Physician Careers in Rural Areas: Transitions and Trajectories

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Abstract

ERIN P. FRAHER: Physician Careers in Rural Areas:
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There is general consensus among health care policy makers on the need to reform and strengthen the primary care infrastructure. This is especially true in rural and underserved areas. Despite significant investment of federal and state dollars in programs to address physician maldistribution, policy interventions have had only limited success. One reason may be that current policies are based on research that does not investigate how the geographic preferences of male and female physicians in different birth cohorts may vary. This dissertation applies the conceptual framework of life course theory from sociology to explore whether the choice of rural practice location diverged for male and female physicians of the same age in different birth cohorts.

Licensure data from the North Carolina Board of Medical Examiners were linked at two-year intervals between 1980 and 2005 to form 13 waves of physician-level location histories. Descriptive statistics, logistic regression and event history analyses were employed to compare the timing of transitions into rural practice in North Carolina for physicians in the Boomer 1 (born 1946-1954), Boomer 2 (born 1955-1964) and Generation X (born 1965-1979) birth cohorts. The most compelling finding was that while female physicians in earlier birth cohorts were significantly less likely than their male colleagues to choose rural practice settings, this gender effect was much smaller in the Generation X cohort. The study also found that both male and female physicians in the Generation X cohort were less likely than an earlier cohort to practice in rural counties and that physicians over the age of 50 were more likely to choose rural settings than younger physicians.

Existing rural workforce polices are based on research which implicitly assumes that the effect of age and gender on physicians' decisions to enter rural areas is equivalent and fixed across birth cohorts. Findings from this dissertation demonstrate the presence of inter- and intra-cohort differences in rural location behaviors for physicians. The study suggests the need for more dynamic policy levers that are differentially targeted toward male and female physicians in different birth cohorts and are specifically designed to work across physicians' career trajectories.

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List of Abbreviations

AAMC .... Association of American Medical Colleges

AHEC .... Area Health Education Center

AMA .... American Medical Association

BHPr .... Bureau of Health Professions

BME .... Board of Medical Examiners

CHC .... Community Health Center

COGME .... Council on Graduate Medical Education

DO .... Doctor of Osteopathy

EHA .... Event History Analysis

GAO .... General Accounting Office

GenX .... Generation X

GP .... General Practitioner

HMO .... Health Maintenance Organization

HPDS .... Health Professions Data System

HPSA .... Health Professional Shortage Area

LINC .... Log-Into-North-Carolina

LM .... Lagrange Multiplier

MD .... Medical Doctor

NC .... North Carolina

NCORHCC .... North Carolina Office of Rural Health and Community Care

NHSC .... National Health Service Corps

OLS .... Ordinary Least Squares

OMB .... Office of Management and Budget

Pre-WWII .... Pre-World War II

Sheps Center .... Cecil G. Sheps Center for Health Services Research

US .... United States

WWII .... World War II

1. INTRODUCTION

1.1. Background

Despite previously forecasting a physician surplus, most policy makers have reversed their positions and are now considering ways to address a predicted physician shortage. Nationally, the Association of American Medical Colleges has called for a 30% increase in medical school enrollments by 2015 [1] and the American Medical Association has both acknowledged a shortage and called for mechanisms to improve the distribution of physicians in rural and underserved areas [2]. While some have questioned whether expanding physician supply is the appropriate way to address access to health care [3, 4], many states have expanded medical school enrollments. Over 85% of existing medical schools have increased first-year enrollments, or plan to do so within the next five years, and more than a dozen new medical schools are planned [5]. The net result of this growth is an expected 30% increase in first-year medical school enrollments by 2017 [5]. Because increasing the number of medical school graduates will have a limited effect on physician supply without increasing the number of residency slots, the Council on Graduate Medical Education (COGME) has also recommended a 15% increase in graduate medical education capacity over the next decade [6].

New policy proposals specifically aimed at improving the supply of physicians in rural areas have been less forthcoming, perhaps due to the fact that the need for such programs has long been debated. Advocates of interventions to improve rural supply have used the fact that rural counties persistently have lower physician-to-population ratios than urban ones as evidence of market failure and a justification for Title VII programs such as Area Health Education Centers (AHEC) and the National Health Service Corps (NHSC). Economists have challenged the market failure argument and suggested that market forces will distribute physicians to where they are needed [7].

There is an active and vocal debate underway about how the market for physician services works and why maldistribution exists and persists. An analysis of physician supply by hospital referral regions in the United States by Goodman & Fisher (2008) revealed that the ratio of the supply in highest-quintile regions to that in the lowest-quintile is 1.56 for primary care physicians, 1.89 for medical specialists and 1.43 for surgical specialists [8]. As one of the most vocal opponents to increasing medical school enrollments and expanding residency training programs, Goodman (2008) has argued that a “trickle down” approach that attempts to increase rural physician supply by increasing overall supply has not worked in the past and is not likely to work in the future [9]. Goodman and colleagues at Dartmouth [3, 10] have also called into question the wisdom of investing in such a large scale medical school expansions when the evidence that increasing physician supply will improve patient outcomes is limited.

Existing research on the relationship between physician supply and health outcomes has demonstrated that a greater supply of primary care physicians lowers mortality rates and reduces racial and socioeconomic disparities in health outcomes, [11] while higher ratios of specialty providers are associated with higher mortality rates, increased utilization of unnecessary services and higher health system costs [12-14]. However, the association between physician supply and mortality is not consistent across the United States. Work by Ricketts and Holmes (2007) showed that this relationship exhibits regional variation—primary care physicians are associated with decreased mortality on the east coast and upper Midwest, but that correlation is non-existent or reversed in the West (with the exception of Washington State) and south central states [15].

While the debate about the need to increase medical school enrollments and the link between physician supply and health outcomes has continued, there has been general agreement about the need to strengthen, and reform, the delivery of primary care services in the United States. One key element of strengthening the primary care system is increasing physician supply in rural and underserved areas by supporting community health centers (CHCs). The nation's 1,200 CHCs form a critical element of the nation's health care safety net, serving approximately 16.3 million people, about 40% of whom are uninsured and two-thirds of whom are low income and members of racial or ethnic minority groups [16]. Slightly more than half (53%) of CHCs are located in rural and frontier areas and they serve about 1 in 7 of all US rural residents [17]. In contrast to other health workforce programs which were cut or received level funding under the

Bush administration, funding for CHCs doubled from $1.1 billion when Bush took office to $2.2 billion in fiscal 2009 [16]. President Obama's current stimulus package includes $1.5 billion for community health centers, but such a large-scale investment of resources raises the question of whether CHCs will be able to recruit the numbers of physicians necessary for an appreciable expansion of this health care safety net.

Shortages of primary care physicians to work in CHCs are a persistent problem, particularly in rural areas. In 2004, 13.3% of positions for family physicians in CHCs were vacant as were 20.8% of obstetrician-gynecologists positions [18]. Because CHCs cannot compete with the salaries offered by other employment settings such as group practices and hospitals, they are heavily dependent on physicians serving obligations through the National Health Service Corps (NHSC) [19, 20]. The NHSC was established in 1971 under the *Emergency Health Personnel Act of 1970* to "increase access to primary care services and reduce health disparities for people in health professions shortage areas" (HPSAs) [21]. Through both loan forgiveness and scholarship programs, the NHSC has placed more than 27,000 health professionals in rural and underserved areas since 1972 [22]. The program was most recently reauthorized under the *Health Care Safety Net Act of 2008* until 2012 [19]. NHSC appropriations totaled $121 million in fiscal year 2009 [23] and there are currently more than 4,600 physicians and other clinicians working in the NHSC [24].

