks to examine this conventional wisdom and clarify the problem of growth management by demonstrating which factors have the greatest influence on growth.

1.2 Objectives

The purpose of this thesis is to identify and analyze key components of recent population growth across the state of Virginia. The specific objectives are to:

1. Develop a conceptual framework to better understand population and employment growth within the state of Virginia.
2. Specify an empirical model that identifies the most important factors influencing growth in Virginia.
3. Estimate the empirical model with county level data for Virginia.
4. Interpret these results in such a way as to make them understandable and useful to planners and other officials.

1.3 Methods and Data

An empirical model is specified as a system of two simultaneous equations that will measure the effects of employment growth (in entirety and by sector groups) and migration (in entirety and by age cohort groups) upon one another, and how each is affected by other exogenous factors. This system will be estimated using the two-stage least squares (TSLS) method. This portion of the model follows directly from that

developed by Steinnes and Fisher (1974), as modified by Carlino and Mills (1987), and Clark and Murphy (1996). Separate equations for births and deaths will be estimated by the ordinary least squares (OLS) method. Parameter estimates from these two regressions will measure the effects of various exogenous factors on births and deaths. Data measuring net changes over two periods, 1975 to 1980, and 1985 to 1990[2] are used for migration, employment growth, births, and deaths. Data measuring exogenous factors is obtained for years at the beginning (or as close to the beginning as possible) of the 1975 to 1980 and 1985 to 1990 periods.

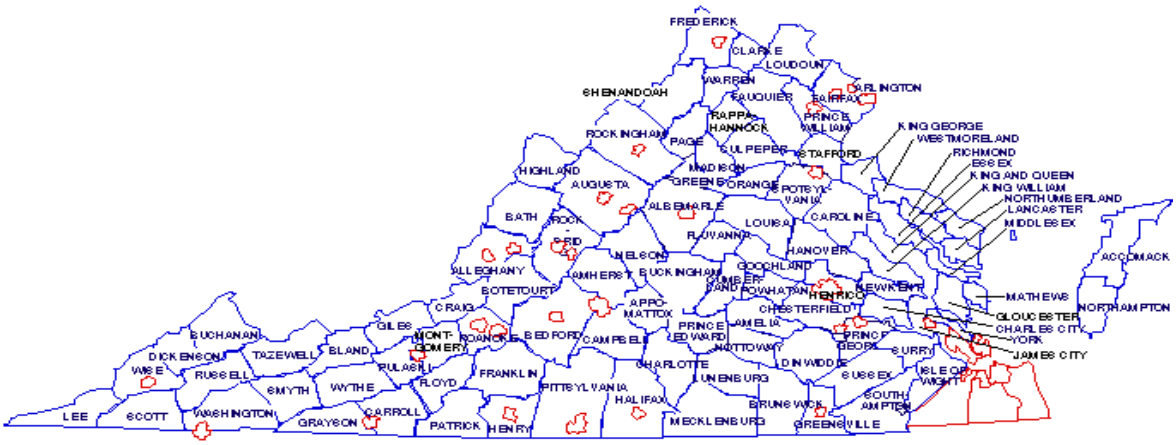
1.4 Organization of the Thesis

The thesis is organized as follows. The next chapter outlines basic issues of growth within the state of Virginia in recent years, and highlights both population and employment trends within the state during the two study periods, 1975 to 1980, and 1985 to 1990. Correlation coefficients for migration (the primary factor in population growth) and employment growth are also presented. Chapter three outlines important concepts of interregional development and includes a literature review of previous studies addressing key growth issues. This chapter constructs the framework of the theoretical model used within. Chapter four contains the empirical specification of the model, and includes information on data sources and relevant data statistics. Chapter five summarizes the results of the empirical model, and chapter six contains discussion of these results and conclusions as to their relevance.

[2] Migration data for 1975 to 1980 and 1985 to 1990 is from the U.S. Census. Therefore, data for the 1990's will not be available until after the 2000 census.

Figure 1-1: Map of Virginia Counties

Virginia's Counties



NOTE: Virginia cities are outlined in red.

Source: Weldon Cooper Center for Public Service, University of Virginia

Chapter 2: Components of County Growth in Virginia

2.1 Chapter Overview

This chapter highlights some general trends in both population growth and employment growth for the period 1985 to 1990, with comparisons to the earlier period, 1975 to 1980. As stated, net population change is the sum of in-migration minus out-migration plus births minus deaths. Subtracting out-migrants from in-migrants yields the total net migration growth or decline for a county or city. Subtracting total deaths from total births yields net natural increases. Average annual rates of total population growth, as well as rates of both migration and natural growth are discussed in Section 2.2. Since jobs are usually an important influence on migration, rates of employment growth are discussed in Section 2.3. The strong relationship between migration and employment growth is explored with correlation coefficient estimates for net migration and net employment growth in Section 2.4. Correlation coefficients are presented for various combinations of age cohort migration and growth of employment sector groups, as well as for overall migration and employment growth.

2.2 Population Trends in Virginia

The wide variations in growth across Virginia become evident as population growth and its major components are examined in this sub-section. Of Virginia's 95 counties, 24 experienced negative rates of overall population growth from 1985 to 1990. Thirty-two counties experienced losses due to net migration, while only 11 had negative rates of natural growth. The greatest negative rates of population growth (see Figure 2-1) were for Highland and Buchanan counties, along the West Virginia border. Migratory decline (see Figure 2-2) was most severe in Buchanan and Wise counties, while natural growth (see Figure 2-3) was lowest in Northumberland and Mathews counties, located along the Chesapeake Bay. The highest rates of overall population growth (Figure 2-1) from 1985 to 1990 were for Spotsylvania and Stafford counties, both located between Washington, D.C. and Richmond along the Interstate 95 corridor. These counties also

experienced the highest rates of migration (see Figure 2-2). Natural growth rates (see Figure 2-3) were highest in Loudoun and Prince William counties in the Washington D.C. metropolitan fringe.

From 1985 to 1990, population growth in incorporated cities (not under county jurisdiction in Virginia) was more variable, but generally more sluggish than for Virginia's counties. Seven of the ten slowest (or negative) population growth jurisdictions analyzed (see Table 2-1) were independent incorporated cities. These ranged from small cities such as Bedford (- 6.8 percent) and Lexington (- 5.2 percent) in the southwest, to larger cities such as Richmond (- 1.7 percent). Of the ten fastest growing jurisdictions (see Table 2-2), only three were independent cities, of which two were university cities (Harrisonburg and Radford). Among cities in decline, smaller cities such as Bedford and Lexington generally experienced declines in both natural and migration growth, while larger cities, such as Richmond, experienced net migration losses but net natural population growth.[3]

Population growth during 1975 to 1980 exhibited similar trends, further demonstrating a pattern of rapid growth in the northern Virginia (NOVA) to suburban Richmond areas, with much slower growth elsewhere. Comparison of Figure 2-2 and Figure 2-3 reveals that interregional variability in net migration is significantly greater than for natural increase. This high degree of variability indicates that migration has been the key factor driving differential rates of overall growth in Virginia during recent years.

2.3 Employment Growth Trends

Examination of employment growth trends across Virginia reveals a pattern of differential growth that is similar to that just described for population growth. Average annual rates of job growth for the period 1985 to 1990 varied from a low of –5.9 percent in Bath County (in the west), to a high of 10.9 percent in Loudoun County. Only 16 of

the counties and cities (or county - city combinations) analyzed[4] experienced negative rates of job growth for the period. Six of the ten slowest employment growth counties (Figure 2-4) were located in the southwestern portion of the state. Four of the top ten fastest job growth counties were in the NOVA or northern piedmont regions, while five were located in the Richmond vicinity. These results indicate a pattern of job growth very similar to that of migration, with very strong growth along the Interstate 95 corridor from the NOVA to Richmond region, surrounded by much slower growth in the rest of the state. As sown in Figure 2-5, this pattern became stronger over time, with a greater disparity between county growth from the 1975 to 1980 to the 1985 to 1990 periods.

Net growth of employment sectors [5] statewide indicates that job growth was concentrated in the trade – service and construction, manufacturing, and trade (CMT) sectors. During the 1985 to 1990 period, these sectors accounted for 355,249 and 81,525 new jobs, respectively (see Figure 2-5). The government sector underwent much slower employment growth during the same period, while jobs were lost in the agricultural sector. Figures for the 1975 to 1980 period exhibit a similar concentration of employment growth in the trade - service and CMT sectors.

Examination of overall employment growth statewide reveals that employment growth has been driven primarily by growth in the CMT and trade-service sector groups in recent years. Further, employment growth trends exhibit a pattern very similar to that of migration and overall population growth for the 1985 to 1990 and 1975 to 1980 periods. To better demonstrate these findings, correlation coefficients for employment growth and net migration for 1985 to 1990 and 1975 to 1980 are presented in the following subsection.

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[3] Rates of natural population growth were generally highest in areas with a younger age structure, and…

[4] Because of Virginia's unusual autonomous status for independent cities, some data sets, such as REIS employment figures, are reported for counties, cities, and county – city combined units. Other data, such as migration files, are tabulated for all political units separately. Since it is impossible to separate counties from cities for data which is reported in county–city combinations, all data was aggregated to match these combinations. The result is 105 combined units for the state.

2.4 Correlation Between Employment Growth and Net Migration

Job growth and migration trends are strongly interrelated in Virginia, as evidenced by the high level of correlation between net employment growth and net migration. Table 2-1 reveals that migration of 20 to 39 year-olds [6] and total employment growth were very highly correlated for the 1985 to 1990 period, with a correlation coefficient of .905 (1.0 representing perfect positive correlation). Migration of 40 to 59 year-olds was also strongly correlated with total employment growth, with a coefficient of .736. Correlation coefficients for sector specific employment growth and net migration of age cohorts suggest that migration is most strongly linked with the CMT and trade - service sectors (see Table 2-3). Lower correlation coefficient values for the agricultural and government sectors indicate a weaker relationship between employment growth and migration. Since employment growth in the agricultural sector was generally negative for the 1985 to 1990 period, the weak positive correlation values suggest that observed employment losses in the sector were associated with out-migration. Correlation between employment growth and migration was weaker for all sector and age groups during the 1975 to 1980 period. High correlation is evident for migration of the 20 to 39 - year old age group with employment growth in both the CMT and trade - service sectors, although all other reported coefficients are low for the 1975 to 1980 period.

2.5 Chapter Summary

The trends exhibited in this chapter suggest that migration of young, economically active individuals is very closely associated with employment opportunities and that this association has increased over time. Migration of older individuals is also associated with employment opportunities, but not as strongly as for younger age groups. Higher correlation coefficients for migration and growth in the CMT and trade-service employment sectors suggest that growth in these sectors is more closely associated with

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[5] Sector groupings are as follows: Agricultural = farm employment + ag. services & forestry + mining; CMT= construction + manufacturing + transportation; Trade - Services = wholesale trade + retail trade + finance & insurance + services; and Government

migration than is growth in the agriculture and government sectors. While demonstrating general trends in migration and employment growth, as well as their strong correlation, this chapter has not answered the fundamental question of which factors are most strongly influencing these trends. To begin formulating answers to this question, the next chapter completes the theoretical framework underpinning the empirical model used in this thesis.

[6] Correlation was analyzed for age categories 20 to 39 and 40 to 59, a more condensed grouping of age cohorts than will be used for later analysis.

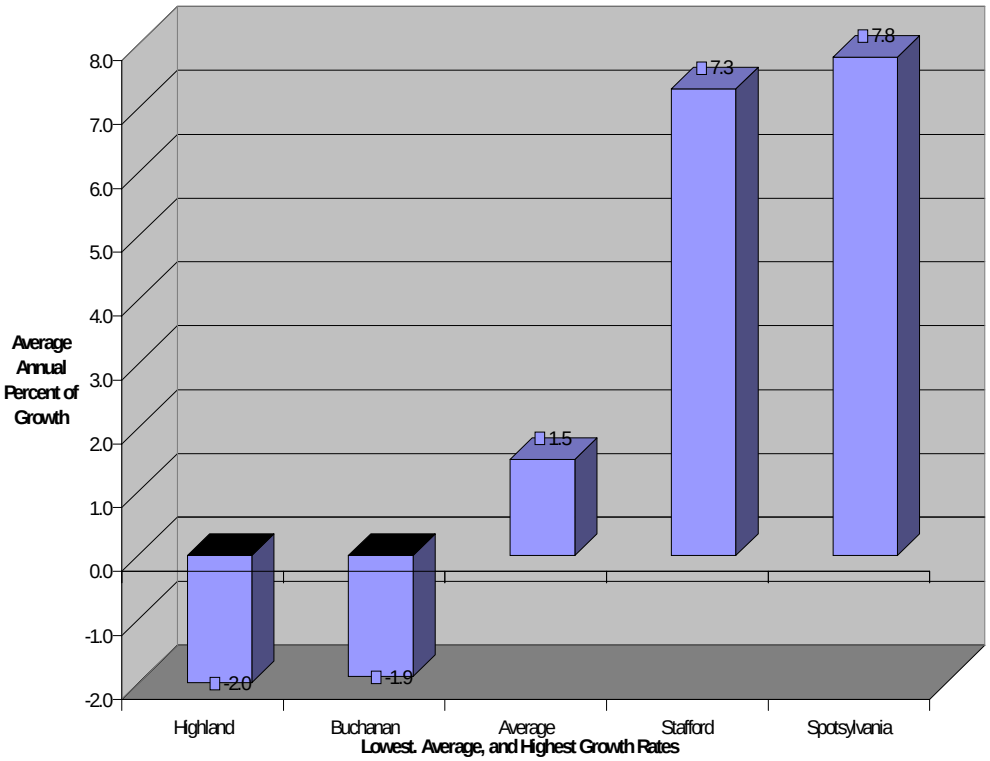

Figure 2-1: Virginia Overall Growth by County, 1985 to 1990

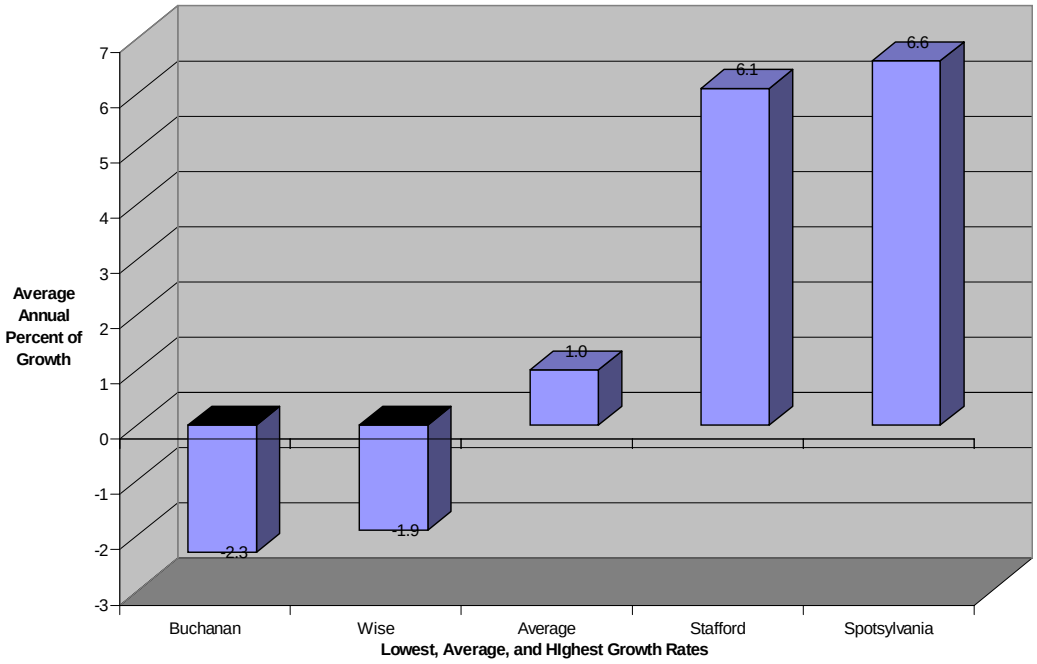

Figure 2-2: Virginia Migration Growth by County, 1985 to 1990

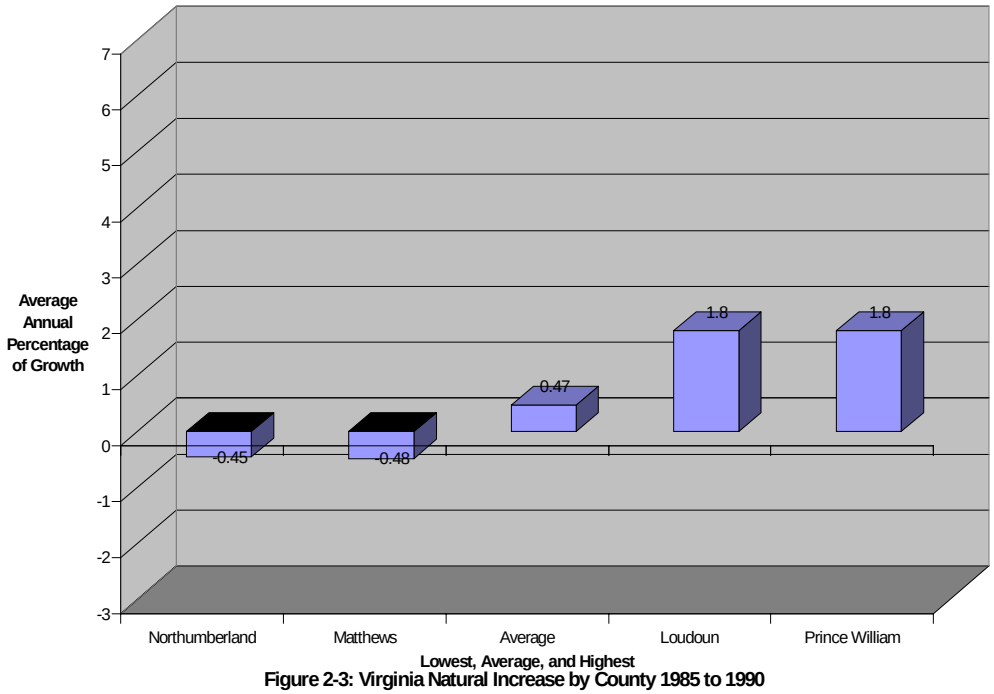

Figure 2-3: Virginia Natural Increase by County 1985 to 1990

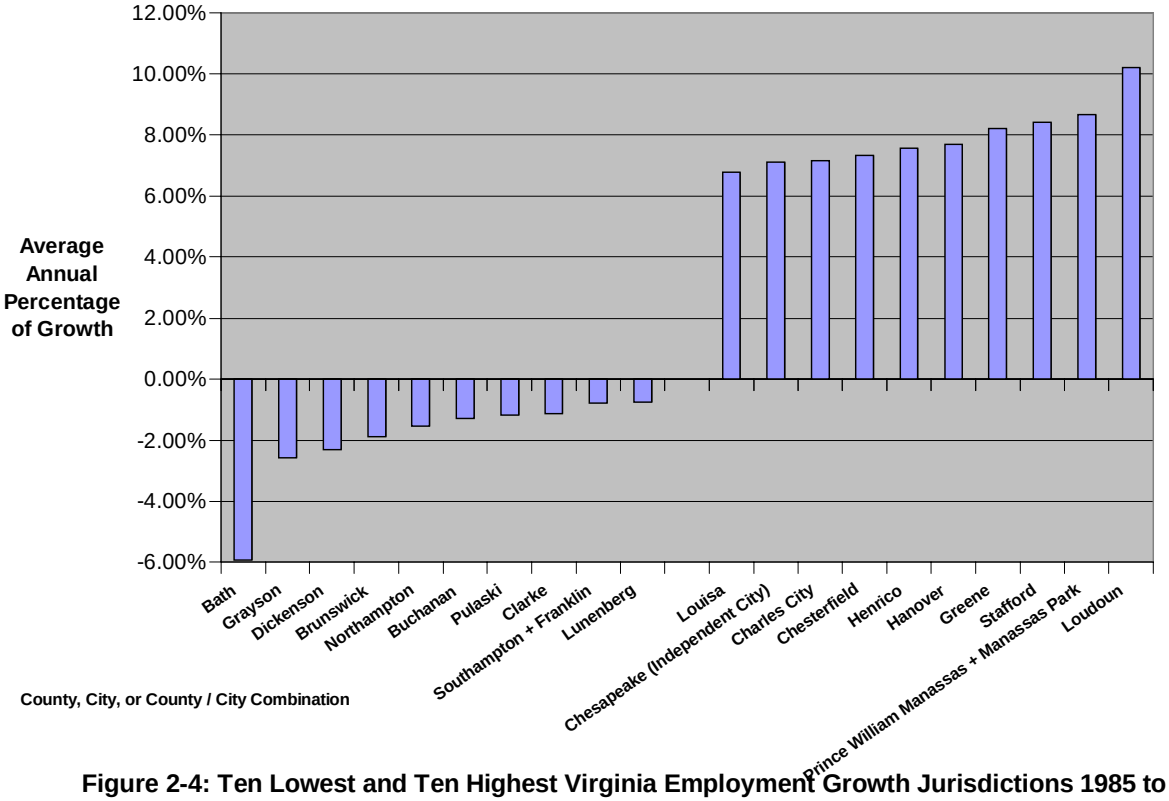

Figure 2-4: Ten Lowest and Ten Highest Virginia Employment Growth Jurisdictions 1985 to 1990

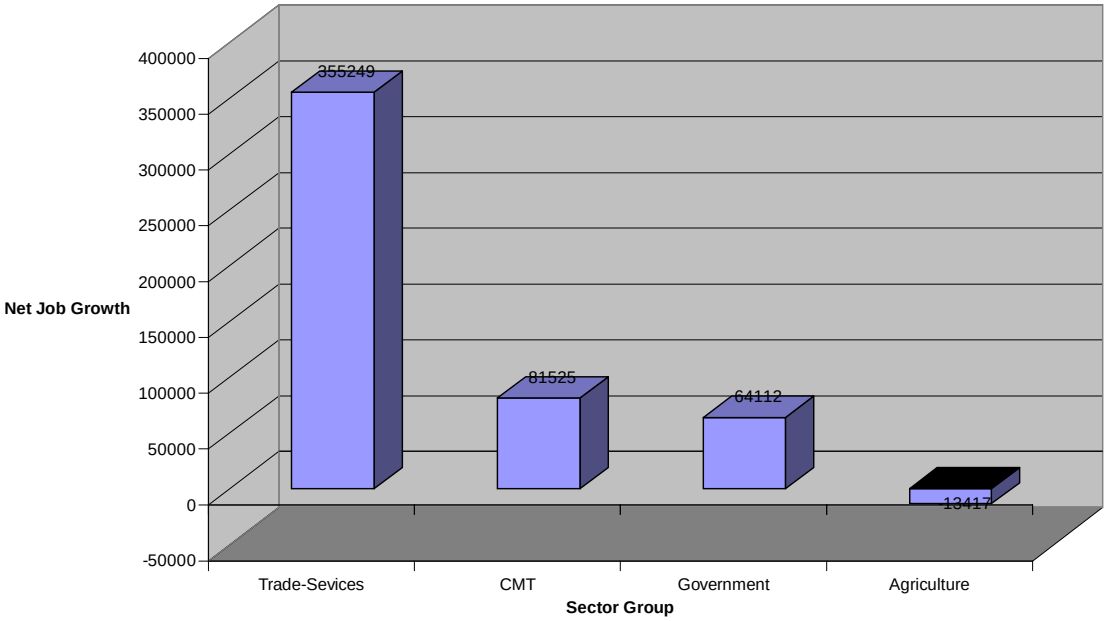

Figure 2-5: Overall Statewide Job Growth by Sector Group,1985 to 1990

Table 2-1: Cities and Counties with Slowest Population Growth, 1985 to 1990.

City/County	Population Growth Rate
	%
Colonial Heights City	-7.46
Bedford City	-6.79
Alexandria City	-6.74
Lexington City	-5.19
York	-3.87
Clifton Forge City	-3.12
Norton City	-2.99
Highland	-2.01
Buchanan	-1.85
Richmond City	-1.71

Table 2-2: Cities and Counties with Fastest Population Growth, 1985 to 1990

City/County	Population Growth Rate
	%
Harrisonburg City	9.85
Radford City	8.78
Spotsylvania	7.76
Stafford	7.25
James City County	6.66
Chesterfield	5.95
Fairfax City	5.66
Powhatan	5.29
Loudoun	5.06
Bedford County	4.91

Table 2-3: Correlation coefficients between migration of age cohorts and employment sector growth, 1985 – 90 and 1975 – 80, State of Virginia.

Employment Sector		Agricultural / Mining	Construction / Manufacturing	Trade & Services	Government	Total
1985 – 1990	Age 20 –39	.637	.802	.857	.575	.905
	Age 40 – 59	.482	.706	.713	.456	.736
1975 – 1980	Age 20 – 39	.271	.587	.784	.004	.735
	Age 40 – 59	.146	.319	.452	-.169	.400

Chapter 3: Theoretical Concepts and Background of Model

3.1 Chapter Overview

Chapter two presented general trends in growth throughout Virginia during recent decades. This chapter completes the development of a conceptual framework for understanding growth throughout the state (and in general). The chapter begins by outlining two major theories of interregional development in Section 3.2, and then presents a regional labor market model that explains labor and capital flows between regions in Section 3.3. Following the presentation of the labor market model, Sections 3.4 and 3.5 detail two important models of interregional population and employment growth; Steinnes and Fisher (1974) and Carlino and Mills (1987). These studies provide the cornerstone for the empirical model developed in this thesis, and are discussed in detail, along with a brief discussion of several other papers relevant to this thesis. Section 3.6 synthesizes the empirical results of the studies described in Sections 3.4 and 3.5.

3.2 Theories of Interregional Development

One of the most widely heralded theories of interregional economic growth is neo-classical convergence. As summarized by Richardson (1985), convergence theory holds that wealthy and poor areas will, over time, converge toward a state of equal affluence. High amounts of capital investment in a wealthy region (Region 1) lead to a rising marginal product of labor, providing upward pressure on wage rates. To reduce costs, producers may direct investment for production away from Region 1 into a poorer, lower wage area (Region 2). The outflow of investment from Region 1 may cause wages to fall as the marginal product of labor decreases. Simultaneously, new investment causes upward pressure on wages in Region 2.

Labor market adjustments bolster this convergence. As workers seek to maximize their utility by moving from lower to higher wage areas, the reduced supply of workers in the lower wage area (Region 2) provides further upward pressure on wages, while increased supply of workers produces downward pressure on wages in the high wage region (Region 1). This process continues as any region that experiences economic gains sees higher wages and outflow of investment, and any region that lags behind can provide lower wages as an inducement to investment. The result is that economies of poorer regions (such as Region 2) will tend to grow at a faster rate than economies of wealthier regions (such as Region 1). Adjustments will eventually lead to equal wages for workers and equal factor returns for producers throughout the entire system.

The neo-classical theory of convergence includes many assumptions about regional dynamics and economic activity. Primary amongst these assumptions is constant returns to scale. Many writers, including Marshal (1920) and Krugman (1991) have described the agglomeration process, in which returns to scale in production increase as populations become larger and economic activity more concentrated within an area. Due to agglomeration, some regions gain an initial economic advantage over others, which tends to perpetuate into long-term inequality. Such inequality has been manifest throughout the development process in the Untied States, as exemplified by the urban-rural prosperity gap of the twentieth century and the perpetuation of industrial concentration in the northeast corridor and rust belt.

Agglomeration and chronic regional inequity are explained by the cumulative causation theory of regional development, first proposed by Myrdal (1957). According to cumulative causation, interregional economic disparity may lead to a situation of either downward or upward spiraling of growth. For example, a shortage of workers in one region may cause wages to rise. Rising wages lead to in-migration and increased in-commuting, creating greater regional demand for goods and services. Producers seek to capitalize on this increased demand by channeling investment into the region and increasing production. For the producer, the potential to capitalize on increased local

demand outweighs the extra cost of paying workers higher wages. More production in turn creates more jobs, and greater upward pressure on wages.

The upward spiral just described may contribute to a downward spiral in another region or regions. The interregional dynamics of growth are described by cumulative causation as spillover and backwash effects. Spillovers are positive effects experienced by regions outside of other rapidly growing regions. Spillovers are often greatest in adjacent regions where workers may commute directly to a neighboring high-growth area. The commuters' region of residence will benefit as increased income spills over in the form of spending. Production in these adjacent areas will also benefit as goods and services produced within the region may be traded to the nearby high growth region, or consumed in greater quantity within the home region by out-commuters. More distant regions may also benefit from spillovers if they are able to produce goods or components of goods for shipment to the high growth region. Backwash effects are negative effects experienced by areas as investment and workers are siphoned out to other areas of high growth. Often, a distinct age-cohort pattern develops in which younger workers with fewer children (generally the most mobile individuals) leave areas of decline, leaving behind a population containing high percentages of older people and children.

Convergence and cumulative causation theories suggest very different patterns of spatial growth. Although the cumulative causation approach explains many observed trends, such as the persistent urban-rural gap, many examples of convergence are evident. Primary amongst these is the rise of economic fortunes in the sun-belt states in recent decades, and the simultaneous decline (or slow growth) in areas of the rustbelt and northeast. Chapter two illustrated that while convergence may be occurring within certain regions of Virginia (between the inner and outer fringe counties of the NOVA region, for example), growth at the statewide level shows interregional patterns of downward and upward spiral. By taking an empirical look at growth in Virginia, the results of this thesis will clarify and explain patterns of growth in Virginia during recent decades, and provide evidence for either convergence or agglomeration.

3.3 A General Theoretical Model

This section presents a generalized regional labor market model in which supply of and demand for labor determine levels of employment. As shown in Figure 3-1, workers provide labor supply, while producers create labor demand. Supply of and demand for labor lead to employment. An imbalance between the supply of and demand for labor results in either unemployment or vacancies, which in turn provide pressure on wages. Changes or interregional inequity in wages influence both workers and producers. Workers respond to wage pressure by commuting or interregional migration, while producers respond by reallocating investments throughout different regions. These responses then affect population and production levels. Corresponding effects upon labor supply and demand complete the cycle of Figure 3-1.

Interregional shifts in the supply of and demand for labor affect the overall economy of a given region. Wages tend to rise when labor demand exceeds supply (vacancies), and fall when supply exceeds demand (unemployment). Regional levels of commuting and migration will adjust accordingly (rising in areas of higher vacancies, and falling in areas of higher unemployment) with varying effects on different localities, as described in Section 3.2. Allocation of investment will also adjust to interregional changes in factor returns.

The model represented in Figure 3-1 is primarily driven by two factors, labor supply and labor demand. Labor supply is influenced by population levels (affected by natural increase as well as migration) while demand for labor is fueled by production (which is driven by capital investment). Labor supply and demand are also influenced by many exogenous factors. While it impossible to measure or observe labor supply and demand directly, two important adjustment mechanisms, employment growth and migration can be observed and measured. In the following chapters, an empirical model is specified and estimated that will measure which factors have had the greatest influence on employment growth, migration and natural increase in Virginia during recent decades. To complete the conceptual framework underpinning this model, the next section outlines

two keystone studies from which this thesis follows; Steinnes and Fisher (1974) and Carlino and Mills (1987).

3.4 Theoretical Background of Simultaneous Population-Employment Modeling

As suggested by the conceptual framework in Figure 3-1, early studies of migration and employment growth assumed employment growth to be an exogenous factor in determining migration and population levels [Alonso (1960), Muth (1961), Wingo (1961)].[7] Such works did not consider the reverse influence of population or migration upon job growth. In their study of the metropolitan Chicago area, Steinnes and Fisher (1974) were the first to introduce a theoretical and empirical model in which employment and population levels are simultaneously determined. In addition, cultural, economic, and social conditions and amenities were incorporated into the system of equations as exogenous variables. Population was decomposed into four types of workers, white blue-collar, black blue-collar, white white-collar, and black white collar, while employment was decomposed into two sector groups, manufacturing and non-manufacturing. The model specification assumed no competition between workers in the two separate sectors, and each population group had its own housing type and location. That is, the ethnic-class groups were non-competing for housing except within their own group. The separation of population and employment into groups allowed for separate estimation of systems for sector – group combinations. The model assumed that firms sought to maximize profits and residents maximized utility through strategic location within the broad study area.

The model starts by defining supply and demand functions for both labor and residences for a given zone (k):

[7] The theoretical basis of this assumption was rooted in export base theory, in which regional economic growth is driven by production of goods for export to other regions. A region that experiences increased demand for its exports will undergo employment growth. This employment growth will lead to increased in-migration, as individuals will tend to gravitate to areas of better employment opportunity.

$$(SF1) \qquad W_k = \lambda_k - \Omega E_k \qquad \text{(Demand for Labor)}$$
$$(SF2) \qquad w_k = \alpha_k + BE_k \qquad \text{(Supply of Labor)}$$
$$(SF3) \qquad P_k = \varepsilon_k + HR_k \qquad \text{(Supply of Residences)}$$
$$(SF4) \qquad p_k = \gamma_k - \Delta R_k \qquad \text{(Demand for Residences)}$$

where (SF1) and (SF2) are demand and supply of labor, respectively, and (SF3) and (SF4) are supply and demand of residences, respectively. In the demand for labor equation, W_k is the wage rate offered by employers. This wage rate is dependent upon E_k, the number of employees, Ω_k, the slope coefficient associated with E_k, and the intercept shift λ_k. In the supply of labor equation, w_k denotes "on location" asking wages, or the wages that would, under equation (SF2), be needed to induce workers to supply in the aggregate the employment in E_k (provided workers are locally available and zero commuting costs). This supply price for labor is also dependent on B_k, the slope coefficient of E_k (a different slope parameter than in SF1) and the intercept shift α_k. In the supply of residence equation, P_k, the price of residences, is dependent upon R_k, the number of residents, H_k, the slope coefficient of R_k, and ε_k, the intercept. p_k denotes "on-location" offering prices for residences, provided that residents were already in the area and had zero commuting costs to work. This offering price for residences is dependent upon the slope parameter Δ_k (a different slope parameter than in SF3), and the intercept shift γ_k. The four intercept shifts are defined as follows:

$$(SF5) \qquad \lambda_k = f(x_1, x_2, x_3, x_4, x_5, x_6) + e_1$$
$$(SF6) \qquad \alpha_k = c + e_2$$
$$(SF7) \qquad \varepsilon_k = f(x_7) + e_3$$
$$(SF8) \qquad \gamma_k = f(x_7, x_8, x_9, x_{10}, x_{11}, x_{12}, x_{13}, x_{14}) + e_4$$

where f denotes a linear function with constant terms, $e_1 - e_4$ denote random vectors with zero expectation, and x_1 through x_{14} are defined as follows:

x_1 = amount of land utilized in industrial employment.
x_2 = corporation tax rate in an area.
x_3 = dummy variable if area is in a trucking zone.

x_4 = number of acres of industrial parks in area.
x_5 = number of beds in state and federal hospitals.
x_6 = number of persons employed in exogenous activities.
x_7 = dummy variable if area is in a ghetto.
x_8 = number of college faculty employed in area.
x_9 = amount of land utilized for residential purposes.
x_{10} = median income or purchasing power.
x_{11} = number of park employees in an area.
x_{12} = dummy variable indicating presence of Lake Michigan water-frontage in an area.
x_{13} = dummy variable indicating if an area has mass transit.
x_{14} = property tax rate of an area.