While the NHSC is the most visible federal program designed to address physician maldistribution, since 1987 the federal Bureau of Health Professions

(BHPr) has matched up to 50% of the funds that states spend on loan repayment programs for primary care practitioners who work in a HPSA. In recent years, federal program funding has averaged about $7 million, and in 2004, 38 states participated in the program. Most states have additional programs designed to recruit physicians into rural and underserved communities and a survey of these programs in 1996 found that 41 states sponsored 82 loan forgiveness, scholarship and other incentive programs [25].

Title VII of the *Public Health Service Act* also provides a variety of grants for students, programs, and institutions to improve the supply, distribution and diversity of the health care workforce. The Area Health Education Centers (AHEC) program is one program funded under Title VII that aims to 1) improve the recruitment, distribution, supply, quality, and diversity of personnel in underserved rural and urban areas; 2) increase the supply of primary care providers in underserved areas; and 3) increase health careers awareness among individuals from underserved areas and underrepresented populations [26]. Currently, 51 AHEC programs exist across the US and federal investments in AHECs totaled over $28 million in fiscal year 2006.[1, 2]

Total federal funding for Title VII programs was nearly $300 million in 2005 [27], but funding has been reduced in recent years due to concerns about program effectiveness. In two separate reports on Title VII programs [28, 29], the

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[1] Most AHECs are not only funded through federal investments but also state legislative appropriations and foundation funding.

[2] While these programs are some of the better known initiatives designed to address rural physician shortages, this list does not represent a complete inventory of related programs in existence. I was unable to find data on total dollars spent and programs in place. Therefore, I likely underestimate total investments directed toward improving the maldistribution of physicians.

General Accounting Office (GAO) identified that "evaluations have not shown that these programs had a significant effect on…the supply distribution, and minority representation of health professionals [28]." Since 2002, Title VII has been operating under expired authorization and in November 2008, Senator Hillary Clinton introduced the *Health Professions and Primary Care Reinvestment Act* which would reauthorize Title VII and create a National Center for Health Workforce Analysis to "collect, analyze, and report data regarding workforce issues" and "describe and evaluate the effectiveness" of Title VII programs [30].

Past evaluations of Title VII programs, and other programs designed to increase physician supply in rural and underserved areas, have demonstrated the consistent difficulty policy makers have linking workforce interventions aimed at increasing physician supply to improved access to health care and better population health. A recently released systematic review of literature by the Cochrane Collaboration found no well-designed studies to support the short- or long-term impact of the many programs in place to increase rural physician supply [31]. Thus, despite significant investments of both federal and state dollars, policies aimed at addressing physician maldistribution have demonstrated limited success. One reason for this limited success may be that existing research, and the policy levers based on this research, is founded on an incomplete understanding of how the career aspirations, geographic preferences and practice behaviors of male and female physicians in different birth cohorts may vary in different historical periods.

Recent research is beginning to illuminate some of the factors that affect the diffusion of physicians into rural areas but many of these studies have been based on analyzing data from just a few points in time. Ricketts & Randolph (2008) used data from the American Medical Association's (AMA) Masterfile to analyze physician movement in two ten-year periods and found that physicians were more likely to go to places with lower physician-to-population ratios but higher per capita income and lower unemployment [32]. Vanasse et al (2007) also used AMA data and found that 13.2% of clinically active primary care physicians moved from one region to another between 1981-2003 and that those most likely to move were women and younger physicians [33]. A similar analysis of AMA data by Fraher and colleagues (2009) investigated the long-term retention of physicians in rural practice between 1991 and 2003 and found that women were and minorities were more likely to leave rural counties, as were younger physicians [34].

Other research has shown that geographic mobility is not just associated with physician gender and age but with the prevailing opportunity structure[3] [35]—existing economic conditions, demographic trends and competition from other physicians—facing the physician when s/he decides to change practice location. Brasure and colleagues (1999) examined the entry behavior of physicians into rural labor markets relative to the supply of physicians already in practice and found a drop in the level of demand needed to entice a first versus a second physician to locate in a rural community [36]. The authors hypothesized

[3] The term "opportunity structure" is from Cloward and Ohlin (1960) *Delinquency and Opportunity: A Theory of Delinquent Gangs*.

that the higher level of demand needed to attract a first physician may be due to the unattractiveness of being a solo practitioner in an area. In a cohort study of French general practitioners (GPs), Dormant and Samson (2008) demonstrated the importance of physician cohort size on choice of medical practice location and physician reimbursement [37]. Physicians in larger medical school cohorts faced stiffer competition and lower life time earnings, while those in smaller cohorts or those who entered practice during a time in which large numbers of physicians retired, experienced less competition and higher incomes. The authors found that the first years in practice were decisive for the physicians' life time earnings.

Thus, existing research on the factors influencing a physician's decision to locate in a rural area has demonstrated the importance of gender, age and practice context but what is lacking is a detailed longitudinal study of physicians' location behaviors that accounts for the fact that social norms **change over time** and that physician careers are located in **specific historical times** and **places** that shape their content, pattern, and direction [38]. Specifically, what is needed is needed is a life course approach to analyzing physician careers in rural areas that recognizes that "background characteristics, the social context and the person's current states combine to produce personal histories with considerable variation but also some regularities [39]. Past research has assumed that a physician's career trajectory follows an "innate developmental dynamic" [39] — that those factors that influence physician location behavior are static and generalizable across time. However, because the social and medical context changes over time, different cohorts of physicians who have entered practice in different historical periods and thus have experienced these social and medical practice changes at different ages and stages of their careers may have very different rural entry patterns.

Past studies have also tended to focus on the relationship between the physician's demographic and practice characteristics and the personal agency that s/he exerts in making the decision to move to a rural area at a *specific* point in time. By contrast, the life course perspective emphasizes the use of longitudinal data to observe the physician over time and to identify how the timing of transitions (e.g. the physician's entry into rural practice) may vary for different birth cohorts of physicians whose medical careers have unfolded in different historical and social contexts.

1.2. Conceptual Framework

This dissertation draws on, and applies, the conceptual framework of life course theory to an investigation of the factors that affect physician entry into rural counties in North Carolina. Life course theory makes two important contributions to physician workforce research: (1) it stresses the importance of longitudinal analyses for understanding the dynamic nature of physicians' workforce participation; and (2) in contrast to economic models that focus on individual agency and rational actor frameworks, life course theory stresses the importance of placing the physician's career decisions in the context of changing medical and social structures. Past studies, guided by more of an economic approach to understanding physician location behavior, have investigated physician location behavior as a series of discrete decisions made at specific points in time. By contrast, the study of the life course emphasizes the need for longitudinal panel studies that follow individuals over time to identify how the timing of decisions in a person's life—such as the decision to relocate a medical practice—vary across different historical periods and contexts.