The first shifter, λ_k , and therefore demand for labor (SF1), is dependent on four industrial amenity factors (x_1 through x_4) and two variables (x_5 and x_6) referred to as "proxies for the level of exogenous activities." These two proxies capture the effects of exogenous state and federal government spending on employment growth. The second shifter, α_k, which affects the supply of labor (SF2), is dependent upon c, a constant, meaning that the on-location asking wage of labor (for a specific area, *k*) is linearly dependent on the amount of labor offered, and not upon any other exogenous variables. The third shifter, ε_k, which effects supply of residences (SF3), is assumed to be dependent upon only one exogenous variable, the dummy ghetto variable (x_7), while the fourth shifter, γ_k, affecting the demand for residences, is dependent upon several cultural, social and natural amenities (x_8 through x_{11}).

A relationship is also derived for the costs of commuting from one area to another (*k* to *k*1). This derivation begins with the definition of the vector $x_{ikk1,}$ which represents the number of people of type i commuting from residences in area *k* to employment in another area *k*1. It is assumed that under an equilibrium scenario, there will be a flow of each worker type in only one direction between two areas. Total commuting costs of all persons is defined as:

$$(SF9) \qquad T_{kk1} = t_{kk1} x'_{kk1} x_{kk1} / 2$$

where t_{kk1} is a positive constant termed a "path resistance coefficient", measuring the marginal cost associated with heavier traffic and greater distance. Equation (SF9) establishes a quadratic relationship between commuting flows, meaning that costs rise exponentially, not linearly, as distance and numbers of commuters increases.

Under equilibrium, the marginal conditions are expressed by the following equations:

$$(SF10) \qquad (W_k - w_k) + (p_k - P_k) = 0$$

$$(SF11) \qquad (W_{k1} - w_{k1}) + (p_k - P_k) = t_{kk1} x_{kk1}$$

meaning that for any person living and working in the same area (SF10), any surplus wage (W_k - w_k) earned will be lost in surplus rent paid ($p_k - P_k$). For a person working in area k, but living in area $k1$, the surplus wage will be lost through surplus rent or commuting costs. Also, a "balancing condition" is specified which states that excess of residents over employees in a given zone must equal net commuting to other zones.

3.5 Empirical Background and Specification

Equations (*SF1*) through (*SF11*) are said to form a "structural model", meaning that they are based on fundamental economic relationships (supply and demand functions, in this case). Unfortunately, a model comprised of so many equations would be of little practical use, as estimation of parameters for x_1 through x_{14} would be impossible. However, by solving out the price and pair-wise flow variables, and making several theoretical assumptions, this structural model is then simplified into a "semi-structural model". In this "semi-structural model," employment and residential levels are approximated as functions of each other and the same range of exogenous variables specified in the structural model. To derive the semi-structural model, first define:

$$(SF12) \qquad a_k = \sum_{k1 \neq k} 1/t_{kk1}$$

referred to as a "point accessibility coefficient", measuring the accessibility of a given zone k to all other zones. Next define, for any variable y_k the potential value:

$$(SF13) \qquad \bar{y}_k = (1/a_k)\sum_{k1 \neq k} y_{k1}/t_{kk1}$$

meaning that the potential value of a variable for zone k is defined as a weighted average of its value for all other zones. These weights are inversely proportional to the path resistance's between zone k and all other zones.

Steinnes and Fisher (1974) continue by using equations (SF1) and (SF2), for the employment market of zone k, equations (SF3) and (SF4), the residence market equations for all other zones, and the marginal balance conditions to derive:

$$(SF14) \qquad E_k = F_k R_k - a_k F_k[-\bar{\gamma}_k + \bar{\varepsilon}_k - \lambda_k + \alpha_k + (\Delta + \mathrm{H})\bar{R}_k]$$

where F_k is an (N x N) matrix defined by:

$$(SF15) \qquad F_k = [I + a_k(\Omega + B)]^{-1}$$

Similarly, Using the residence market equations (SF3) and (SF4) for zone k, employment market conditions (SF1) and (SF2) for all other zones, and the balancing conditions, they derive:

$$(SF16) \qquad R_k = G_k E_k - a_k G_k[\bar{\lambda}_k - \bar{\alpha}_k + \gamma_k - \varepsilon_k - (\Omega + B)\bar{E}_k]$$

where G_k is an (N x N) matrix defined by:

$$(SF17) \qquad G_k = [I + a_k(\Delta + H)]^{-1}$$

Assuming that all the potential (those representing weighted averages of a variable for all zones, excluding the value for zone *k*) variables are predetermined, Equations (SF14) and (SF16) are said to comprise a "complete system in the endogenous variables". This system comprises 2N scalar equations in 2N endogenous variables for each zone *k* (N in this case equals eight, for each residential-employment sector combination). Since under equilibrium conditions, certain columns of F_k and G_k are approximately equal to one another, and certain columns of $(\Omega + B)$ and $(\Delta + H)$ are also approximately equal, the two equations (SF14) and (SF16) can then be reduced to a smaller system of approximate equations:

$$(SF18) \qquad E_k^{\ n} \approx f[R_k^{\ m}, (\lambda_k^{\ m} - \alpha_k^{\ m}), (\bar{\gamma}_k^{\ m} - \bar{\varepsilon}_k^{\ m}), \bar{R}_k^{\ m}, a_k]$$

$$(SF19) \qquad R_k^{\ m} \approx f[E_k^{\ n}, (\gamma_k^{\ n} - \varepsilon_k^{\ n}), (\bar{\lambda}_k^{\ n} - \bar{\alpha}_k^{\ n}), \bar{E}_k^{\ n}, a_k]$$

Where E_k^n and R_k^m denote, respectively, the (*n* x 1) and (*m* x 1) vectors obtained by summing elements within each of the *n* (or *m*) subsets of the (N x 1) vector E_k (or R_k).[8] In view of (SF5), (SF6), (SF7), and (SF8), (SF18) and (SF19) are rewritten as (subscript *k* omitted):

$$(SF20) \quad E^n \approx f(R^m, \bar{R}^m, x_1, x_2, x_3, x_4, x_5, x_6, \bar{x}_7, \bar{x}_8, \bar{x}_9, \bar{x}_{10}, \bar{x}_{11}, \bar{x}_{12}, \bar{x}_{13}, \bar{x}_{14}, a_k) + u_1$$

$$(SF21) \quad R^m \approx f(E^n, \bar{E}^n, \bar{x}_1, \bar{x}_2, \bar{x}_3, \bar{x}_4, \bar{x}_5, \bar{x}_6, x_7, x_8, x_9, x_{10}, x_{11}, x_{12}, x_{13}, x_{14}, a_k) + u_2$$

which are assumed to be linear functions. This assumption is made despite the presence of a_k which was presented in (SF19) and (SF20) as being non-linear. The assumption of linearity was made primarily to reduce costs in computation, which at the time were quite

[8] *n* and *m* represent the numbers of employment (two) and residential (four) categories, respectively.

high for non-linear estimation methods. Citing the nature of their study as “exploratory”, the authors felt that errors due to this assumption would be relatively small and insignificant. Equations (SF21) and (SF22) are referred to as "employment location" and "residential location" functions, respectively. Both equations are over-identified, as the potential variables in each are predetermined (x_7 through x_{14} in (SF21) and x_1 through x_6 in (SF22)) and are not estimated.

The theoretical and empirical model of Steinnes and Fisher (1974) was extended by Carlino and Mills (1987). Using county level data for the entire U.S., a simultaneous system was developed for both population and employment density. Beginning with an empirical model consisting of a pair of simultaneous equations following SF21 and SF22:

$$(CM1) \qquad E^* = A_E P + B_E S$$

$$(CM2) \qquad P^* = A_P E + B_P T$$

where E^* and P^* are equilibrium values of county employment and population, respectively, and S and T are vectors of exogenous variables affecting employment and population. A_E, and A_P, B_E, and B_P represent the coefficients of the exogenous and endogenous variables in the system.

Following the suggestion of Mills and Price (1984) that population and employment adjust to equilibrium values with substantial lags, a distributed lag adjustment is introduced:

$$(CM3) \qquad E = E_{-1} + \lambda_E (E^* - E_{-1})$$

$$(CM4) \qquad P = P_{-1} + \lambda_P (P^* - P_{-1})$$

where the subscript –1 refers to the variable lagged one period, and λ_E and λ_P are speed of adjustment coefficients (λ_E greater or equal to zero, λ_P less than or equal to one).

Substitution of (CM1) and (CM2) into (CM3) and (CM4), respectively, and rearrangement of terms gives:

$$(CM5) \qquad E = \lambda_E A_E P + \lambda_E B_E S + (1-\lambda_E)E_{-1}$$

$$(CM6) \qquad P = \lambda_P A_P E + \lambda_P B_P T + (1-\lambda_P)P_{-1}$$

which are "simultaneous equations in the observable endogenous variables *E* and *P*." Each equation depends upon the other endogenous variable, a set of exogenous variables, and on the lagged value of its own endogenous variable, which in this case is treated as exogenous. These theoretical equations are then empirically specified[9] as:

$$(CM7) \qquad P_i = A_o + A_1E_i + A_2P_{i-1} + A_3PB_i + A_4I_i + A_5T_i + A_6Y_i + A_7CR_i + A_8MS_i + A_9CC_i + \sum_{j=10}^{11} A_j NM_j + \sum_{j=12}^{19} A_j R_j$$

$$(CM8) \qquad E_i = B_o + B_1P_i + B_2E_{i-1} + B_3PB_i + B_4I_i + B_5Y_i + B_6U_i + B_7IDB_i + B_8CC_i + \sum_{j=9}^{10} B_j NM_j + \sum_{j=11}^{18} B_j R_j$$

where:

P_i = 1980 population density in county *i*;
E_i = 1979 total employment density in county *i*;
P_{i-1} = 1970 population density in county *i*;
E_{i-1} = 1969 total employment density in county *i*;
PB_i = percent black in *i* in 1970;
I_i = interstate highway density in *i* by 1982;
T_i = local government taxes per capita in *i* in 1972;
Y_i = median family income in *i* in 1970;
CR_i = crime rate per 100,000 people in *i* in 1975;
U_i = union membership as percentage of employees by state, 1970;
MS_i = median school years attained in *i* in 1970;
IRB_i = value of industrial revenue bonds issued through 1980 by state;
CC_i = center city dummy variable[10];
NM_j = two metropolitan-nonmetropolitan dummy variables[11];

[9] Descriptions and parameter estimates for all variables in this and other related studies are summarized in table xx.
[10] Assigned a value of one if county i contains a central city, zero otherwise.

R_j = eight regional dummy variables[12];

In equations (CM7) and (CM8), end-of-period values are used for the dependent variables to reduce simultaneity and direction of causation issues since end-of-period values do not affect the values for the independent variables at the beginning of each period. If beginning values had been used for the dependent variables, coefficients of the exogenous variables may have in part been measuring effects of the right-hand side endogenous variable.

A number of other studies have followed the Carlino and Mills (1987) approach. Clark and Murphy (1996) updated the Carlino and Mills (1987) study in another nationwide county level study. Although no significant changes were made to the basic model, a wider range of variables were incorporated (see Table 3-1). Henry, et al (1997) extended the Carlino and Mills model in studying Functional Economic Areas of South Carolina. In their study, the basic model was expanded to measure spillover and backwash effects between metropolitan and non-metropolitan areas. A matrix of variables representing combinations of each pair of places within the study region and the distance between them was introduced into the model, along with other modifications. Boarnet (1994) examined spatially lagged effects of employment and population on a city's own population and employment change. Since such measurements are not within the scope of this paper, the specification of the Boarnet (1994) and Henry, et al (1997) models will not be discussed in detail.

3.6 Results and Conclusions of Earlier Studies

The results of Steinnes and Fisher (along with those of Carlino and Mills (1987) and Clark and Murphy (1996)) are summarized in Table 3-1. Based on *t*-tests at the 95

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[11] The first of these is one if the county is adjacent to a metropolitan one. The second is one if the county is neither metropolitan nor adjacent. Metropolitan suburban counties are the base case.

[12] R_j = 1 if the county falls in the *j*th region, the *j* regions defined as New England, Middle Atlantic, East North Central, West North Central, East South Central, West South Central, Mountain, and Pacific. South Atlantic is the base case (R_j=0).

percent confidence interval, TSLS estimates[13] for the residence equations show a negative relationship between population density and nearness to ghetto areas for whites, and a positive relationship for black populations and ghetto proximity. High property taxes were positively associated with white population density and negatively associated with black population densities. Income and population density were negatively associated for some population groups, while no relationships between population density and most of the other variables were found.

The findings of Carlino and Mills (1987) differ significantly from those of Steinnes and Fisher (1974). While Steinnes and Fisher (1974) did not estimate the employment portion of their model, Carlino and Mills did, finding that employment growth was associated positively with inner city counties and predominantly black areas. This positive association may be due to lower operating costs in such areas, and argues in favor of convergence. Examination of employment and population trends at the national level revealed increasingly positive effects upon population and employment density of mild climates such as those found in the sun-belt states. Other key findings of Carlino and Mills (1987) were that public policy options, such as industrial revenue bonds and other government investment for business development had only a very slight relationship with either population or employment levels.

Clark and Murphy (1996) updated the Carlino and Mills (1987) study for the 1980s with an expanded list of exogenous variables. Also, employment was analyzed in terms of six separate sector groups. The findings of this study were generally in line with

[13] Steinnes and Fisher (1974) estimated the residential portion of their model (SF21) using both ordinary least squares (OLS) and two-stage least squares (TSLS). OLS is traditionally used to estimate parameters of single equations, whereas TSLS is used to estimate simultaneous systems of two or more equations. Such simultaneity occurs when the dependent variable of one equation is included as an independent variable of one or more other equations within the system. Classic examples of such simultaneity include amounts of money lent and interest rates for lending. Steinnes and Fisher (1974) were among the first to assert that such simultaneity existed between population and employment. The use of two separate estimation techniques was included to show that the traditional view (at the time) that employment was strictly an exogenous factor in determination of residential choice was incorrect. The authors asserted that higher significance levels of the employment variables for the OLS estimation as compared to those in the TSLS estimation were the result of biased OLS estimates. The conclusion that simultaneity exists and that TSLS is the proper and most efficient technique for estimation of population-employment models has become widely accepted.

those of Carlino and Mills (1987). Climatic amenities were found to be positively associated with both population and employment (throughout most sectors), while government spending was found to have little effect upon either equation. The results of Clark and Murphy (1996) indicated that the effects of population density on employment density were greater than the effects of employment density upon population density. These results raised serious questions regarding the pre-Steinnes and Fisher conventional wisdom that employment was an exogenous factor influencing population, and provided strong support for the simultaneity argument.

3.7 Chapter Summary

This chapter has outlined a basic residential and labor market model. Utilizing this framework, the concept of simultaneity between migration and employment growth has been formally introduced. From this introduction followed the presentation of the theoretical and empirical model of Steinnes and Fisher (1974), and the modifications of Carlino and Mills (1987). Results from these two studies reveal different findings. Due to limited computing capacity at the time, the empirical estimates of Steinnes and Fisher (1974) revealed nothing about the effects of exogenous factors upon employment growth. However, the framework that they established formally introduced the concept of simultaneity between population levels and employment levels, which was supported by comparisons of OLS versus TSLS model estimates.

With greater computing capability, Carlino and Mills (1987) included more variables and performed estimation of both the population and employment portions of their model. Their results suggested positive impacts of urban location for employment growth, little impact of government spending on overall growth, and distinct regional growth trends across the nation. In the following chapter, the empirical model used in this thesis is specified. This model follows directly from that used by Carlino and Mills (1987). Parameter estimates from this model will reveal which factors have had the greatest influence upon growth in Virginia during recent decades.