Another theoretical construct used to frame this analysis is the sociology of aging, as developed by Matilda Riley. Riley's work on aging, as it underpins life course theory, motivated the analytic approach undertaken in this dissertation because it identified "variations in life patterns among different birth cohorts [and] helped elaborate a multidimensional model of aging and the life course, the principal elements of which are age of the individual (time since birth), historical period describing the larger society and cohort (the aggregate of persons of the same age)."… Riley's cohort studies in aging showed that "the shape of the life course was different depending one's year of birth; that is age, period and cohort intersect with each other produce different life patterns among different age groups or generations [39]."

Both the sociology of aging and the life course as theoretical frameworks emphasize the "idea of time as a social category" [40] and thus, by definition, require longitudinal study designs. Data sets are needed that contain information about individuals collected in waves over a long period of time so that one can investigate the effects of "period (the distinctive historical and cultural events experienced by persons of a given age and cohort), cohort (the socially shared experience of age peers), and age (the biological or developmental time since the births of individuals) [39].”

North Carolina has such a longitudinal database for physicians and is the subject of this dissertation research. Data are collected annually for physicians from annual licensure forms and these cross-sectional data files were combined to create physician-specific geographic location histories. With these histories it was possible to compare the timing of physicians’ transitions into rural counties between physicians in different birth cohorts who were in medical practice in North Carolina between 1980-2005.

1.3. Specific Aims

The dissertation is organized around three research objectives.

Aim 1.
Document the changing characteristics of rural and medical practice context in North Carolina.

The practice of medicine in North Carolina has undergone dramatic change in the past twenty-five years. To fully understand why physicians’ transitions into rural counties may differ now from in the past, one must place the physician’s career in the context of the rural practice environment over time. The likelihood that a physician will choose to enter rural practice is “a joint function of the characteristics of the person and of the environment” [41] and it is also a dynamic process that changes over time. Thus, the life course approach suggests an analytic strategy that first identifies the major changes that have occurred in the context of rural medical practice over time and then investigates how these historical changes may have resulted in different rural entry patterns for successive birth cohorts of physicians.

Aim 2.
Age and Cohort Effects: Investigate whether physicians of the same age in different birth cohorts exhibit similar or dissimilar patterns of entering rural practice.

A limitation of past workforce research is that it has not incorporated the life course perspective of age differentiation which is described by Elder (1975) as an awareness that “age locates individuals in historical time by defining their cohort membership and in the social structure by indicating their life or career stage [42].” Depending on the historical period in which physicians practiced and their age when major shifts occurred in medical education, medical practice and societal expectations, physicians in different birth cohorts are likely to have very different expectations about their careers. The purpose of this aim was to investigate whether the physician’s age affects rural entry patterns and whether these age effects differ by birth cohort. The fundamental question of interest is whether physicians in successive birth cohorts exhibit stable or divergent rural career transitions. The hypothesis of this research aim is best summarized by Matilda Riley whose years of work on the sociology of aging established the cohort principle: “Because society changes, members of different cohorts cannot age in precisely the same way [43]”.

Aim 3.
Gender Effects: Determine if different rural entry patterns exist for male and female physicians in different birth cohorts.

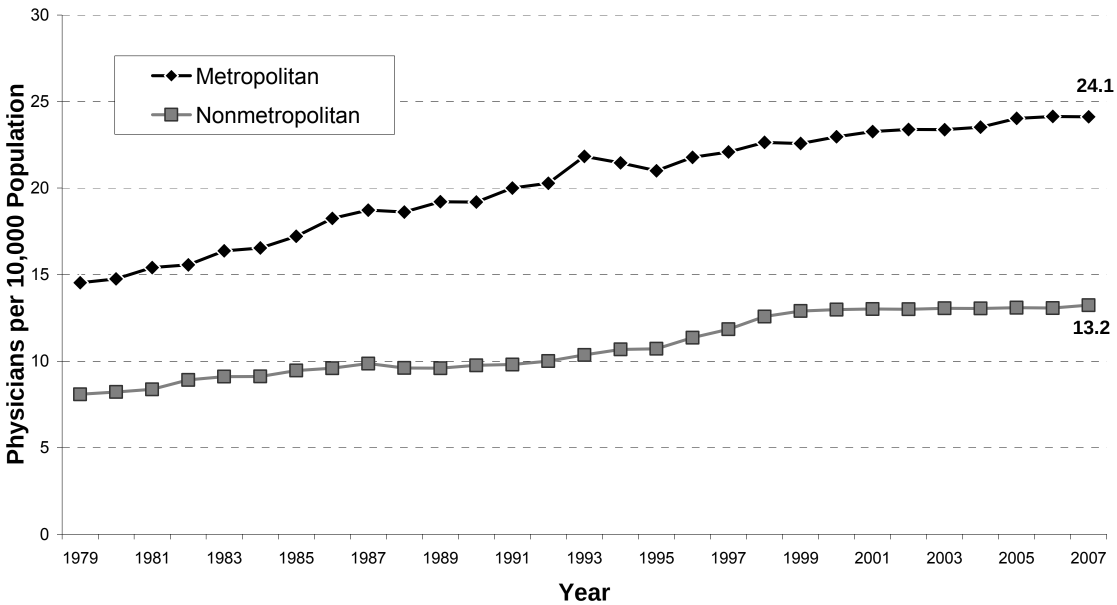
While women represent an increasingly important component of the physician workforce in rural areas, past research has not investigated whether gender differences exist between, or within, cohorts in the timing of male and female physicians' decisions to locate to rural areas. A third objective of this dissertation was to determine whether inter-cohort gender effects existed (i.e. did rural entry patterns vary between male and female physicians of the same age in different cohorts?) and if there were intra-cohort gender effects (i.e. did rural entry patterns vary between male and female physicians of the same age within the same birth cohort?)

1.4. Policy Significance

The goal of this dissertation is to provide policy makers with a better understanding of the demographic factors that not only influence *whether* a physician enters rural practice at a specific point in time, but also an appreciation of how the timing of *when* the physician enters rural practice may differ for male and female physicians in different birth cohorts. Only with this understanding can policy makers design rural practice incentives that are more specifically tailored to the physician's gender, age, birth cohort to have the maximum effect on rural physician recruitment.

This undertaking is timely given the near consensus among policy makers that North Carolina, and the nation, face an emerging physician shortage [1, 44-46]. North Carolina's supply of physicians in rural areas has continuously lagged behind that of urban ones (**Figure 1.1**) despite the sustained attention the issue has received, and despite persistent policy interventions implemented by the NC AHEC, the NC Office of Rural Health, the state's public medical schools and other entities.

Figure 1.1. Physicians per 10,000 Population by Metropolitan and Nonmetropolitan Counties, North Carolina, 1979-2007



Sources: North Carolina Health Professions Data System, 1979 to 2007; North Carolina Office of State Planning. Figures include all licensed, active, in-state, nonfederal, non-resident-in-training physicians. North Carolina population data are smoothed figures based on 1980, 1990 and 2000 Censuses. Source for Metropolitan-Nonmetropolitan definition: Office of Management and Budget, 2006.

The issue of rural physician recruitment is especially important in the context of an emerging physician shortage. In a competitive market for physicians, urban areas are likely to be more successful at attracting physicians. Research has shown rural practice is less appealing to physicians due to a perceived sense of professional isolation, a lack of amenities, lower incomes and higher care burdens (i.e. a larger amount of on call duty and fewer other physicians with whom to share the workload) [47-49] but these effects may differ across different cohorts of physicians as well as by age and gender.