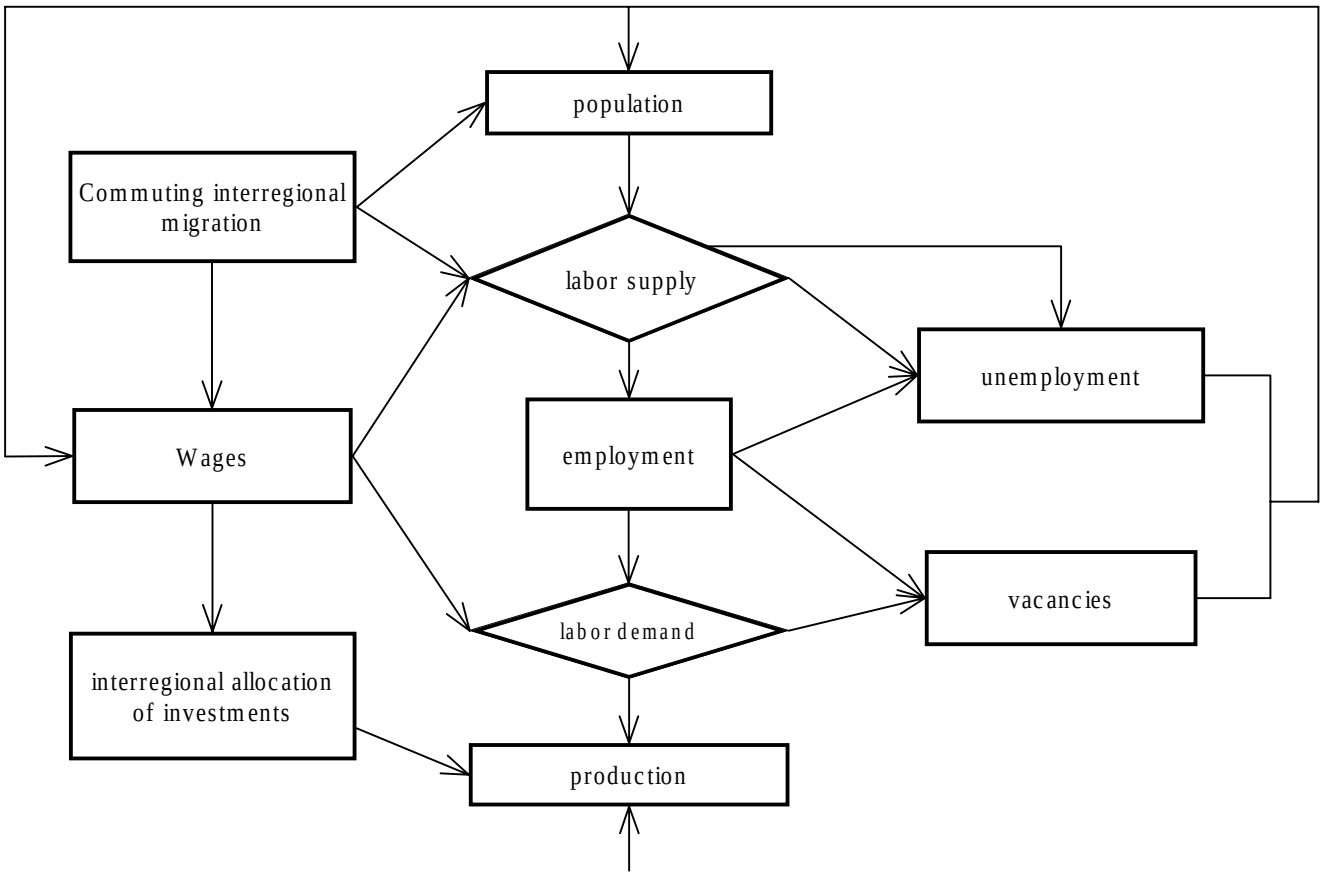

Figure 3-1: Flow Diagram of A Regional Labor Market Model.

Table 3-1: Summary of variables used in earlier studies.

Variable Description	***Steinnes & Fisher (1974)***		***Carlino & Mills (1987)***		***Clark & Murphy (1996)***	
	Population[14]	Employment	Population	Employment	Population	Employment
Constant			-0.4827E01 (-4.01)*	-0.5547E-01 (-4.44)+	-0.01639 (-0.66)	-0.08432 (-1.62)
Population Final				0.6194E-2 (3.55)*		0.09937 (2.63)*
Employment Final -Total	-0.03[15] (-0.26)		0.5916E-01 (21.32)*		0.11078 (1.53)	
-Manufacutring	0.17 (1.18)					
Population Initial			0.8398 (534.67)*		-0.03952 (-0.91)	
Employment Initial -Total	0.20 (0.18)			0.8690 (385.84)*		-0.09682 (-1.37)
-Manufacutring	0.86 (1.15)					
Federal Spending -Total						1.20E-06 (0.45)
-Defense						0.00018 (2.88)
Local Taxes -Total			-0.8036E-05 (-0.42)		1.68E-06 (0.64)	1.57E-05 (2.27)*
-Property	2293.0 (2.15)+				0.00011 (1.45)	0.00031 (3.78)*
Local Government Spending -Total					1.65E-06 (0.61)	5.42E-07 (0.14)
-Education					2.26E-05 (0.24)	1.85E-06 (0.02)
-Police					-3.48E-05 (-0.07)	0.00238 (3.10)*
-Highway					-0.00015 (-0.81)	-9.42E-05 (-0.55)
-Welfare					0.00028 (1.31)	0.00076 (1.46)
-Hospital					-8.04E-05 (-0.88)	-4.22E-06 (-0.05)
Educational Attainment -High School					0.00193 (2.76)*	
-College (4 Years +)	-19.6[16] (-2.27)*				0.00161 (2.27)*	
State Revenue Bonds				0.3244E-06 (0.09)		5.96E-12 (2.29)*
Income	-0.64 (-2.52)*		0.1351E-04 (10.42)*	0.8683E-05 (7.45)*	4.01E-06 (4.44)*	4.08E-06 (2.93)*
Hourly Wages						0.00201 (1.13)
Percent Black	-2285[17] (-3.55)*		-0.7095E-04 (-0.57)	0.7308E-04 (0.60)	-0.00024 (-3.53)*	-0.00029 (-3.26)*
Poverty Rate					-0.00001 (-0.06)	-0.00009 (-0.50)
Highway Density -North					-0.00072 (-0.67)	-0.00177 (-0.82)

[14] Steinnes and Fisher (1974) analysed four population groups, white and blue-collar whites, and white and blue-collar blacks. Only blue-collar whites are summarized here.

[15] Coefficient represents all employment other than manufacturing. Also, since only a single period is represented in this study, the final employment parameters represent employment potential, while the initial employmet parameters represent the actual employment numbers for the study time.

3 Parameter represents number of college faculty in area.

4 Parameter represents dummy ghetto variable, classification based on percentage of nonwhites in an area, or adjacency to such an area.

* Indicates significance of t-statistic at 95 % confidence interval.

-South				0.00986 (1.52)	0.02456 (2.26)*
-Total		0.2218 (5.50)*	0.2295 (6.1)*		
Union Percentage			-0.1485E-03 (-0.64)		-0.00024 (-1.25)
Central City Dummy		0.2953E-01 (4.67)*	0.4597E-01 (7.70)*	.006540 (0.87)	0.00090 (0.09)
Isolated Rural Dummy		-0.1559E-01 (-2.78)*	0.4648E-02 (0.89)	-0.01594 (-4.00)*	0.00866 (1.15)
Non-Isolated Rural Dummy		-0.2126E-01 (-3.96)*	0.4447E-04 (0.01)	-0.1442 (-3.63)*	0.00854 (1.04)
Coastal Dummy	700.0 (0.35)			0.01001 (2.08)*	
Crime Rate				-8.29E-05 (-0.76)	-0.00018 (-1.66)
Heating Degree Days				1.90E-06 (1.96)*	1.15E-07 (0.10)
Cooling Degree Days				3.22E-06 (1.28)	1.14E-06 (0.53)
Rainfall				7.83E-06 (0.06)	
Sunshine				0.00059 (3.23)*	
Temperature Variation				-0.00077 (-3.60)*	1.29E-05 (0.05)
Major League Sports				0.00439 (3.93)*	

Chapter 4: Empirical Specification and Data

4.1 Chapter Introduction

This chapter formally specifies the empirical model that will be used to estimate factors influencing migration and natural population growth in Virginia during the periods 1975 to 1980 and 1985 to 1990. In Section 4.2, a simultaneous system of equations is specified for migration and employment growth, while individual equations are specified for both births and deaths. Section 4.3 provides justification for the variables included in the specification. In Section 4.4, data sources and descriptive statistics are briefly discussed.

4.2 Empirical Specification

The empirical model for the migration and employment growth portions of this study follows directly from the theoretical and empirical specifications of Steinnes and Fisher (1974), as modified by Carlino and Mills (1987). It is specified as follows:

$$(1)\quad N_{ci} = \beta_0 + \beta_1 E_{si} + \beta_2 P_{(t-1)ci} + \beta_3 E_{(t-1)si} + \beta_4 PERCBLK_i + \beta_5 POPDEN_i + \beta_6 CRIMCAP_i + \beta_7 INCCAP_i + \beta_8 AMENITY_i + \beta_9 COMMUTE_i + \beta_{10} RETSALECAP_i + \beta_{11} PHYSCAP_i + \beta_{12} BEDSCAP_i + \beta_{13} SCHSPEND_i + \beta_{14} GOVSPEND_i + \beta_{15} INTERGOVREV_i + \beta_{16} PROPTAX_i + \beta_{17} HOMEPRIC_i + \beta_{18} UNEMP_i + \beta_{19} PERCPOV_i + \beta_{20} DUMMETRO_i + \beta_{21} DUMADJ_i + \varepsilon_1$$

$$(2)\quad E_{si} = \alpha_0 + \alpha_1 N_{ci} + \alpha_2 P_{(t-1)ci} + \alpha_3 E_{(t-1)si} + \alpha_4 PERCBLK_i + \alpha_5 POPDEN_i + \alpha_6 PERCCOLL_i + \alpha_7 INCCAP_i + \alpha_8 AMENITY_i + \alpha_9 COMMUTE_i + \alpha_{10} RETSALECAP_i + \alpha_{11} PHYSCAP_i + \alpha_{12} BEDSCAP_i + \alpha_{13} SCHSPEND_i + \alpha_{14} GOVSPEND_i + \alpha_{15} INTERGOVREV_i + \alpha_{16} PROPTAX_i + \alpha_{17} HOMEPRIC_i + \alpha_{18} UNEMP_i + \alpha_{19} PERPOV_i + \alpha_{20} DUMMETRO_i + \alpha_{21} DUMADJ_i + \varepsilon_2$$

where all variables are defined in Table 4-1. The variables N_{ci}, E_{si}, $P_{(t-1)ci}$, and $E_{(t-1)si}$ specified above represent categories of variables for net migration of age cohorts,

employment growth by sector groups, age cohort population at period beginning, and employment sector job numbers at period beginning, respectively. For all variables used herein, the subscript i refers to any one of the 105 counties, cities, or county-city combinations within the state of Virginia.[18]

Given the multiple numbers of age cohort and employment sector groups, it is necessary to analyze each age cohort group along with total employment change, and each employment sector group with total population. This results in 16 separate TSLS regressions; six for each age cohort group with total employment growth (three for each period, 1975 to 1980 and 1985 to 1990); eight regressions for total migration and sector employment growth (four for each period); and two for total migration and total employment growth (one each period). Each system is just identified, with the crime rate variable being unique to each migration equation, and the percent of population that has completed college unique to each employment growth equation.

The natural increase component of population growth is specified as follows:

$$B_i = \beta_0 + \beta_1 PERCFEM_i + \beta_2 PERCBLK_i + \beta_3 POPDEN_i + \beta_4 INCCAP_i + \beta_5 COMMUTE_i + \beta_6 PHYSCAP_i + \beta_7 SCHSPEND_i + \beta_8 UNEMP_i + \beta_9 PERCPOV_i + \varepsilon_3 \tag{3}$$

$$D_i = \beta_0 + \beta_1 PERCOLD_i + \beta_2 PERCBLK_i + \beta_3 POPDEN_i + \beta_4 INCCAP_i + \beta_5 COMMUTE_i + \beta_6 PHYSCAP_i + \beta_7 SCHSPEND_i + \beta_8 UNEMP_i + \beta_9 PERCPOV_i + \varepsilon_4 \tag{4}$$

where (3) and (4) are unrelated equations.

[18] Previous studies involving the simultaneous modeling of employment and population have used county level data across the nation (Carlino and Mills (1986), Clark and Murphy (1996)). In smaller scale studies, Steinnes and Fisher (1974) examined corporate suburbs and community areas of the Chicago region, while Henry, et al (1997) examined Functional Economic Areas (FEAs) within the state of South Carolina. In this study, county and city level data are used to analyze trends within the state of Virginia.

Statistical analysis for this study is conducted with MATLAB. The TSLS method is used for the migration-employment parts of the model for each of the 16 separate equation systems mentioned above. Equations (3) and (4), representing the components of natural growth are estimated separately using ordinary least squares (OLS). Parameter estimates and *t*-statistics are reported in a later section.

4.3 Variables Included

Migration Equations

In this study, migration is one of the left-hand side variables in the simultaneous system.[19] The inclusion of migration as such allows for more detailed analysis of population growth than in previous studies.[20] In the migration equation (1), N_{ci} represents the left hand side dependent variable, while the initial population levels ($P_{(t-1)ci}$) and initial employment levels ($E_{(t-1)si}$) are included as right hand side exogenous variables. Parameter estimates for initial population and employment are expected to be positive, as migration should tend to be higher into areas of higher initial population and employment (in cases of agglomeration). Employment growth (E_{si}), the other simultaneously determined variable, is a right-hand side variable in the migration equation. Given the strong correlation values between migration and employment growth discussed in

[19] Steinnes and Fisher (1974) used actual numbers of residents in determining hypothetical equilibrium populations, reporting the difference between hypothetical and actual numbers of people as residential potential. Carlino and Mills (1987) introduced the use of a lagged adjustment model in specifying population densities in terms of population density at an earlier period. More recent studies, such as Boarnet (1994), Clark and Murphy (1996) and Henry, et al (1997) have used overall population change (from time *t-1* to *t*) as the dependent variable in the population portion of their models.

[20] Separation of migration from natural increase allows for more detailed analysis of both processes. Also, the migration level approach will allow for examination of migration amongst different age cohorts. While many studies, such as Clark and Hunter (1992) have addressed age cohort migration in terms of economic and other conditions (within a non-simultaneous regression framework), such cohort differences have not been addressed in the simultaneous employment – population framework.

Chapter two, positive parameter estimates for this variable will indicate that employment growth was a major causal factor influencing migration.[21]

The percentage black, crimes per capita, property tax, unemployment rate and poverty variables[22] are all expected to have negative parameter estimates in the migration equations. The impact of large minority populations upon the location decisions of residents has been a major topic in regional development. This negative impact has been referred to as "white flight" from the inner cities, and is an important concept in the effort to revitalize urban centers with large minority populations.[23] Generally, urban centers tend to have higher rates of crime. The inclusion of the crime rate variable will measure migrant aversion to such areas. From an economic theory perspective, unemployment rate is generally a measure of oversupply of low-skill workers while high rates of poverty may be indicative of high unemployment and / or low wages for workers, both of which may result from an oversupply of labor. Negative signs for unemployment and poverty estimates should confirm migrant aversion to areas having an oversupply of labor.

The property tax parameter estimates will measure the relationship between migration and property taxes. While some migrants may be attracted to more exclusive areas with higher property taxes,[24] parameter estimates should generally be negative for this variable. As the primary source of school funding, some of the benefits of higher property taxes should be captured in positive estimates for school spending in the migration equations. Since such benefits should be greatest for the younger age cohorts, signs for property tax and school spending estimates should tend to be greater for younger groups and lower (or more negative) for older groups.

Other exogenous variables in the migration equation with expected positive parameter estimates are those representing natural amenities, percentage of commuting

[21] Viewed together, parameter estimates for this variable and the migration variable in the employment growth equations may indicate which factor has the greatest influence on overall growth.
[22] From hereon, subscripts are omitted when referring to the exogenous variables.
[23] Steinnes and Fisher (1974) obtained strong negative estimates for their ghetto variable for whites and strong positive estimates for blacks.

workers, retail sales per capita, physicians and hospital beds per capita, total government spending and intergovernmental revenue. Greater natural and medical amenities should have positive effects for all age groups, although these effects should be considerably greater for the 55 and older cohort. The commuter parameter estimate should be positive for the two younger age groups (these comprise the bulk of the working population) who should be attracted to areas that are close to major employment centers. Government spending, intergovernmental revenue and retail sales parameter estimates should be positive for all age groups. The two government spending parameter estimates should be more strongly positive for the older age cohort, which requires a greater level of government services.

No predictions are made for the signs of population density, income, home price, metropolitan dummy and metropolitan-adjacent dummy parameter estimates. As discussed in Chapter three, population density may have positive or negative effects upon migration. Income levels may have positive or negative effects on migration as well, with age specific variations. The effects of differential living costs will be reflected in the home price parameter estimate. The two dummy variables will measure the appeal of an area's spatial proximity to major population and employment centers.[25] The parameter estimates for the dummy variables will reveal migration trends throughout three different types of regions; counties within metropolitan areas, non-metropolitan counties that are adjacent to metropolitan areas, and non-metropolitan counties that are not adjacent to metropolitan areas. Such information will provide evidence for spillover or backwash effects between different regions, and will help to answer the greater question regarding agglomeration versus convergence type patterns of development in Virginia.

Employment Growth Equations

[24] As discussed in Chapter 3, Steinnes and Fisher (1974) did obtain positive estimates for their property tax variables for whites.

[25] The first dummy variable takes a value of either zero or one, based upon whether the county is metropolitan or non-metropolitan. The second takes a value of zero or one depending upon if the county is non-metropolitan and adjacent to a metropolitan area (metropolitan counties receive a value of zero).

The employment growth variable E_{si}, comprises the left hand side of the employment growth equation (2). The migration variable N_{ci}, is one of the right hand side variables. Given the strong correlation between migration and employment growth described in Chapter two, positive parameter estimates for this variable will indicate that migration was a major causal factor influencing employment growth. Initial population levels ($P_{(t-1)ci}$) and initial employment levels ($E_{(t-1)si}$) are included as exogenous variables (as in the migration equations). Parameter estimates for these variables are expected to be positive, as employment growth should tend to be higher in areas of higher initial population and employment.

The only exogenous variable that is predicted to have negative parameter estimates in the employment growth equations is property taxes.[26] Government spending and intergovernmental revenue are expected to have a positive influence on the employment equations, as governments (both local and at higher levels) often spend substantial amounts of money to lure and subsidize business development. Physicians and hospital beds per capita, natural amenities and home prices may have only slight effects (but should be positive) upon employment location.

No predictions are made about the influence of the other exogenous variables in the employment equations. The percentage black and poverty variables may have a negative influence on these equations (for reasons similar to those given for migration), but lack of precedence from earlier studies makes prediction difficult. Income per capita and unemployment estimates will indicate convergence or agglomeration (with positive income and negative unemployment estimates indicating agglomeration – negative income and positive unemployment estimates indicating convergence). School spending and percent of college graduates estimates will determine the level of importance that businesses place on the educational attainment of their workforce. As for migration, percent of commuters and the two metropolitan dummy estimates will indicate which

[26] Bartik (1985) found high tax rates to be moderately discouraging to new plant location (examining employment growth individually).

general types of areas were most desirable for employment growth during the periods 1975 to 1980 and 1985 to 1990.

Birth and Death Equations

Fewer Variables are used to estimate the births and deaths equations (equations (3) and (4), respectively). Many, such as those for government spending and property taxes are left out, as they should have little influence upon either births or deaths. Each equation does have one unique variable. Percent of population that is female and between the ages of 15 to 34 is unique to the birth equations, and should have positive parameter estimates. Percent of population aged 55 and older is unique to the death equations, and should have positive parameter estimates. The predicted signs for these variables is intuitive, as the largest group of child bearing people are young females, and mortality is highest amongst older individuals.

Percent of black population and poverty should be positively related with both births and deaths, as both fertility and death rates are generally thought to be greater among poor and minority populations. No predictions are made about the relationships of any of the other variables in (3) or (4) with either births or deaths.

4.4 Data and Descriptive Statistics

Data sources, descriptions, means, and standard deviations for all variables used in this study are summarized in Table 4-1. Net migration amongst age cohort groups for the two five-year periods are from the U.S. Census Bureau's County to County Migration Files, obtained via the Consortium for International Earth Science Information Network (CIESEN) internet site.[27] The files contain an entry for each county or city in the nation for which individuals falling into various age, race, social, and economic categories moved to or from in the five-year period preceding the U.S. Census. Subtracting out-migrants from in-migrants yields the total net migration growth or decline for the county

or city. For this study, reported migration for 18 different age categories was condensed into three categories:[28] young adult (15 to 34),[29] middle-aged (35 to 54), and mature adult (55 plus). Migration is not analyzed in terms of racial, social or economic categories in this study. Examination of data means for both 1975 to 1980 and 1985 to 1990 provide further evidence that migration is most prevalent among younger individuals (see Table 4-1).

Employment sector growth data are from the Regional Economic Information System (REIS) CD-rom published by the U.S. Department of Commerce. As for migration data, figures for the previously described set of employment sectors (agriculture-mining, construction, manufacturing, and transportation, trade-services, and government) were calculated from a much more complex classification of job types. Data means for these variables illustrate the general trends in employment sector growth outlined earlier, with the strongest growth in the trade - services and CMT sector groups (see Table 4-1).

Initial age cohort populations for 1980 and 1970, and initial sector employment levels for both 1985 and 1975 were obtained from the U.S. Census Bureau City and County Databook and the REIS CD-rom, respectively. These initial level variables are exogenous in the model. Amongst the many other exogenous variables used, the primary source for most was the U.S. Census Bureau City and County Databook. These are regularly published in both paper and electronic formats. Data for the earlier period were taken from the printed version of the 1972 book and the electronic version of the 1977 edition[30]. Data for the later period was obtained from the 1988 book on CD-rom. Data for all exogenous variables was obtained for the closest available years to 1985 and 1975. Some social statistics were only available for 1980 (1970), such as percent black and families below poverty level. Many of the available statistics on economic and fiscal activity were available only for the 1981 to 1982 (and 1971 to 1972) fiscal years.

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[27] http://infoserver.ciesen.org/datasets/us.demog/us-demog-home.html.
[28] Analysis has not been conducted for any migration of individuals aged 0 to 14.
[29] The young adult category begins at a younger age than would generally be considered adult. This categorization was necessary due to the grouping of 15 to19 year-olds in the data files.

4.5 Chapter Summary

This chapter has presented an empirical model that specifies migration, employment growth and the elements of natural population increase as variables that are dependent upon each other (for migration and employment growth) and a variety of other variables. Justification has been provided for the model variables, most of which are similar to those used in earlier related studies. For those variables unique to this study, explanation has been provided to justify their inclusion. Section 4.4 concluded with a brief description of data sources and some basic descriptive statistics that reinforce some of the trends presented in Chapter two. The model specified here will be estimated in the next chapter. The estimation results will help to determine, for the state of Virginia; the influence of migration and employment growth upon one another; the impacts of various exogenous factors upon both migration and employment growth; and the impacts of various exogenous factors on births and deaths.

[30] From the Inter-university Consortium for Political and Social Research (ICPSR) database.

Table 4-1: Variables, descriptions, and data sources.

Variable		*Data Type*	*Source*	*Data Mean 1975-80*	*Std. Deviation 1975-80*	*Data Mean 1985-90*	*Std. Deviation 1985-90*
N_{ci}	$YOUNGMIG_i$	net migration of 15-34 age cohort in county i	U.S. Census Bureau County to County Migration Files	1083	5259	2160	7610
	$MIDMIG_i$	Net migration of 35-54 age cohort in county i	U.S. Census Bureau County to County Migration Files	299	2859	780	4980
	$OLDMIG_i$	Net migration of 55+ age cohort in county i	U.S. Census Bureau County to County	55.9	969	110	980
E_{si}	$AGJOBSGRO_i$	Total employment change in agricultural sector in county i	U.S. Dept. of Commerce REIS CD	5.0	259	-60	390
	$CMTJOBSGRO_i$	Total employment change in constr./manuf. sector in county i	U.S. Dept. of Commerce REIS CD	829	1690	1020	2930
	$TSJOBSGRO_i$	Total employment change in trade/services sector in county i	U.S. Dept. of Commerce REIS CD	2071	5718	3080	9930
	$GOVJOBSGRO_i$	Total employment change in government sector in county i	U.S. Dept. of Commerce REIS CD	315	888	570	1460
$P_{(t-1)ci}$	$YOUNGPOP_i$	1985 (1975) population 15-34 age cohort in county i	U.S. Census Bureau 1990 (1980) Census	14254	22898	18710	29840
	$MIDPOP_i$	1985 (1975) population 34-54 age cohort in county i	U.S. Census Bureau 1990 (1980) Census	10275	16731	11510	19690
	$OLDPOP_i$	1985 (1975) population 55+ age cohort c in county i	U.S. Census Bureau 1990 (1980) Census	7130	8843	9470	11890
$E_{(t-1)ci}$	$AGJOBS_i$	1985 (1975) employment agricultural sector group in county i	U.S. Dept. of Commerce REIS CD	1165	1109	1250	1250
	$CMTJOBS_i$	1985 (1975) employment construction sector group in county i	U.S. Dept. of Commerce REIS CD	5934	8722	7930	1180
	$TSJOBS_i$	1985 (1975) employment trade & services sector group in county i	U.S. Dept. of Commerce REIS CD	9968	20683	14742	3369
	$GOVJOBS_i$	1985 (1975) employment government sector group in county i	U.S. Dept. of Commerce REIS CD	5978	14117	6190	15980
$AMENITY_i$[31]		natural amenities ranking in county i	ERS natural amenities scale	0.22	1.19	0.22	1.19
$INCCAP_i$		money income per capita ($) in county i in 1985 (1974)	U.S. Census Bureau City and County Databook (CD)	4917	1155	12360	2730

[31] Identical means and standard deviations for the natural amenity and metropolitan dummy variables are due to the use of identical figures for both time periods. The metropolitan codes were only available for 1983, so these figures were used for both periods. Although this could create some endogeneity problems for the analysis of the 1975 to 1980 time period, it is likely that there were few reclassifications of metropolitan / non-metropolitan counties from 1975 to 1983. No problems should arise from the use of natural amenities rankings from a single same year, natural amenities generally do not change over the course of a few years or decades.

$UNEMP_i$	Civilian unemployment rate in i 1985 (1975)	Counties USA CD	7.5	2.7	7.8	3.8
$COMMUTE_I$	Percent of out-commuting workers in i in 1980 (1970)	U.S. Census Bureau Journey to Work files from REIS CD & City and County Databook	38.6	31.2	43.4	42.1
$PROPTAX_i$	real property tax (effective rate per $100) in i in 1983 (1975)	Virginia Dept. of Taxation Annual Reports	0.58	0.30	0.58	0.28
$POPDEN_i$	Population density (persons per sq. mile) in i 1980 (1975)	U.S. Census Bureau City and County Databook (CD)	436	1313	440	1350
$CRIMCAP_i$	Crime rate per 100,000 people (serious crimes reported to police) in i in 1985 (1975)	U.S. Census Bureau City and County Databook (CD)	2515	1885	2384	1686
$PERCPOV_i$	Percent of families in poverty in i 1980 (1970)	U.S. Census Bureau City and County Databook (CD)	18.0	7.6	11.1	4.1
$PERCBLK_i$	Percent black in county i in 1980 (1970);	U.S. Census Bureau City and County Databook (CD)	23.3	18.5	21.7	17.5
$PHYSCAP_i$	Number of physicians per 100,000 people in i 1985 (1975)	U.S. Census Bureau City and County Databook (CD)	89.4	95.3	119	149
$BEDSCAP_i$	Number of hospital beds in i per 100,000 people 1985 (1975)	U.S. Census Bureau City and County Databook (CD)	464	881	415	562
$HOMEPRIC_i$	Median owner occupied home price (thousand $) in i in 1985 (1975);	U.S. Census Bureau City and County Databook (CD)	13.1	4.9	39.52	13.34
$PERCCOLL_i$	Percent of population 25 and older with 4 plus years of college in I	U.S. Census Bureau City and County Databook (CD)	7.4	5.1	12.0	7.3
$RETSALECAP_i$	Retail sales per capita in i 1982 (1972)	U.S. Census Bureau City and County Databook (CD)	1607	722	3340	1540
$INTERGOVREV_i$	Intergovernmetnal revenue (millions) to i in 1982 (1972)	U.S. Census Bureau City and County Databook (CD)	7.0	12.7	18.8	29.5
$SCHSPEND_i$	School expenditure ($) per pupil in i in 1982 (1972)	U.S. Census Bureau City and County Databook (CD)	799	206	2100	450
$GOVSPEND_i$	Direct general expenditure (millions) 1982 (1972) in i	U.S. Census Bureau City and County Databook (CD)	17.6	36.9	46.2	90.2
$DUMMETRO_i$	Metropolitan – non – metropolitan dummy variable. [32]	Rural-Urban Continuum Codes, Economic Research Service, U.S. Dept. of Agriculture	0.35	0.48	0.35	0.48
$DUMADJ_i$	Metropolitan-adjacency dummy variable	Rural-Urban Continuum Codes, ERS, U.S. Dept. of Agriculture	0.36	0.48	0.35	0.48
$PERCFEM_i$	Percent of population in i that is female and aged 15-34.	U.S. Census Bureau 1990 (1980) Census	14.67	2.31	23.88	4.51
$PERCOLD_i$	Percent of population in i aged 55 and older.	U.S. Census Bureau 1990 (1980) Census	19.59	4.78	21.67	5.08

[32] The first is one if the county is adjacent to a metropolitan county. The second is one if the county is neither metropolitan or adjacent to a metropolitan county.

Chapter 5: Results

5.1 Chapter Overview

This chapter presents the results of the sixteen migration-employment growth TSLS regressions and the four OLS regressions (two each) for births and deaths. Sections 5.2 through 5.9 present results for the eight separate age cohort migration – sector group employment growth regressions. The results are then discussed in Section 5.10, with emphasis on variables whose parameter estimates are consistently significant[33] across the various cohort-sector systems of regressions. Section 5.11 presents the birth and death regression results, which are discussed in Section 5.12. Section 5.13 summarizes the most important empirical findings.

5.2 Total Migration – Total Employment Growth Results

Parameter estimates and *t*-statistics for the total migration - total employment growth regression are reported in Table 5-1. Ten of 44 parameter estimates for the migration equations and three of the 44 estimates for the employment equations are significant based upon *t*-statistic values.[34] No significant relationships are found between migration and employment growth:

<u>Migration</u>

The results in Table 5-1 indicate that government spending was positively related with migration for both 1985 to 1990 and 1975 to 1980, whereas intergovernmental revenue was negatively related to migration from 1985 to 1990. No relationship can be established between intergovernmental revenue and migration for the 1975 to 1980

[33] Estimates with *t*-statistics greater than 1.96 or less than negative 1.96 are statistically significant at the five percent confidence level. All variables discussed in this chapter are significant at this level unless otherwise noted.

[34] There are a total of 88 parameter estimates (44 each for migration and employment growth), including the intercepts; 22 for each equation (both migration and employment growth, for each period, 1975 to 1980 and 1985 to 1990.

period. School spending and migration were negatively related for 1985 to 1990 (significant at the 10 percent level) and 1975 to 1980. Property taxes and migration were negatively related for the 1975 to 1980 period. Retail sales were positively related with migration, while crime rates were negatively related with migration for 1985 to 1990. Retail sales and crime parameter estimates were insignificant for the 1975 to 1980 period.

Employment Growth

Population density and school spending had strong negative relationships with employment growth for 1985 to 1990, with no measurable relationship for 1975 to 1980. The parameter estimate for initial population level indicates a slight positive relationship between initial populations and employment growth for 1975 to 1980.

5.3 Age 15 to 34 Migration – Total Employment Growth Results

Results for the migration of 15 to 34 year-olds - total employment growth regression are presented in Table 5-2. Two parameter estimates from the migration equations and four parameter estimates from the employment growth equations are significant for this system. No significant relationships are found between migration and employment growth:

Migration

No relationships between any of the exogenous variables and migration are apparent for 1985 to 1990. Income per capita and migration were positively related for 1975 to 1980.

Employment Growth

Employment growth was positively related with government spending but negatively related to amounts of intergovernmental revenue for 1985 to 1990. Parameter estimates indicate that neither of the government spending variables were related to employment growth for 1975 to 1980. Employment growth was positively related to beginning period employment levels for 1975 to 1980. A strong negative relationship is shown for school

spending and employment growth for both 1985 to 1990 (parameter estimate is significant at the 10 percent level) and 1975 to 1980.

5.4 Age 35 to 54 Migration – Total Employment Growth Results

Results for the migration of persons aged 35 to 54 - total employment growth regression are reported in Table 5-3. Four parameter estimates from the migration equations and two parameter estimates from the employment growth equations are significant for this system. No significant relationships are found between migration and employment growth:

Migration

The parameter estimate for the adjacent metropolitan dummy indicates a positive relationship with migration for 1985 to 1990, but no significant relationship for 1975 to 1980. Population density, intergovernmental revenue and number of physicians per capita were negatively related with migration for the 1975 to 1980 period. Population density was also negatively related with migration for the 1985 to 1990 period (the population density estimate is significant at the 10 percent level), indicating a consistent trend of high migration of the 35 to 54 age cohort to areas with low population density.

Employment Growth

Government spending was positively related with employment growth for 1985 to 1990. Employment levels at period beginning were positively related with employment growth, while property taxes were negatively related to employment growth for 1975 to 1980. No significant relationships between either initial employment levels or property taxes and employment growth are evident for 1985 to 1990.