The fundamental goal of this dissertation is to identify the degree to which male and female physicians of the same age in different birth cohorts in North Carolina have exhibited stable or differing rural entry patterns between 1980-2005. This investigation is critical to identifying if new and more targeted policy levers are needed that recognize both inter-cohort and intra-cohort differences in rural career transitions. If differences exist in the rural entry patterns between cohorts (e.g. inter-cohort effects) then those mechanisms that have worked in the past to attract physicians to rural areas may no longer be effective for more recent cohorts of physicians. More specifically, while physicians in older cohorts may have been attracted to the clinical autonomy [49, 50] of rural practice (that necessarily required long hours and a resiliency to high patient demand), newer cohorts may prefer a more controllable lifestyle in a salaried or group practice. Alternatively, social norms unique to specific cohorts may make some cohorts of physicians more likely to move than others. For example, female physicians in older birth cohorts may be more likely to move than female physicians in more recent cohorts to accommodate the needs of a spouse or to relocate in search of an employment situation that allows them to juggle the competing demands of motherhood and medicine.

The need for more refined policy levers that differentially target male and female physicians in different birth cohorts and that work across the physician's career trajectory is a policy nuance that has not received attention. For example, existing interventions to increase physician supply in rural areas are generally focused on the physician's early career decisions. Current strategies include recruiting students to medical school who are from rural areas since these students have been shown to be more likely to return to a rural community to practice [51, 52]; designing curriculum that emphasizes rural health issues and encourages students to consider rural practice [53]; funding clinical placements in rural and underserved areas to increase medical students' and resident's exposure to the challenges and rewards of practicing medicine in a rural setting [54, 55]; and providing loan repayment and scholarship programs to pay off the medical debt of students who then serve in rural and underserved areas when they first enter practice [56, 57]. But what if physicians who are most likely to enter rural practice are increasingly mid- to late-career? What if important differences exist between cohorts in the ages that physicians are most likely to enter rural practice? What if the effect of gender on a physician's decision to locate to a rural county is not consistent between cohorts? Such differences in physician location behavior would suggest the need for policy interventions that are more dynamically tailored to the physician's cohort, gender and age. This dissertation focuses on identifying inter- and intra-cohort effects and makes specific recommendations about how existing policy levers might be enhanced to have a greater effect on rural physician supply.

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2. LITERATURE REVIEW

2.1. The Need for a Better Understanding of the Temporal Organization of Physicians' Career Transitions across Different Structural and Historical Contexts

The relative undersupply of physicians in rural communities is a stable characteristic of the US health care system [1]. In 2004, 17% of the US population lived in rural counties where the ratio of 12.6 physicians per 10,000 people was nearly half of the ratio of the 24.8 physicians per 10,000 people in urban areas [2].[4] Physicians most likely to practice in rural areas are male and in primary care specialties [3, 4]. Research demonstrates that female and minority physicians are less likely to stay in rural practice even if initially enticed there by loan repayment programs [5, 6], but that the gender gap is narrowing [4].

Despite the stable and enduring picture of physician supply in rural areas, workforce research to date has not acknowledged how the interplay of two important temporal forces—changing lives and changing social/medical structures—might combine to produce very different career pathways for physicians in different birth cohorts. As Riley (1998) suggests, "[i]n the continuing dialectic between changing lives and changing structures, it is not only lives that change; structures also change. Full understanding of how lives change (as in

[4] Author's calculations based on 2004 data from the American Medical Association in the Area Resource File.

the life course approach) also requires understanding the process of change in the surrounding structures [7].”

2.1.1. Changing Lives

Life course theory as a conceptual framework stresses the importance of studying individuals over time and “a central line of conceptual development has been in identifying, characterizing, and explaining the temporal organization of the life course and its variations across structural and historical contexts [8]”. By contrast, most physician workforce research is either cross-sectional or employs a longitudinal approach focused on a discrete event (i.e. did the physician enter, exit or remain in a rural community) between time A and time B. The research designs of these studies implicitly assume that physicians march through a series of discrete transitions that in the aggregate produce rural career trajectories that are not much different now than they have been in the past. A review of the literature reveals that the vast majority of research employs a “transitions in career” approach. Analyses focus on an economic model of rational choice that treats each location decision as a discrete decision and views the physician’s career as a set of discrete transitions between a series of career roles, from medical student to resident, from residency to setting up initial practice, from initial to ongoing practice, and finally into retirement and exit from the workforce. To date, research has generally focused on one of four transitions of a physician’s career described below.

1. **The transition between medical school and residency training**.

   Studies falling into this category investigate why medical students choose specific practice locations. The literature tends to focus on the effect of medical school on the physician's later selection of a rural practice location [9-11]. Examples include studies investigating whether Area Health Education Center (AHEC) training rotations during medical school increase the likelihood of selecting a rural practice location [12] and Rabinowitz's numerous works on the Physician Shortage Area program at Jefferson Medical College [13-16].

2. **The transition between residency training and initial practice location.** Research in this domain focuses on factors that affect the physician's initial practice location. Examples include research on the location of residency training programs as a predictor of future rural practice location and the success of the National Health Service Corps and state loan repayment and forgiveness programs, in recruiting and retaining physicians in rural and underserved areas [17-19].
3. **The physician's mature career trajectory**. Examples of research in this area include investigations of gender differences in the challenges facing physicians in rural practice [5, 20, 21] and physician retention and turnover in rural and health professional shortage areas [22, 23].
4. **The physician's exit from the workforce**. Studies that focus specifically on physician retirement have increased with rising concerns about the effect the retiring Baby Boomers will have on supply [24, 25]. Researchers have studied the effect of the aging rural physician workforce [26], the

implications of physician retirement for workforce planning [27] and the accuracy of physicians stated retirement intentions [28].

While past research acknowledges the developmental nature of the physician’s career over time and the importance of transitions in the work life, it falls short of employing more dynamic methods that investigate factors related to the *timing* of the physician’s decision to enter rural practice. More specifically, research does not investigate whether career transitions into rural practice vary for physicians in different birth cohorts whose careers have unfolded during very different structural and historical contexts. The evolution of the physician’s practice trajectory, the biological process of aging, changes in the medical practice context and the historical period all have the potential to combine to produce career transitions with considerable variation [29].

2.1.2. Changing Medical Practice Structures and Rural Context

The practice of medicine in North Carolina (and nationally) has undergone dramatic change in the past twenty years. Fee-for-service and private insurance arrangements have declined while health maintenance organizations (HMOs) and public insurance plans (i.e. Medicaid and Medicare) have grown. Lengths-of-stay in hospitals have dropped dramatically and many medical procedures that formerly required inpatient stays are now performed on an out-patient basis. Health care has become more regional and less local. Procedures that once were performed by a primary care physician or general surgeon in a rural area are now referred to tertiary care settings in urban areas. Practice arrangements for physicians have also changed. Fewer physicians practice in traditional self-employed practitioner offices and more are salaried in group practices. Physicians are increasingly specializing and fewer medical students are opting for careers in primary care.