5.5 Age 55 and Older Migration – Total Employment Growth Results

Results for the migration of persons aged 55 and older - total employment growth regression are reported in Table 5-4. Three parameter estimates from the migration equations and 11 parameter estimates from the employment growth equations are significant for this system. A positive relationship between migration of people aged 55 and older and employment growth is indicated for the 1975 to 1980 period (the parameter estimate for the OLDMIG variable in the employment equation is significant at the 10 percent level):

Migration

No relationships between any of the exogenous variables and migration were found for 1985 to 1990. Crime rates and intergovernmental revenue were positively associated with migration, while population density was negatively associated with migration for 1975 to 1980.

Employment Growth

Population (of 55 and older age cohort group) at period beginning was negatively associated with employment growth, while total employment levels at period beginning and government spending were positively associated with employment growth for 1985 to 1990. Total employment levels at period beginning were also positively associated with employment growth for 1975 to 1980. School spending and employment growth were negatively related for both 1985 to 1990 and 1975 to 1980. Property taxes and intergovernmental revenue were negatively related, while percentage of college graduates was positively related with employment growth for 1975 to 1980.

5.6 Total Migration – Agricultural Sector Employment Growth Results

Results for the total migration - agricultural sector group employment growth regression are reported in Table 5-5. Only one parameter estimate from the migration equations and two parameter estimates from the employment growth equations are

significant for this system. No significant relationships are found between migration and employment growth:

Migration

No relationships between any of the exogenous variables and migration were found for 1985 to 1990. Government spending was positively related to migration for 1975 to 1980.

Employment Growth

Population density and employment growth had a strong negative relationship for 1975 to 1980 and 1985 to 1990.

5.7 Total Migration – CMT Employment Growth Results

Table 5-6 presents results for the total migration - construction, manufacturing and transportation sector group employment growth regression. Two parameter estimates from the migration equations and two parameter estimates from the employment growth equations are significant for this system. No significant relationships are found between migration and employment growth:

Migration

Property taxes were positively related to migration for 1985 to 1990, but negatively related to migration for 1975 to 1980.

Employment Growth

Population density and employment growth had a strong negative relationship for both 1985 to 1990 and 1975 to 1980.

5.8 Total Migration – Government Employment Growth Results

Results for the total migration - government sector employment growth regression are reported in Table 5-7. One parameter estimate from the migration equations and three parameter estimates from the employment growth equations are significant for this system. No significant relationships are found between migration and employment growth:

Migration

No relationships between any of the exogenous variables and migration are found for 1985 to 1990 or 1975 to 1980.

Employment Growth

Population density and employment growth were negatively related for both 1985 to 1990 and 1975 to 1980. Government employment at period beginning and employment growth were positively related for the 1975 to 1980 period.

5.9 Total Migration – Trade and Services Employment Growth Results

Table 5-8 presents results for the total migration - trade and services sector group employment growth. Nine parameter estimates from the migration equations and five parameter estimates from the employment growth equations are significant for this system. Trade and services employment growth and migration were positively related for 1975 to 1980:

Migration

School spending and migration were negatively related for both 1985 to 1990 and 1975 to 1980 (the parameter estimate is significant at the 10 percent level for 1975 to 1980). Hospital beds per capita and migration were positively related, while intergovernmental revenue and migration were negatively related for the 1985 to 1990 period.

Intergovernmental revenue and migration were also negatively related for 1975 to 1980. Government spending and migration were positively related, while income and property taxes were negatively related with migration for 1975 to 1980.

Employment Growth

Population density and employment growth were negatively related for both 1985 to 1990 and 1975 to 1980. Government spending was negatively related with employment growth, while income was positively related with employment growth for 1975 to 1980.

In summary, the results just described for all eight migration – employment growth combinations reveal few relationships between the jointly determined variables (those for migration and employment growth), providing little evidence concerning the question of dominant causality between migration and employment growth. However, these results have revealed consistently significant relationships for population density, income, school spending, property taxes, government spending and intergovernmental revenue with migration and employment growth. Analysis of these relationships and their implications follows in the next section.

5.10 Discussion of Migration and Employment Growth Results

It is impossible to make conclusions regarding the dominant causality between employment growth and migration based on the parameter estimates presented in the previous section. These results differ significantly from those of Carlino and Mills (1987) whose population and employment estimates were significant at very high levels. Clark and Murphy (1996) had mixed results for their population and employment variable estimates, with only a few *t*-statistics indicating five-percent significance.

Migration

Table 5-9 provides a tabulation of significant parameter estimates for the initial population, initial employment, population density and income variables. As expected,

initial population levels had a positive relationship with migration (in two of the regressions) while initial employment levels had no measurable relationship with migration.

Regression estimates for population density indicate a negative relationship with migration of middle aged and older people for 1975 to 1980 that was not evident for the 1985 to 1990 period. Considering the positive relationship between initial population and migration, the negative relationship between population density and migration indicates stronger migration to areas of higher but diffuse population (such as metropolitan fringe counties) for the 1975 to 1980 period. While no relationships are noted for initial population levels or population density with migration for 1985 to 1990, the positive relationship between the adjacent metropolitan dummy and migration of 35 to 54 year-olds for 1985 to 1990 indicates a continued trend of strong migration to such areas.

Given that income was negatively related with overall migration in two of the 1975 to 1980 regressions, the positive relationship of income with migration of 15 to 34 year-olds (for 1975 to 1980) confirms that younger people were inclined to migrate in search of greater earnings opportunities.[35] These results also indicate that older migrants tended to avoid areas of higher income (usually meaning higher cost as well). An absence of significant relationships between income and migration indicate that these trends weakened by 1985 to 1990.

Significant parameter estimates for the government spending, intergovernmental revenue, school spending and property tax variables are tabulated in Table 5-10. The government spending and intergovernmental revenue results indicate that while overall government spending was conducive to migration (and / or that migration lead to increased costs for local governments), high intergovernmental revenue was not.[36] Since

[35] These findings agree with predictions and with the findings of Clark and Hunter (1992). Utilizing data from the early 1970s', Clark and Hunter studied migration individually, with employment growth as an exogenous factor. Their results indicated that economic opportunities were highly influential in the migration patterns of younger, working age males.

[36] These estimates could be measuring other factors associated with areas receiving large amounts of outside governmental aid, such as high levels of poverty.

these results are spread out temporally throughout the migration equations, no conclusions can made regarding trends among age cohort groups.

Although tax related variables in earlier studies have generally yielded estimates of low significance,[37] the negative relationship (indicated by three of four significant parameter estimates) between property taxes and migration was expected. Higher school spending (supposedly meaning better schools) was expected to have a positive effect for migrants. While this positive effect should have offset the negative effects of high taxes, the results indicate otherwise, with two negative and no positive relationships found between migration and school spending throughout all of the regressions. While it is unlikely that migrants have been avoiding areas because of higher school spending per se, these results indicate that the costs associated with higher school spending have had a much greater impact in the "bottom line" decision making of many.

Employment Growth

Significant parameter estimates for the initial population, initial employment, population density and income variables in the employment growth equations are summarized in Table 5-11. While initial population levels (at period beginning) had little impact on employment growth, five of the initial employment level (at period beginning) estimates indicated a positive relationship with employment growth (four of these were for the 1975 to 1980 period).[38] Surprisingly, population density was negatively related with employment growth in nine of the regressions.[39] Considering the positive initial employment estimates, these results indicate a pattern of employment growth very similar to that of migration, with strong growth in regions of high, but diffuse populations. The positive relationship between income and employment growth for the 1975 to 1980 total

[37] Property tax variable estimates from Steinnes and Fisher (1974) yielded positive estimates for whites and negative estimates for blacks.
[38] Most of the significant estimates for the initial employment level variables were from the age cohort - total employment regressions. An absence of trends in the total migration - sector group employment growth regressions makes it difficult to infer how initial employment levels affected sector specific growth.
[39] Clark and Murphy (1996) obtained several negative and estimates for population density, but these estimates were not as consistent or as proportionately strong as the population density estimates in this study.

migration – trade and services sector group regression indicates that growth in this sector was more strongly bolstered by high income levels than were other sectors. The estimate for the 1985 to 1990 period indicates that this relationship weakened over time.

Significant parameter estimates for the school spending, property tax, government spending and intergovernmental revenue variables in the employment growth equations are summarized in Table 5-12. Despite predictions that employers might desire the benefits of a more highly educated work force, and that this desire might counteract some of the negatives associated with higher taxes, employment growth was even more negatively related with school spending than with property taxes. While it is unlikely that employers were consciously rejecting areas due to higher school spending per se, the magnitude and consistency of the negative estimates for this variable indicate little or no attraction to areas of higher school spending.

Parameter estimates indicate relationships for government spending and intergovernmental revenue with employment growth that are similar to those with migration. Generally, government spending was positively related while intergovernmental revenue was negatively related with employment growth. It is difficult to determine if the positive relationship between government spending and employment growth was due to increased employment growth due to government spending, or if growth itself was creating the need for higher government spending. While the government spending and intergovernmental revenue relationships with migration weakened over time, the employment growth relationships became stronger between the 1975 to 1980 and 1985 to 1990 periods.

5.11 Birth and Death Results

Births

Results for the birth regressions are reported in Table 5-14. Surprisingly, no relationships between percentage of young females and births were evident. Population density and births were negatively related for both 1985 to 1990 and 1975 to 1980, while population at period beginning and births had a very strong positive relationship for 1985 to 1990 and 1975 to 1980. Physicians and births were negatively related, while crime and births were positively related for 1975 to 1980.

Deaths

Results for the death regressions are reported in Table 5-15. As predicted, percentage of older persons and crime were positively associated with deaths, while income was negatively related to deaths for both 1985 to 1990 and 1975 to 1980. Population density was positively related with deaths 1975 to 1980 period, but unrelated to deaths for 1985 to 1990. Strong positive relationships between population at period beginning and deaths are present for both periods.

5.12 Discussion of Births and Deaths Results

Births

The lack of a discernable relationship between percentage of young females and births is probably explained by the small variation in the percent of young females across the state (note the standard deviation for the PERCFEM variable in Table 4-1). The negative relationship for physicians and births and the positive relationship between crime and births during the 1975 to 1980 period indicate higher birth rates in areas associated with fewer medical services and higher crime. The negative relationship between population density and births is also surprising, as densely populated inner city areas are often assumed to have high birthrates. Considering the strong relationship between initial population and births, these results indicate that higher birth rates are most positively associated with areas of higher, but diffuse populations.

Deaths

As predicted, deaths were positively related with older populations and crime. Higher death rates may in part be due to crime itself, but are more likely the result of other social factors in areas of higher crime. The positive relationships between deaths and both population at period beginning and population density (for 1975 to 1980) indicate that death rates were greatest in densely populated (urban) areas, and lower in more diffusely populated areas.

5.13 Chapter Summary

The relationships between migration and employment growth described by the results presented in this chapter are not significant enough to provide evidence regarding the jobs – population causality question. However, several of the exogenous variables are shown to have had a significant influence on overall growth in Virginia.

Government spending was positively related, while intergovernmental revenue was negatively related with both migration and employment growth. Population density has had negative relationships with migration, employment growth and births, and a positive relationship with deaths. These relationships indicate that population density and overall growth had a strong negative relationship in Virginia during recent decades. Considering that initial population and employment levels had positive effects on migration and employment growth, respectively, the population density results indicate that overall growth has been greatest in areas of higher, but diffuse populations. Results from the birth and death equations indicate that natural population growth was also greatest in such areas.

The model results agree with the trends described in Chapter two, where growth was shown to be greatest in metropolitan fringe and inter-metropolitan corridor counties,

and imply that convergence and / or spillover effects between metropolitan and adjacent areas were occurring throughout the 1985 to 1990 and 1975 to 1980 periods. However, low rates of growth for other regions indicate that downward spiraling growth patterns and backwash effects were evident in many areas.

Strong negative relationships are noted for both property taxes and school spending with overall growth. As seen in Table 5-16, the negative relationships of property taxes and school spending with employment growth were especially strong. Collectively, these results indicate that areas spending more on education will experience slower growth and economic development than will areas spending less, and raise serious questions about Virginia's present system of educational funding. The policy implications of these results will be the focus of Chapter six, which concludes this thesis.

Table 5-1: Estimation Results for Structural Equations, Total Migration-Total Employment Growth.

Variable	***1985 to 1990***		***1975 to 1980***	
	Migration	Employment	Migration	Employment
Intercept	1.36 [0.20]	-10.79 [-1.38]	11.11 [1.90]	-20.87 [-1.40]
Population Initial	0.02 [0.93]	0.10 [2.55]*	0.03 [2.27]*	-0.09 [-0.59]
Employment Initial	0.01 [0.29]	0.06 [0.66]	0.04 [0.40]	-0.26 [-0.36]
Migration		-0.64 [-0.86]		2.59 [0.71]
Employment Growth	0.22 [0.58]		0.64 [1.81]	
CRIMCAPi	-0.13 [-2.17]*		-0.01 [-0.45]	
PERCCOLLi		0.40 [1.68]		-0.26 [-0.28]
POPDENi	-0.44 [-0.19]	-7.30 [-4.25]*	1.63 [0.95]	-0.86 [-0.15]
PERCBLKi	0.01 [0.29]	-0.05 [-1.07]	0.01 [0.47]	0.01 [0.12]
PHYSCAPi	0.95 [3.07]*	-0.05 [-0.06]	0.47 [0.95]	-0.21 [-0.12]
BEDSCAPi	-0.10 [-1.12]	-0.21 [-1.20]	0.00 [0.06]	0.02 [0.20]
SCHSPENDi	-3.30 [-1.89]	-6.92 [-1.99]*	-4.02 [-2.42]*	12.00 [0.58]
GOVSPENDi	0.23 [5.08]*	0.25 [1.25]	0.13 [2.61]*	-0.28 [-1.04]
INTERGOVREVi	-0.44 [-4.70]*	-0.45 [-1.12]	-0.24 [-1.29]	0.84 [0.52]
RETSALECAPi	0.99 [2.17]*	-0.02 [-0.04]	0.95 [1.24]	-1.48 [-1.05]
PERCPOVi	0.19 [1.07]	0.42 [1.38]	-0.05 [-0.47]	-0.02 [-0.06]
UNEMPi	-0.09 [-0.65]	0.12 [0.50]	-0.11 [-1.04]	0.31 [0.56]
COMMUTEi	0.00 [0.40]	-0.00 [-0.18]	0.01 [1.25]	-0.03 [-0.60]
INCCAPi	-0.16 [-0.53]	0.50 [1.17]	-1.53 [-2.35]*	3.10 [1.12]
HOMEPRICi	0.13 [0.93]	0.30 [1.32]	0.02 [0.11]	-0.28 [-0.28]
PROPTAXi	1.36 [0.51]	-1.89 [-0.47]	-3.94 [-2.29]*	11.52 [0.63]
AMENITYi	0.18 [0.41]	0.97 [1.64]	-0.08 [-0.27]	-0.13 [-0.12]
DUMMETROi	-0.89 [-0.78]	-0.01 [-0.01]	0.37 [0.33]	-2.33 [-0.36]
DUMADJi	-0,56 [-0.46]	1.88 [1.28]	-0.67 [-0.64]	0.46 [0.18]

Numbers in parenthesis are *t*-statistics.

* Indicates significance of *t*-statistic at the five percent confidence level.

Table 5-2: Estimation Results for Structural Equations, Migration Age 15 to 34 and Total Employment Growth.

Variable	***1985 to 1990***		***1975 to 1980***	
	Migration	Employment	Migration	Employment
Intercept	-1.90 [-0.05]	-18.23 [-0.96]	-13.62 [-2.17]*	14.43 [0.82]
YOUNGPOPi	-0.25 [-0.11]	0.63 [1.09]	0.17 [0.37]	-0.09 [-0.11]
TOTEMPi	-0.20 [-0.24]	0.11 [1.46]	-0.02 [-0.54]	0.03 [2.22]*
YOUNGMIGi		-2.00 [-1.00]		0.98 [0.57]
TOTEMGi	5.63 [0.27]		0.79 [0.66]	
CRIMCAPi	0.70 [0.30]		0.01 [0.13]	
PERCCOLLi		0.51 [0.82]		0.03 [0.13]
POPDENi	7.13 [0.20]	-7.63 [-1.35]	-1.53 [-0.76]	1.12 [0.23]
PERCBLKi	-0.02 [-0.13]	-0.05 [-0.67]	-0.01 [-0.41]	0.01 [0.13]
PHYSCAPi	-4.81 [-0.30]	-0.28 [-0.24]	-0.38 [-1.01]	0.33 [0.42]
BEDSCAPi	0.57 [0.24]	-0.30 [-1.27]	-0.02 [-0.48]	0.01 [0.19]
SCHSPENDi	22.14 [0.27]	-6.29 [-1.64]	5.53 [0.70]	-6.85 [-3.47]*
GOVSPENDi	-1.41 [-0.28]	0.22 [3.41]*	-0.23 [-1.06]	0.26 [1.46]
INTERGOVREVi	2.83 [0.26]	-0.64 [-3.35]*	0.23 [0.27]	-0.36 [-0.73]
RETSALECAPi	-5.52 [-0.31]	-0.28 [-0.27]	-0.97 [-1.36]	1.01 [0.81]
PERCPOVi	-1.24 [-0.23]	0.62 [1.25]	0.08 [0.84]	-0.06 [-0.32]
UNEMPi	0.42 [0.26]	0.03 [0.11]	0.07 [0.39]	-0.10 [-0.71]
COMMUTEi	-0.02 [-0.24]	0.00 [0.03]	-0.01 [-0.68]	0.01 [1.10]
INCCAPi	0.39 [0.27]	0.48 [0.58]	1.70 [3.17]*	-1.75 [-0.72]
HOMEPRICi	-0.89 [-0.22]	0.43 [1.66]	-0.05 [-0.20]	0.08 [0.38]
PROPTAXi	-6.05 [-0.32]	-3.94 [-0.69]	3.17 [0.67]	-4.03 [-1.79]
AMENITYi	-1.64 [-0.21]	1.10 [1.02]	0.13 [0.46]	-0.11 [-0.23]
DUMMETROi	3.52 [0.23]	-1.53 [-0.56]	-0.56 [-0.25]	0.91 [0.54]
DUMADJi	1.54 [0.27]	0.99 [0.43]	0.90 [0.89]	-0.78 [-0.34]

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Numbers in parenthesis are *t*-statistics.

* Indicates significance of *t*-statistic at the five percent confidence level.

Table 5-3: Estimation Results for Structural Equations, Migration Age 35 to 54 and Total Employment Growth.

Variable	***1985 to 1990***		***1975 to 1980***	
	Migration	Employment	Migration	Employment
Intercept	-4.30 [-0.86]	-13.82 [-1.20]	-1.75 [-1.00]	1.87 [0.23]
MIDPOPi	0.23 [0.49]	0.96 [1.79]	0.31 [1.70]	0.65 [0.65]
TOTEMPi	0.02 [0.58]	0.07 [1.44]	0.00 [0.13]	0.03 [2.51]*
MIDMIGi		-1.90 [-0.90]		-0.11 [-0.03]
TOTEMGi	0.08 [0.08]		-0.09 [-0.31]	
CRIMCAPi	0.04 [0.62]		-0.01 [-0.51]	
PERCCOLLi		0.06 [0.30]		0.26 [1.71]
POPDENi	-2.11 [-1.62]	-5.54 [-1.21]	-1.19 [-5.46]*	-0.84 [-0.18]
PERCBLKi	-0.02 [-1.38]	-0.03 [-0.61]	-0.01 [-1.02]	-0.03 [-0.73]
PHYSCAPi	-0.46 [-0.55]	0.05 [0.05]	-0.42 [-2.24]*	-0.25 [-0.14]
BEDSCAPi	0.01 [-0.07]	-0.14 [-1.21]	0.00 [0.11]	-0.04 [-1.00]
SCHSPENDi	-1.02 [-0.52]	-4.26 [-1.18]	-1.56 [-1.54]	-2.31 [-0.40]
GOVSPENDi	0.02 [0.16]	0.20 [2.12]*	0.01 [0.38]	-0.09 [-0.82]
INTERGOVREVi	-0.16 [-0.40]	-0.74 [-1.95]	-0.28 [-4.14]*	-0.09 [-0.08]
RETSALECAPi	-0.26 [-0.53]	0.05 [0.10]	-0.18 [-0.56]	0.37 [0.32]
PERCPOVi	0.11 [0.37]	0.55 [1.55]	0.07 [1.88]*	0.08 [0.28]
UNEMPi	0.09 [0.65]	0.03 [0.11]	-0.03 [-0.38]	-0.14 [-1.06]
COMMUTEi	-0.00 [-0.23]	0.00 [0.23]	-0.00 [-0.25]	0.01 [0.81]
INCCAPi	0.24 [1.73]	0.34 [0.50]	0.13 [0.55]	-0.65 [-0.78]
HOMEPRICi	0.06 [0.32]	0.30 [1.87]	0.15 [1.53]	0.15 [0.30]
PROPTAXi	-0.29 [-0.29]	-0.13 [-0.04]	-0.77 [-0.44]	-6.30 [-2.60]*
AMENITYi	0.27 [0.72]	0.92 [1.12]	0.20 [1.33]	0.28 [0.40]
DUMMETROi	0.61 [0.49]	-0.21 [-0.10]	0.78 [1.17]	1.68 [0.62]
DUMADJi	0.80 [2.11]*	1.23 [0.58]	0.60 [1.32]	0.82 [0.36]

Numbers in parenthesis are *t*-statistics.

* Indicates significance of *t*-statistic at the five percent confidence level.

Table 5-4: Estimation Results for Structural Equations, Migration Age 55 plus and Total Employment Growth.

Variable	***1985 to 1990***		***1975 to 1980***	
	Migration	Employment	Migration	Employment
Intercept	0.75 [0.46]	3.64 [0.44]	-0.28 [-0.40]	7.18 [2.11]*
OLDPOPi	-0.10 [-0.68]	-0.53 [-1.98]*	-0.03 [-1.24]	-0.16 [-1.23]
TOTEMPi	0.01 [0.56]	0.05 [2.32]*	-0.00 [-0.35]	0.06 [5.64]*
OLDMIGi		-9.32 [-1.09]		3.28 [1.75]
TOTEMGi	-0.23 [-0.52]		0.04 [0.74]	
CRIMCAPi	-0.01 [-0.28]		0.01 [2.26]*	
PERCCOLLi		-0.10 [-0.38]		0.45 [3.34]*
POPDENi	-0.91 [-1.47]	-6.87 [-1.41]	-0.51 [-5.36]*	0.23 [0.22]
PERCBLKi	-0.01 [-0.97]	-0.08 [-1.13]	-0.01 [-1.21]	-0.03 [-1.80]
PHYSCAPi	0.39 [0.77]	2.37 [1.76]	0.05 [0.66]	-0.29 [-0.63]
BEDSCAPi	-0.02 [-0.30]	-0.01 [-0.08]	-0.01 [-0.98]	-0.02 [-0.41]
SCHSPENDi	-1.26 [-0.63]	-6.38 [-2.17]*	0.09 [0.18]	-6.39 [-4.09]*
GOVSPENDi	0.06 [0.48]	0.24 [3.52]*	-0.04 [-2.02]	0.32 [4.83]*
INTERGOVREVi	-0.08 [-0.41]	-0.24 [-1.01]	0.08 [2.77]*	-0.39 [-2.09]*
RETSALECAPi	0.29 [0.62]	1.49 [1.49]	0.12 [0.99]	-0.14 [-0.20]
PERCPOVi	0.04 [0.45]	0.17 [0.69]	-0.01 [-0.43]	-0.01 [-0.11]
UNEMPi	-0.05 [-0.65]	-0.31 [-0.96]	-0.01 [-0.44]	0.00 [0.30]
COMMUTEi	-0.00 [-0.38]	-0.01 [-0.53]	0.00 [0.39]	0.01 [1.39]
INCCAPi	0.11 [0.89]	0.78 [1.05]	0.08 [0.97]	-0.42 [-0.99]
HOMEPRICi	0.01 [0.31]	0.07 [0.41]	-0.01 [-0.18]	-0.03 [-0.22]
PROPTAXi	-0.46 [-0.59]	-5.00 [-0.94]	-0.07 [-0.17]	-4.79 [-2.67]*
AMENITYi	0.14 [1.14]	1.13 [1.01]	0.05 [1.09]	-0.33 [1.33]
DUMMETROi	0.21 [0.43]	2.92 [0.73]	0.24 [1.07]	1.18 [1.05]
DUMADJi	0.26 [0.91]	2.90 [0.85]	0.10 [0.70]	0.04 [0.05]

Numbers in parenthesis are *t*-statistics.

* Indicates significance of *t*-statistic at the five percent confidence level.

Table 5-5: Estimation Results for Structural Equations, Total Migration and Agricultural Employment Growth.

Variable	***1985 to 1990***		***1975 to 1980***	
	Migration	Employment	Migration	Employment
Intercept	0.60 [0.37]	-15.36 [-1.22]	0.83 [1.07]	-17.57 [-1.23]
TOTPOPi	-0.01 [-0.14]	-1.72 [-1.04]	0.08 [1.03]	-1.64 [-1.67]
AGEMPi	0.01 [0.30]	0.32 [0.81]	-0.02 [-1.25]	0.45 [1.24]
TOTMIGi		-13.31 [-0.33]		17.05 [0.36]
AGEMPGROi	0.02 [0.27]		0.04 [0.87]	
CRIMCAPi	-0.00 [-0.59]		0.00 [0.11]	
PERCCOLLi		0.19 [0.64]		0.07 [0.13]
POPDENi	0.05 [0.10]	-7.47 [-1.96]*	0.21 [0.84]	-5.00 [-7.72]*
PERCBLKi	0.00 [0.61]	-0.04 [-0.40]	-0.01 [-1.11]	0.06 [0.15]
PHYSCAPi	-0.02 [-0.52]	-0.89 [-0.61]	0.05 [0.74]	-1.13 [-1.50]
BEDSCAPi	-0.00 [-0.04]	-0.19 [-0.83]	0.00 [0.59]	-0.05 [-0.85]
SCHSPENDi	0.07 [0.60]	-0.52 [-0.16]	-0.12 [-0.71]	1.53 [0.15]
GOVSPENDi	-0.00[-0.50]	0.02 [0.33]	0.03 [3.07]*	-0.50 [-0.54]
INTERGOVREVi	-0.00[-0.32]	-0.25 [-0.66]	-0.01 [-0.44]	0.09 [0.08]
RETSALECAPi	0.01 [0.42]	-0.12 [-0.17]	0.07 [1.06]	-1.36 [-0.60]
PERCPOVi	-0.02 [-0.57]	0.26 [0.43]	-0.01 [-0.30]	0.17 [0.43]
UNEMPi	-0.02[-1.10]	-0.04 [-0.05]	-0.01 [-0.43]	0.06 [0.15]
COMMUTEi	0.00 [0.37]	-0.00 [-0.03]	-0.00 [-0.04]	-0.00 [-0.00]
INCCAPi	-0.05 [-1.65]	-0.29 [-0.14]	-0.02 [-0.24]	0.75 [0.35]
HOMEPRICi	-0.00 [-0.04]	0.40 [1.21]	-0.04 [-1.57]	0.78 [0.65]
PROPTAXi	0.47 [1.00]	-0.43 [-0.03]	0.03 [0.18]	-1.10 [-0.30]
AMENITYi	-0.00 [-0.06]	1.00 [1.22]	0.00 [0.11]	0.05 [0.05]
DUMMETROi	-0.08 [-0.42]	1.66 [0.62]	0.08 [0.62]	-0.88 [-0.11]
DUMADJi	-0.13 [–0.59]	1.42 [0.38]	-0.07 [-0.52]	1.64 [1.13]

Numbers in parenthesis are *t*-statistics.

* Indicates significance of *t*-statistic at the five percent confidence level.

Table 5-6: Estimation Results for Structural Equations, Total Migration Construction, Manufacturing, and Transportation Employment Growth.

Variable	*1985 to 1990*		*1975 to 1980*	
	Migration	Employment	Migration	Employment
Intercept	-3.26 [-0.80]	-20.82 [-1.55]	1.36 [0.54]	-6.31 [-0.44]
TOTPOPi	-0.01 [-0.12]	0.19 [1.87]	0.02 [1.47]	0.08 [0.39]
CMTEMPi	0.04 [1.18]	0.13 [0.91]	0.04 [1.00]	0.45 [1.31]
TOTMIGi		-1.62 [-0.78]		-4.28 [-0.56]
CMTEMPGROi	0.11 [0.52]		0.00 [0.00]	
CRIMCAPi	-0.05 [-1.68]		-0.01 [-0.89]	
PERCCOLLi		0.37 [1.44]		0.39 [0.95]
POPDENi	-0.36 [-0.28]	-7.47 [-3.05]*	-0.16 [-0.22]	-5.66 [-3.32]*
PERCBLKi	0.02 [0.87]	-0.05 [-0.89]	-0.00 [-0.20]	-0.09 [-1.49]
PHYSCAPi	-0.04 [-0.26]	-0.62 [-1.05]	-0.03 [-0.15]	-1.65 [-1.36]
BEDSCAPi	-0.01 [-0.20]	-0.17 [-1.07]	-0.01 [-0.80]	-0.11 [-0.89]
SCHSPENDi	-0.51 [-0.65]	-4.49 [-1.70]	-1.29 [-1.90]	-7.75 [-0.72]
GOVSPENDi	-0.01 [-0.35]	0.11 [1.86]	0.00 [0.22]	-0.07 [-0.53]
INTERGOVREVi	-0.03 [-0.69]	-0.22 [-1.23]	-0.06 [-0.69]	-0.60 [-1.03]
RETSALECAPi	0.42 [1.60]	-0.22 [-0.31]	0.11 [0.36]	-0.75 [-0.47]
PERCPOVi	-0.01 [-0.10]	0.40 [1.49]	0.00 [0.04]	0.24 [1.40]
UNEMPi	0.04 [0.56]	0.25 [0.80]	0.02 [0.42]	0.06 [0.19]
COMMUTEi	0.01 [1.40]	0.00 [0.15]	0.00 [0.77]	0.01 [0.37]
INCCAPi	-0.14 [-0.85]	0.45 [0.87]	-0.26 [-1.01]	0.05 [0.02]
HOMEPRICi	0.09 [1.08]	0.41 [1.25]	0.12 [1.26]	0.83 [0.94]
PROPTAXi	4.45 [2.48]*	0.28 [0.04]	-1.77 [-2.43]*	-9.79 [-0.61]
AMENITYi	-0.23 [-0.90]	0.65 [0.97]	0.02 [0.15]	0.67 [1.01]
DUMMETROi	-1.09 [-1.60]	0.22 [0.08]	0.29 [0.53]	3.71 [1.07]
DUMADJi	-0.21 [-0.30]	2.32 [1.47]	-0.04 [-0.10]	1.78 [0.93]

Numbers in parenthesis are *t*-statistics.

* Indicates significance of *t*-statistic at the five percent confidence level.

Table 5-7: Estimation Results for Structural Equations, Total Migration and Government Employment Growth.

Variable	***1985 to 1990***		***1975 to 1980***	
	Migration	Employment	Migration	Employment
Intercept	2.24 [1.10]	1.29 [0.08]	2.32 [1.04]	-10.05 [-1.02]
TOTPOPi	0.02 [0.63]	0.54 [1.24]	-0.00 [-0.38]	-0.03 [-0.55]
GOVEMPi	-0.03 [-1.36]	-0.04 [-0.21]	-0.03 [-0.81]	0.28 [3.36]*
TOTMIGi		-5.93 [-0.66]		-4.69 [-0.58]
GOVEMPGROi	0.10 [0.68]		0.15 [1.11]	
CRIMCAPi	-0.02 [-0.90]		-0.02 [-1.46]	
PERCCOLLi		0.50 [1.39]		0.66 [1.00]
POPDENi	0.22 [0.23]	-9.18 [-2.24]*	0.46 [0.74]	-6.17 [-2.49]*
PERCBLKi	0.00 [0.08]	-0.07 [-0.95]	0.01 [0.86]	-0.08 [-1.60]
PHYSCAPi	0.06 [0.50]	-0.77 [-1.24]	0.38 [2.10]*	-0.71 [-0.55]
BEDSCAPi	0.01 [0.37]	-0.19 [-1.13]	0.00 [0.14]	-0.08 [-0.90]
SCHSPENDi	0.53 [0.91]	-2.84 [-0.90]	-0.37 [-0.61]	-5.35 [-0.77]
GOVSPENDi	0.03 [1.31]	0.36 [1.00]	-0.02 [-1.14]	-0.25 [-0.87]
INTERGOVREVi	-0.03 [-0.57]	-0.66 [-1.12]	0.15 [1.94]	0.09 [0.12]
RETSALECAPi	0.21 [1.62]	1.10 [0.71]	0.40 [1.52]	-0.29 [-0.15]
PERCPOVi	0.02 [0.31]	0.36 [0.88]	-0.02 [-0.62]	0.28 [1.53]
UNEMPi	-0.07 [-1.46]	-0.19 [-0.35]	-0.02 [-0.41]	-0.10 [-0.33]
COMMUTEi	0.00 [0.13]	-0.00 [-0.09]	0.00 [0.42]	0.01 [0.32]
INCCAPi	-0.17 [-1.95]	-0.52 [-0.36]	-0.39 [-1.67]	0.22 [0.11]
HOMEPRICi	-0.03 [-0.56]	0.13 [0.78]	-0.03 [-0.40]	0.40 [1.18]
PROPTAXi	0.42 [0.49]	-0.71 [-0.15]	0.42 [0.64]	-1.36 [-0.29]
AMENITYi	0.11 [0.74]	1.74 [1.05]	-0.02 [-0.12]	0.91 [1.12]
DUMMETROi	0.17 [0.44]	2.42 [0.74]	0.38 [0.86]	5.65 [0.88]
DUMADJi	-0.23 [-0.59]	1.26 [0.67]	-0.15 [–0.39]	2.46 [1.17]

Numbers in parenthesis are *t*-statistics.