Despite the fact that these changes in the context of medical practice are fairly obvious and well-documented, a review of the literature reveals that almost without exception, physician workforce analyses fail to employ birth cohort analyses to explore the importance of historical change on physician practice behaviors [30]. The vast majority of workforce analyses are cross-sectional or longitudinal with few observation periods. Those studies that are longitudinal analyses have generally failed to investigate the dynamic interaction over time of the physician's developing career trajectory and the changing practice environment.

The importance of studying the interrelated changes in two research units—the individual and the surrounding structures—is a recurring theme of life course research and was demonstrated by Streib (1993) in a study of retirement communities. Streib found that "the characteristics and experiences of residents in these communities depended not only on the residents but also on the 'adaptability, vitality, and long range survival' of the community itself….just as residents grow older over time and new cohorts are recruited, structures also move through 'stages'—social, economic and physical". (quotation marks in the original) [7].

Recognizing the importance of context to decisions about where to practice, Cutchin (1994) proposed that the physician's "socio-cultural integration" in the rural community was a predictor of retention [31]. Cutchin proposed a theoretical model of retention called "experiential place integration" that suggested that "each physician's pathway of integration is an outcome of the combination of unique personal history and self with a specific situation and time" [32]. This dissertation builds on, and extends, Cutchin's beginning formulations of a more dynamic theory that incorporates the interplay of the physician's developing career and the changing rural practice environment. However, instead of investigating retention in rural areas, this analysis focuses on the physician's decision to move into a rural area. Further, because the dataset used in this dissertation has many more observations than were in Cutchin's analysis and because it contains data on the physician and the rural practice environment over a longer period of time, it allows for a richer comparison of career transitions into rural areas between different cohorts of physicians who practiced in different historical periods.

A temporal version of Bronfenbrenner's ecology of human development provides one way to conceptualize the complex interaction of the physician's unfolding career and his or her changing practice context. Bronfenbrenner proposed that "[t]the characteristics of the person at a given time in his or her life are a joint function of the characteristics of the person and of the environment" and he suggested that this interaction occurs at three levels: a micro-, meso- and macro-level [33]. While Bronfenbrenner's conceptualization of the ecology of human development does not consider how temporal factors such as age and historical time influence life transitions, his typology provides a useful way to structure an investigation into the way in which physician's career decisions are influenced by the rural practice environment.

Micro-level influences might be exerted by the norms of the particular specialty in which the physician practices. Physician specialties exert a strong socializing force upon their members and the professional culture of surgery is very different than that of family medicine. Meso-level structuring might occur at the level of employment setting. Hospitals in rural areas may open or close. Physician practice settings have changed. More physicians are employed in group practice settings while solo-practitioner offices used to be more of the norm in rural areas. Increasingly, large tertiary medical centers are buying small rural practices. The availability of jobs in certain practice settings, as well as collegiality and competition from other providers is likely to affect rural physician career decisions.

Examples of macro contextual factors likely to influence the entry decisions of rural physicians include the proportion of the population on Medicaid; changes in population size and the economic growth or decline of their community; and the presence of service sector industries that contribute to physicians' quality of life (i.e. availability of shopping and entertainment centers). At the broadest macro-level, changes in societal expectations about female physicians' roles as mothers and doctors also need to be considered.

The strength of basing this analysis on life course theory is that the theory provides a new lens through which to view physician careers. The life course framework suggests an approach that first identifies the major changes that have occurred in the rural and medical practice over time and then investigates how these effects may have influenced the decision to enter rural practice for successive birth cohorts of male and female physicians who encountered these changes at different ages and stages of their medical careers.

2.2. Cohort Effects: The Changing Context of Medical Practice Produces Different Rural Career Transitions for Physicians of the Same Age in Different Birth Cohorts

This dissertation uses a cohort design to locate physicians in historical time and allow for an examination of how micro-, meso- and macro-effects have "rippled" through the workforce [34].[5] A cohort design is critical because depending on the historical period during which physicians practiced and their age when major shifts occurred in medical education, medical practice and societal expectations, physicians in different birth cohorts are likely to have very different expectations about their careers. In contrast to traditional agency-based approaches that have modeled the physician's decision to locate in a rural community as a discrete choice made at a specific point in time and then generalized the findings to other time periods and other cohorts, a cohort design "allows for the encoding of historical events and social interaction outside the person as well as the age-related biological [29]" changes that occur over the physician's career trajectory. The benefit of this type of design is that the factors affecting the location decision, for example age and gender, are allowed to vary across cohorts and between time periods.

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3 The "ripple" metaphor was borrowed from pg. 9 in *Changing Britain, Changing Lives: Three Generations at the Turn of the Century*.

In the current policy debate about whether or not the US faces an emerging physician shortage there has been much attention paid to the issue of whether more recent birth cohorts practice in the same way as their predecessors [35-37]. However, very few empirical analyses exist that directly address this question[6] [38-40] and none deal directly with differences between cohorts in geographic location behaviors.

The issue of work-life balance is one that has been given much attention in physician supply discussions and centers on whether new generations of physicians share the same commitment to medicine as their predecessors [41]. There is a commonly held perception that physicians in the Baby-Boom generation (born 1946-1964) work longer hours, hold their physician identity more central to their self-identity and are generally more committed to their medical careers. By contrast, Generation X physicians (born 1965-1979) are perceived to be more concerned with achieving a balance between home and work, are more likely to see their medical role as only part of their self-identity [42-45].

Existing workforce research does not use cohort designs to test the hypothesis that because the practice context continuously evolves, physicians in different birth cohorts (and different genders within these cohorts) will not follow

[6] Three exceptions are the works by

Fraher, E., Ricketts, T.C. Slacker Gen Xers or Workaholic Boomers?: An Analysis of Age, Gender, Cohort and Historical Period Effects on Physician Practice;

Watson, D.E., Slade, S., Buske, L., Tepper, J. Intergenerational Differences in Workloads Among Primary Care Physicians: A Ten-Year, Population-Based Study; and

Crossley, T.F., Hurley, J., Jeon, S.H. Physician Labour Supply in Canada: A Cohort Analysis.

the same career trajectory patterns. Reflecting on the limitations of previous research on aging, Riley (1998) identifies two important fallacies (life course and cohort-centrism) that are directly relevant to rural physician workforce studies [7].

The **"life course fallacy"** involves "erroneously interpreting cross-sectional age differences as if they referred to the process of aging [7]." Workforce analyses have fallen into a life course fallacy by interpreting cross-sectional differences in rural entry patterns between by age as if they revealed insight into how younger physicians' careers will evolve [46, 47]. The limitation is that one is looking at the physician population at a given point in time and assuming that a static process governs how the physician's career will develop. The second limitation is the **"fallacy of cohort-centrism"** or "assuming that members of all cohorts will grow older in the same fashion as members of our own cohort [7]." Workforce research that examines the practice patterns of a single cohort over time and then abstracts these findings to all cohorts ignores the influence of historical period and gender effects on different cohorts of physicians [48].

This dissertation addresses past research limitations by employing birth cohorts to illuminate important period effects related to the organization of medicine and society that influence physicians' decisions to enter rural practice. Exploring the relationship between contextual factors and individual physicians' career decisions greatly enhances current workforce research that views the physician outside of the context of historical time and place.

2.3. Age Effects: The Physician's Age Affects Decision to Enter Rural Practice

Life course studies emphasize the importance of age in structuring how people organize their lives and make decisions about family, education, and work. Age structuring exists, in part, because individuals have expectations about what they will have achieved by a certain age and these expectations are both individually determined and normed to the expectations of society. Neugarten, Moore and Lowe (1965) conducted a seminal study of age-related norms in the 1950s [49]. With the use of age-graded timetables for men and women and the "Age Norm Checklist", the authors asked individuals for the "best" age at which to accomplish a series of life transitions (e.g. marriage, childbearing). They found a high degree of consensus around the specific ages at which individuals expected to experience life transitions. Their study "supported the notion that a set of age expectations underlie adult life, and that men and women are aware of the social clocks that operate in their lives and of their own timing in relation to them [50]." Since Nuegarten et al's study, other research has revealed more heterogeneity in how individuals organize their lives [50, 51]. Technology, the restructuring of the economy, the emphasis on life-long learning, lower mortality and morbidity rates, advances in reproductive science and other changes have created more heterogeneity in the organization of the life course.

To the degree that individuals have a "mental map"[7] [52] of the age-graded deadlines by which they expect to achieve certain life transitions,

[7] From Hagestad GO and Nuegarten BL. (1985). "Age and the Life Course.", as cited in Settersten "Age Structuring and the Rhythm of the Life Course"

Settersten (2004) proposes that this map exists at different levels [52]. "*General timetables* are widely shared timetables for major life transitions that most individuals experience. In contrast, *specialized timetables* exist for specific populations……such as cohort, sex, race, and social class…*Personal timetables* are those timetables that are 'not shared and not normative' [52]. Settersten's taxonomy provides a useful approach to structuring an investigation of the degree to which there are age-related norms in the transitions that physicians make into rural counties and whether these age-related norms are the same or different between cohorts.. Settersten's taxonomy suggests three potentially fruitful areas for investigation: 1. whether rural entry patterns vary for physicians of the same age in different birth cohorts (e.g. is there evidence of different inter-cohort age effects?); 2. whether age-structuring is the same for male and female physicians within cohorts (e.g. is there evidence of intra-cohort gender differences in age structuring?); and 3. whether rural entry patterns vary for male and female physicians of the same age in different cohorts (e.g. is there evidence of inter-cohort gender differences in age structuring?). If age structuring is an invariant attribute of rural medical careers, one would expect to see a high degree of uniformity in the rural entry patterns of physicians in different cohorts at the same age. Such a finding would support the idea that rural physicians' careers are relatively stable across time. This is the implicit assumption of existing research that uses cross-sectional data to identify the effect of age on rural entry and then extrapolates these effects to physicians in different birth cohorts in different historical periods. If the effect of age on physician location patterns has changed over time, one would expect to see heterogeneity between the location behaviors of physicians in different cohorts at the same ages. This type of finding would suggest the need for policy interventions that are more dynamically tailored to influence specific cohorts' location behaviors.

The existence of *inter-cohort* differences in rural location behaviors could suggest that there are socially or environmentally patterned behaviors shared within cohorts that influence physicians' geographic location behaviors (e.g. cohort effects). If *intra-cohort* differences exist, the data would reveal different rural entry patterns for male and female physicians within the same birth cohorts. Both inter- and intra-cohort analyses of age structuring by gender is important because as Riley proposes, "a theory of age must include a theory of gender" [7]. Female physicians, more than their male counterparts, adjust their medical careers to better manage the competing demands of family and work obligations [53]. The result is that men are more oriented toward age-related deadlines that make their careers more predictable by age but women's careers are "more fluid, unpredictable and discontinuous" [53].

Physician workforce studies have identified that younger physicians are more likely to enter and exit rural communities [54] perhaps because these physicians have fewer family responsibilities and are more mobile [55], but there are no studies of whether this age effect is constant between male and female physicians in different cohorts. Recent work on age-gender-cohort effects on physician productivity suggests it may not be. In an analysis of differences in hours worked by male and female physicians in different birth cohorts, Fraher and Ricketts (2009) found that while female physicians in different cohorts worked approximately the same number of hours at the same ages, they consistently worked fewer hours in their 40s than in their 30s and 50s. Thus, for female physicians the data showed a more pronounced age effect than a cohort effect. By contrast, male physicians in more recent cohorts worked fewer hours at the same age than physicians in older birth cohorts and the gender differential between hours worked by male and female physicians had narrowed in the Generation X cohort [38]. These findings point to a consistent age effect for women that is likely dictated by their biological clocks. That male physicians in more recent cohorts worked fewer hours may be evidence of a cohort effect related to achieving a “controllable lifestyle”.

2.4. Gender Effects: The Gendered Dynamics of Physician Transitions into Rural Practice

Arguably one of the most dramatic changes in medical practice has been the increasing number of women entering medicine. In 1972, Congress passed the *Educational Amendment Act* which prohibited educational institutions receiving federal funds from discriminating against female applicants to colleges and universities. This and other federal legislation, in concert with the accomplishments of the feminist movement, removed many discriminatory barriers women had previously faced in pursing education toward a professional degree [56]. Inter-cohort comparisons by gender are important because physicians in the seven birth cohorts analyzed in this dissertation grew up in very different phases of the feminist movement. **Table 2.1** shows that women began to enter the physician workforce in greater numbers starting with the Boomer 1 cohort.

Table 2.1
Percent Female by Birth Cohort

Cohort (birth year)	% Female
Pre-Depression (before 1912)	5.9%
Depression (1912-1921)	5.1%
Pre-WWII (1922-1927)	5.1%
WWII (1928-1945)	6.2%
Boomer #1 (1946-1954)	16.4%
Boomer #2 (1955-1964)	26.8%
Generation X (1965-1979)	39.2%
Total Sample	**17.5%**

The break between the WWII and Boomer cohorts makes intuitive sense because woman born in the Boomer 1 cohort were between 11 and 19 years of age, still very formative years in terms of career selection, when the feminist movement was in full swing in mid-1960s. By contrast, women in the WWII cohort were in their 20’s and 30’s and had already selected into careers by the time the women’s movement changed the way that society viewed women’s work outside the home.

Understanding the effect of gender on the dynamics of rural physician recruitment is important given the rapidly changing demographics of the physician workforce. **Figure 2.1** shows that in 1980 women represented just 6.6% of all physicians licensed to practice in North Carolina, but their representation in the workforce steadily increased so that by 2005, one in every four physicians (25.4%) in the state was a woman. The gender transformation of medicine is likely to continue and is not unique to North Carolina. Nationally, 44.7% of all residents-in-training in 2007 were women [57].