* Indicates significance of *t*-statistic at the five percent confidence level.

Table 5-8: Estimation Results for Structural Equations, Total Migration and Trade and Services Employment Growth.

Variable		***1985 to 1990***		***1975 to 1980***
	Migration	Employment	Migration	Employment
Intercept	2.57 [0.43]	-8.88 [-1.01]	6.26 [1.61]	-12.64 [-3.21]*
TOTPOPi	0.07 [1.64]	0.22 [1.67]	0.01 [0.56]	-0.01 [-0.15]
TSEMPi	-0.01 [-0.23]	0.07 [0.77]	0.05 [0.81]	-0.05 [-0.24]
TOTMIGi		-1.25 [-0.78]		1.70 [1.38]
TSEMPGROi	0.03 [0.08]		0.49 [1.99]*	
CRIMCAPi	-0.06 [-1.21]		0.01 [0.25]	
PERCCOLLi		0.32 [1.26]		0.06 [0.26]
POPDENi	-0.19 [-0.09]	-6.45 [-5.93]*	1.36 [1.12]	-3.19 [-2.41]*
PERCBLKi	-0.01 [-0.26]	-0.06 [-1.13]	0.02 [0.92]	-0.04 [-1.76]
BEDSCAPi	0.95 [3.75]*	0.62 [0.39]	0.14 [0.45]	-0.47 [-0.76]
PHYSCAPi	-0.08 [-1.18]	0.24 [-1.10]	0.01 [0.50]	-0.03 [-0.64]
SCHSPENDi	-3.70 [-2.73]*	8.31[1.37]	-1.94 [-1.84]	2.91 [0.72]
GOVSPENDi	0.19 [6.66]*	0.29 [0.89]	0.14 [3.94]*	-0.25 [-2.26]*
INTERGOVREVi	-0.34 [-5.28]*	-0.51[0.85]	-0.36 [-2.97]*	0.56 [0.91]
RETSALECAPi	0.37 [0.95]	-0.20 [-0.30]	0.53 [0.93]	-1.21 [-1.76]
PERCPOVi	0.18 [1.20]	0.50 [1.27]	-0.01 [-0.17]	0.05 [0.45]
UNEMPi	-0.04 [-0.30]	0.11 [0.43]	-0.08 [-1.24]	0.13 [0.71]
COMMUTEi	-0.00 [-0.38]	-0.01 [-0.55]	0.01 [1.24]	-0.01 [-0.79]
INCCAPi	0.20 [0.79]	0.78 [1.59]	-0.93 [-1.98]*	1.83 [3.43]*
HOMEPRICi	0.06 [0.47]	0.28 [1.30]	-0.02 [-0.18]	0.09 [0.38]
PROPTAXi	-2.40 [-1.11]	-5.38 [-0.74]	-2.54 [-2.22]*	4.20 [1.20]
AMENITYi	0.23 [0.61]	1.09 [1.56]	-0.04 [-0.20]	0.15 [0.42]
DUMMETROi	-0.49 [-0.53]	-0.07 [-0.03]	-0.23 [-0.36]	0.60 [0.51]
DUMADJi	-0.11 [-0.11]	2.07 [1.30]	-0.53 [-0.82]	1.20 [1.40]

Numbers in parenthesis are *t*-statistics.

* Indicates significance of *t*-statistic at the five percent confidence level.

Table 5-9: Tabulation of significant parameter estimates for initial population, initial employment level, population density and income per capita variables for migration equations.

Variable	Number of Significant Parameter Estimates-Migration Equations					
	1985 to 1990		1975 to 1980		Total	
	Positive	Negative	Positive	Negative	Positive	Negative
Initial Population	1	0	1	0	2	0
Initial Employment	0	0	0	0	0	0
POPDEN	0	0	0	2	0	2
INCCAP	0	0	1	2	1	2

Table 5-10: Tabulation of significant parameter estimates for school spending, property tax, total government spending and intergovernmental revenue variables for migration equations.

Variable	Number of Significant Parameter Estimates-Migration Equations					
	1985 to 1990		1975 to 1980		Total	
	Positive	Negative	Positive	Negative	Positive	Negative
SCHSPEND	0	1	0	1	0	2
PROPTAX	1	0	0	3	1	3
GOVSPEND	1	0	2	1	3	1
INTERGOV-REV	0	1	1	2	1	3

Table 5-11: Tabulation of significant parameter estimates for initial population, initial employment level, population density and income per capita variables for employment growth equations.

Variable	Number of Significant Parameter Estimates-Employment Equations					
	1985 to 1990		1975 to 1980		Total	
	Positive	Negative	Positive	Negative	Positive	Negative
Initial Population	0	1	0	0	0	1
Initial Employment	1	0	4	0	5	0
POPDEN	0	5	0	4	0	9
INCCAP	0	0	1	0	1	0

Table 5-12: Tabulation of significant parameter estimates for school spending, property tax, total government spending and intergovernmental revenue variables for employment growth equations.

Variable	Number of Significant Parameter Estimates-Employment Equations					
	1985 to 1990		1975 to 1980		Total	
	Positive	Negative	Positive	Negative	Positive	Negative
SCHSPEND	0	2	0	2	0	4
PROPTAX	0	0	0	2	0	2
GOVSPEND	3	0	0	1	3	1
INTERGOV-REV	0	2	0	1	0	3

Table 5-13: Estimation Results for Births Equation OLS Regression.

VARIABLE	1985 to 1990	1975 to 1980
INT	-0.001 [-0.20]	0.0033 [0.97]
TOTPOPi	0.1128 [45.12] *	0.0735 [33.41] *
PERCFEMi	-0.0049 [-0.18]	-0.0003 [-0.01]
POPDENi	-0.3146 [-2.23] *	-0.2086 [-1.87]
PERCBLKi	0.0111 [1.23]	0.0007 [0.13]
PHYSCAPi	-0.1954 [-1.67]	-0.4388 [-3.05] *
CRIMCAPi	0.019 [1.33]	0.0267 [2.50] *
UNEMPi	-0.054 [-1.33]	-0.0432 [-1.17]
COMMUTEi	-0.001 [-0.26]	-0.0047 [-1.34]
INCCAPi	-0.0303 [-0.46]	0.019 [0.17]
R^2	0.9764	0.9656

Numbers in parenthesis are *t*-statistics.

* Indicates significance of *t*-statistic at 95 percent confidence interval.

Table 5-14: Estimation Results for Deaths Equation OLS Regression.

VARIABLE	1985 to 1990	1975 to 1980
INT	-0.0018 [-0.54]	0.0029 [1.21]
TOTPOPi	0.0304 [17.88] *	0.0273 [17.06] *
PERCOLDi	0.0451 [2.25] *	0.0477 [3.31] *
POPDENi	0.0161 [0.17]	0.1877 [2.40] *
PERCBLKi	-0.0038 [-0.62]	0.0015 [0.38]
PHYSCAPi	0.0889 [1.17]	0.135 [1.30]
CRIMCAPi	0.0621 [6.97] *	0.0215 [2.79] *
UNEMPi	0.0051 [0.17]	-0.0178 [-0.64]
COMMUTEi	0.0005 [0.20]	-0.0017 [-0.71]
INCCAPi	-0.1113 [-3.27] *	-0.214 [-3.48] *
R^2	0.9141	0.9092

Numbers in parenthesis are *t*-statistics.

* Indicates significance of *t*-statistic at 95 percent confidence interval.

Table 5-15: Parameter estimates significant at 15 percent level for the school spending and property tax variables from the TSLS regressions of migration and employment growth.

Regression	**Time Period**	**SCHSPEND**		**PROPTAX**	
		Migration	Employment	Migration	Employment
Total Migration – Total Employment Growth	1985 to 1990	-3.30 [-1.89]	-6.92 [-1.99]		
	1975 to 1980	-4.02 [-2.42]		-3.94 [-2.29]	
Migration 15 – 34 - Total Employment Growth	1985 to 1990		-6.29 [-1.64]		
	1975 to 1980		-6.85 [-3.47]		-4.03 [-1.79]
Migration 35-54 - Total Employment Growth	1985 to 1990				
	1975 to 1980	-1.56 [-1.54]			-6.30 [-2.60]
Migration 55 plus – Total Employment Growth	1985 to 1990		-6.38 [-2.17]		
	1975 to 1980		-6.39 [-4.09]		-4.79 [-2.67]
Total Migration – Agricultural Employment Growth	1985 to 1990				
	1975 to 1980				
Total Migration – CMT Employment Growth	1985 to 1990		-4.49 [-1.70]	4.45 [2.48]	
	1975 to 1980	-1.29 [-1.90]		-1.77 [-2.43]	
Total Migration – Government Employment Growth	1985 to 1990				
	1975 to 1980				
Total Migration – Trade & Services Employment Growth	1985 to 1990	-3.70 [-2.73]			
	1975 to 1980	-1.94 [-1.84]		-2.54 [-2.22]	

Numbers in parenthesis are *t*-statistics.

Chapter 6: Model Limitations, Further Research and Conclusions

6.1 Model Limitations

Specification testing was conducted by plotting recursive least squares (RLS) parameter estimates. First, the county level data was arranged in ascending order by income. OLS estimates were then plotted for the lowest twenty income counties only. RLS was then used to calculate and plot OLS parameter estimates as each higher income county was added to the data set, continuing until all 105 counties were included. These plots revealed significant changes in many of the parameter estimates as several of the highest income counties were included in the data set. Based upon these plots, the three highest income counties were deleted from the data set in order to reduce the parameter instability. Additionally, the hospital beds per capita and the metropolitan dummy variables were omitted to gain degrees of freedom. These changes did not yield greater numbers of significant parameter estimates for remaining variables.

In theory, specification of the model could be improved in several ways. The linear relationships between exogenous and endogenous variables may not hold over all regions of the state. Additional re-specification might include modeling of the state as two separate regions (along with the omission of more exogenous variables[40]). Virginia is an economically and socially diverse state, therefore a model measuring factors in different parts of the state might be more appropriate than the one used herein. For example, the counties and cities of the NOVA to Richmond region might be better modeled along with Washington D.C. and neighboring counties in Maryland. The rest of Virginia could then be modeled separately. While such a scheme requires two separate models the resulting parameter estimates may better capture observed relationships.

[40] With only 105 observations, the inclusion of over 20 exogenous variables plus the simultaneously determined variables in each equation of the migration-employment growth system leaves limited degrees of freedom. Such limited degrees of freedom mean that statistical tests have little power.

Following Steinnes and Fisher (1974) and Carlino and Mills (1987), the right-hand side variables in the various equations are assumed to be linearly related to the left-hand side dependent variables. This linearity assumption was adopted in previous studies to save computing time and costs. As computational barriers are significantly lower today, re-specification with non-linear relationships of key variables might be an appropriate and reasonable alternative. Examination of data plots for the different variables used in the model specification could reveal patterns other than linearity. These patterns could be used to guide the re-specification process. Such re-specification might require the deletion of some other model variables, as greater degrees of freedom are required to estimate non-linear models.

In summary, the re-specification suggestions mentioned in this section could be used to guide further study in this area. Implementation of any of these suggestions would reduce degrees of freedom. Modelling of the state as two separate regions would reduce the numbers of observations per model, while inclusion of non-linear variable relationships would also reduce degrees of freedom. The best alternative may be to adopt some of these suggestions while omitting several of the variables used within. It is also possible that low significance for parameter estimates for many of the variables in this study may be correctly indicating weak relationships between the right and left-hand side variables. Further re-specification would help to determine the robustness of current results.

6.2 Implications of Thesis Results

The results of this thesis indicate varying patterns of growth throughout Virginia during recent decades. Analysis of growth rates in Chapter two and the results of the model regression in Chapter five both indicate that growth was very closely related to lower population density, moderate to high overall population, and proximity to metropolitan areas. Inner metropolitan areas generally grew at moderate rates (except for some urban core areas), while more distant regions generally underwent slow growth or decline. Parameter estimates for the income variables indicate a significant migration

trend of younger people from slow growth, low-income areas to rapid growth and high income areas. These migration patterns indicate that near-metropolitan areas have experienced positive spillover effects from metropolitan core areas, resulting in localized patterns of convergence. Meanwhile, backwash effects from metropolitan regions may be partially responsible for stifled growth in more distant regions.

The negative consequences of these growth patterns will be difficult to reverse. Areas of intense growth have been characterized by moderate but diffuse populations. Countywide or regional measures to maintain growth in certain areas within counties while leaving other areas untouched by residential and / or economic development may prove effective, as increasing population densities in developed portions may have a balancing effect on growth rates. Such plans are currently in effect in several areas of Virginia, such as Virginia Beach City's "Greenline" development plan, and the recent (and very controversial) Unified Development Ordinance plan imposed by the City of Suffolk that severely limits all development in the southern portion of the city.

Areas of sluggish growth may need substantial outside assistance from higher levels of government (although the results for intergovernmental revenue in Chapter five might argue otherwise). While it unlikely that many slow growth regions will be able to attain significantly higher growth rates in the foreseeable future, business recruitment and diversification of industry are needed to avoid further declines. Promotion of such areas as retirement havens may be an effective development strategy. Older individuals are often attracted to slow growth, lower cost regions. Parameter estimates for the property tax variables in Chapter five indicate that regions which maintain low property tax rates may be especially attractive to both migrants and prospective employers. Increased in-migration of retirees can have positive effects upon employment levels, as they create increased demand for goods and services (recalling the positive relationship of overall migration with trade and services employment sector growth).

Regression results for the property tax and school spending variables indicate that high property tax and school spending areas have been heavily disadvantaged in the

effort to stimulate growth. Table 6-1 reveals a wide discrepancy in property tax rates, the level of funding for schools and rates of overall population growth for 1985 to 1990 between urban core, peri-urban and rural areas. The four urban core jurisdictions presented had an average level of per pupil school spending of $2830 per year, an average property tax rate of $1.23, and average total population growth of –1.52 percent per year. In contrast, the four peri-urban fringe counties had lower average per pupil spending of $1960 per year, a lower average property tax rate of $0.78, and much higher average population growth of 5.06 percent per year. The four southwestern and south-side counties had high average per pupil spending of $2280, a low average property tax rate of $0.39, and low growth averaging –1.30 percent per year for 1985 to 1990.

These statistics indicate that taxes needed to maintain higher levels of educational spending in urban core areas may be a major causal factor driving the negative estimates obtained for the educational and property tax variables in Chapter five. Per pupil school spending may be correlated with other attributes of many slow growing counties and cities. These attributes include higher overall costs of schooling in urban core areas and high per pupil spending due to coal tax revenue in many southwestern counties. Clearly, in many urban areas, the negative effects of higher property taxes seem to strongly outweigh any positive affects of higher school spending. Such strong negative effects of property taxes could provide pressure on many already slow growing jurisdictions to cut property taxes, in many cases resulting in reduced levels of school spending.

Higher school spending is undoubtedly a positive factor for migrants, and probably for employers as well. However, higher property taxes, which generally provide over 50 percent of educational funds appear to be having a much stronger negative influence on growth. Since school spending is usually the major expenditure for counties and cities, the school spending estimates are probably measuring the strong negative effects of property taxes.

Ultimately, the results of this study indicate that zoning ordinances which clearly demarcate areas for new development may be an effective tool for slowing rapid growth

while still allowing growth to occur at a moderate pace and at affordable cost. Slow growth regions need to pursue new enterprise and diversify their economic base. Promotion of slow growth areas as low cost living alternatives may provide another tool for stimulating growth. At the statewide level, reform of educational financing may prove an effective strategy for curbing increased disparity in growth across the state of Virginia. However, these results also raise additional questions about the roles of state and local government in implementing such changes. Along with the results indicating the need for property tax reform are results indicating that assistance from higher levels of government may have little impact on local growth. The model presented and estimated in this thesis might benefit from some alterations, and the overall body of the thesis should be updated with data from the upcoming 2000 U.S. Census. A refined and updated model could provide further evidence for the conclusions drawn within as well as emerging patterns of growth as Virginia moves into the 21st century.

Table 6-1: Property Tax, School Spending per Pupil and Annual Average Population Growth 1985 to 1990 for Select Jurisdictions and Areas.

County or City	Property Tax Rate (Thousands of Dollars)	School Spending per Pupil (Thousands of Dollars)	Annual Average Population Growth 1985 to 1990
Urban Core Areas			
Alexandria	1.30	3.97	-6.74
Norfolk	1.10	2.32	1.69
Portsmouth	1.14	1.93	0.68
Richmond	1.40	3.12	-1.71
Mean	1.23	2.83	-1.52
Peri-Urban Counties			
Chesterfield	0.92	2.06	5.95
Powhatan	0.53	1.49	5.29
Loudoun	0.97	2.37	5.06
Virginia Beach	0.70	1.91	3.94
Mean	0.78	1.96	5.06
Southwest and South-side			
Buchanan	0.43	2.83	-1.85
Greensville	0.42	1.69	-0.07
Wise	0.29	1.93	-1.43
Bath	0.41	2.69	-1.84
Mean	0.39	2.28	-1.30
Statewide Mean	0.58	2.10	1.47
Statewide Standard Deviation	0.20	0.45	2.18

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