Figure 2.1. Number of Male and Female Physicians North Carolina, 1980-2005

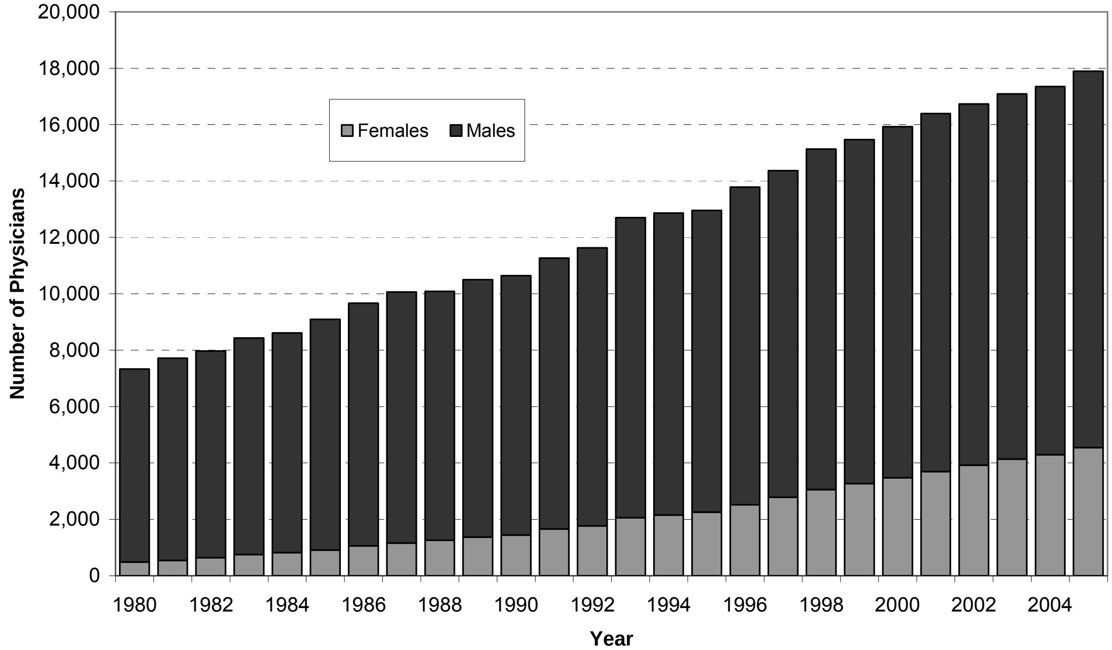


Table 2.2 shows that certain medical specialties in North Carolina have feminized more rapidly than others. Between 1980 and 2005 women increased their representation in pediatrics by 34 percentage points, a specialty in which they now are in the majority. By contrast, women have not increased their numbers in the surgical specialties as rapidly. They make up only 2% of the urologic and orthopedic surgical workforce and only 5% of neurosurgeons.

The relative feminization of some specialties and not others is important because it demonstrates that women have been more likely to gravitate toward primary care specialties in which there is greater opportunity for a controllable lifestyle. The fact that primary care physicians are more likely to be found in rural communities creates an opposing force to past research that has consistently shown female physicians to be less likely than their male counterparts to practice in rural areas [6]. The literature demonstrates that important gender differences exist between male and female physicians regarding the choice to locate in a rural area [5] and the issues that face them once in practice [20]. Past research also shows that women are more likely to be influenced by childcare availability, flexible scheduling, and family leave [5]. Female physicians want to live in a good place to raise a family, to not have too much on-call responsibility and to have the opportunity to balance their personal and professional lives [21]. These differences in practice preferences by gender were confirmed in a large study of female family physicians in rural settings that found that the main issues facing women in rural medicine revolve around family/social issues, such as balancing work and family and being accepted into the community, and professional issues like availability of advanced training, work overload, and lack of female colleagues [20].

Table 2.2.
Percent Female in Sex-Segregated Specialties, North Carolina Physicians, 1980-2005

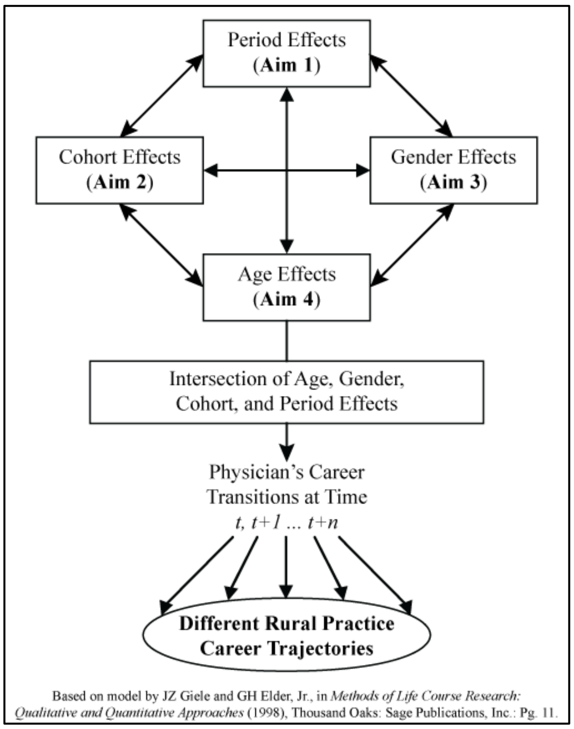
Specialty	1980	1985	1990	1995	2000	2005	% point change 1980-2005
Urological Surgery	0%	0%	0%	2%	1%	2%	2%
Orthopedic Surgery	1%	0%	2%	2%	2%	3%	2%
Neurosurgery	0%	3%	3%	4%	5%	5%	5%
Cardiovascular Disease	0%	2%	4%	4%	5%	2%	2%
General Surgery	1%	2%	4%	6%	7%	8%	7%
Otorhinolaryngology	1%	2%	4%	5%	6%	9%	8%
Gastroenterology	1%	5%	4%	7%	7%	8%	7%
Ophthalmology	2%	4%	7%	10%	12%	16%	14%
Radiology	4%	4%	10%	12%	14%	17%	13%
Total NC Physicians	**7%**	**10%**	**14%**	**17%**	**22%**	**25%**	**18%**
Internal Medicine	7%	10%	15%	20%	24%	29%	22%
Child Psychiatry	26%	23%	29%	35%	35%	38%	12%
Psychiatry	11%	16%	22%	26%	32%	35%	24%
Dermatology	6%	7%	19%	27%	31%	38%	32%
Obstetrics/Gynecology	4%	7%	14%	19%	30%	39%	35%
Pediatrics	18%	24%	33%	39%	48%	52%	34%

More recent research shows that the gender gap in rural areas is closing [4]. Yet, while women represent an increasingly important component of the physician workforce in rural areas, research does not focus on whether the influence of gender on physicians' transitions into rural practice differs for female physicians in different birth cohorts. Examining female physicians by successive birth cohorts will likely reveal important differences in geographic mobility patterns between male and female physicians and between younger and older birth cohorts of each sex. Female physicians who began to practice in the early years when solo-practitioner offices were more of the norm and female doctors were fewer in number in rural areas may have been less likely to choose rural practice careers. By contrast, later cohorts of female physicians who commenced practicing in an era of greater acceptance of women attempting to balance both careers and families likely were able to exert more agency in their choice of practice location and to identify employment settings that allowed for more flexible practice schedules. Thus, as the number of group practices has increased, as women have increasingly selected into primary specialties, and as the number of female physicians practicing in rural communities has increased, it is possible that rural practice has become more attractive to female physicians than in the past and that the gender gap in rural practice selection has narrowed for younger physicians in more recent birth cohorts.

2.5. Conceptual Model for Research Incorporates Historical, Cohort, Gender and Age Effects

Existing research on rural physician careers [46] does not account for gender, age, cohort and historical effects. Most studies are based on cross-sectional or longitudinal data with few observation periods and thus may produce biased results if gender-age-cohort patterns change over time. By contrast, the research described in this dissertation, and depicted in **Figure 2.2.** investigates how changes in the context of medicine and rural practice may create historical effects that are experienced differently by male and female physicians in different birth cohorts. The goal of this dissertation is to identify the degree to which the rural entry patterns of male and female physicians in different birth cohorts in North Carolina have exhibited stable or differing patterns between 1980-2005.

Figure 2.2. Conceptual Model: Factors Affecting Physician's Decision to Move to Rural County



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3. METHODS

3.1. Overview of Methods

A retrospective cohort analysis of licensed physicians in North Carolina from 1980-2005 was conducted to determine if rural entry patterns varied for male and female physicians of the same age in different birth cohorts.

The study employs descriptive analyses, event history methods (more specifically Kaplan-Meier survivor analyses), and logistic regression to investigate whether male and female physicians of the same age in different birth cohorts have similar or dissimilar geographic location patterns. The decision to locate to a rural county was examined separately for new-to-practice physicians and for physicians already in practice. Logistic regression was used to investigate whether there were age, cohort and gender effects on initial choice of rural practice county by new-to-practice physicians. Survival analyses were used to investigate when, in terms of biological age, physicians in different birth cohorts who were already in practice entered rural counties.

Separate survival analyses were conducted to determine if inter-cohort differences existed (e.g. variation in location behaviors between physicians of the same age in different birth cohorts), as well as if intra- and inter-cohort gender effects were present (e.g. variation in location behaviors between male and female physicians within the same and different cohorts). Event history analysis

(EHA) methods such as survival curves are well-suited to the aims of this dissertation because they allow one to explicitly model the time that elapses (e.g. in terms of age) before a physician makes a transition from one status to another (e.g. s/he enters rural practice).

3.2. Study Design

The first task was to combine the records of multiple years of physician licensure data from the North Carolina Medical Board. Licensure records from 1980-2005 were combined at two-year intervals to form 13 waves of physician-specific practice location histories. In each wave, the physician was categorized as entering, exiting or remaining in a rural county.

3.3. Data Sources

The main data source for the study was physician licensure files derived from the North Carolina Medical Board's licensure renewal process and housed at the North Carolina Health Professions Data System (HPDS). Cross-sectional physician licensure files from the HPDS were linked over time and reconfigured to create physician-level location histories from 1980-2005. Such longitudinal data are essential to crafting life course studies because they allow for "a more precise picture of how individual lives are mutually shaped by personal characteristics and the social environment" [1]. Unlike cross-sectional data which cannot distinguish between age and cohort effects, panel data allow one to account for the fact that different processes may govern the career transitions of physicians of the same age in different birth cohorts.

County-level data were collected from multiple sources including Log-Into-North-North Carolina (LINC) and internal Sheps Center databases. Data were also obtained from the North Carolina Office of Rural Health and Community Care on whether or not the physician was serving a loan or scholarship obligation with the National Health Service Corps.

3.3.1 Physician Licensure Data

Physician licensure data used in the analysis are housed by the North Carolina Health Professions Data System (HPDS) at the Cecil G. Sheps Center for Health Services Research at the University of North Carolina at Chapel Hill. Files contain physician demographic and practice information, including the physician's business address, birth year, sex, race, information on medical and residency training (i.e., program name and state and year graduated), specialty, activity status, and county where s/he practices. Physician-level data used in the analysis are detailed in **Table 3.1**.

The activity status of a given physician may change over time (i.e. the person may retire, move out of the state but maintain a license, or maintain a license while working in another profession), therefore having a license does not always indicate that the physician is actively practicing. To eliminate this measurement error, the data used in this research include only those physicians who indicated on their renewal form that they were working in North Carolina and were actively engaged in the profession. Active status may include administrators, researchers and educators who are active in the profession but not engaged in direct patient care. Active status is assigned to individuals who are newly licensed and have not reported their status. Doctors of medicine (MDs) and doctors of osteopathy (DOs), both of whom register with the N.C. Medical Board, are included in the data. Physicians are classified by specialty according to the self-reported primary specialty indicated on their Application for Registration with the N.C. Medical Board.

Table 3.1. Description of Study Variables

Variables	Source	Type
Dependent Variables		
Physician entered a rural county (all analyses)	1	Dichotomous
New-to-practice physician entered rural county (logistic regression)	1	Dichotomous
Age from when physician first observed in licensure file until move to rural county (survival analyses)	1	Continuous
Explanatory/Control Variables		
Physician-level variables		
Physician's age	1	Continuous
Physician's birth cohort		
Pre-Depression (before 1912), Depression (1912-1921), Pre-WWII (1922-1927), WWII (1928-1945), Boomer 1 (1946-1954), Boomer 2 (1955-1964) and Generation X (1965-1979))	1	Dichotomous variables
Physician's sex	1	Dichotomous
Physician's race (White, Black, Asian, Other)	1	Dichotomous variables
Primary care physician	1	Dichotomous
General Surgeon	1	Dichotomous
Serving National Health Service Corps Obligation	2	Dichotomous
County-level variables		
Population (000)	3	Continuous
Population 65 years & over (%)	3	Continuous
Population covered by Medicaid (%)	4	Continuous
Non-white population (%)	1	Continuous
Unemployment rate	6	Continuous
Per capita income (00)	5	Continuous
Number of acute care hospital beds	4	Continuous

Sources: 1. NC Health Professions Data System; 2. NC Office of Rural Health and Community Care;, 3. US Census; 4. NC Department of Health and Human Services; 5. US Bureau of Economic Analysis; 6. NC Department of Commerce

The creation of a longitudinal data set required the linking of 25 years of licensure data. Individual physicians were matched via their unique license number or, where that number was mis-coded, they were looked up using the North Carolina Board of Medical Examiner's (BME) “doc finder” system. Often during the data linking process, records were identified that conflicted with earlier or later data on the physician. This happened most often for physician birth year, medical school graduation year and year of initial licensure. To verify which information was correct, approximately 300 records were looked up on the BME website. The initial merged file contained 172,957 records and after data cleaning, removing duplicates, correcting license numbers and re-linking the data, the final analysis file contained 172,949 observations on 33,338 physicians.

3.3.2. Physicians Serving National Health Service Corps Obligations

Because physicians may enter a rural community as part of an obligated service to fulfill a loan repayment or scholarship obligation with the National Health Service Corps (NHSC), data on NHSC physicians serving obligations in North Carolina from 1997 to 2005 were obtained from the NC Office of Rural Health and Community Care (NCORHCC). These records were matched to the physician licensure files using individual-level identifiers. **Table 3.2** shows the number of physicians serving NHSC obligations in NC by year.

Table 3.2. Number of Physicians Serving National Health Service Corps Obligations in NC, 1997-2005

Year	Total NHSC physicians
1997	27
1999	65
2001	78
2003	86
2005	93

Unfortunately, not all NHSC physicians were able to be identified in the data (i.e. a physician can be directly placed in NC by the federal office) and data were only available from 1997-2005. However, because 45% of NHSC physicians entered rural counties in North Carolina, these data were included in the analysis as a way to partially control for physicians who entered a rural county to serve an obligation.

3.3.3. County-Level Data

County-level data were obtained from multiple sources, including Log-into-North Carolina (LINC) and existing data sets housed at the Sheps Center, as well as from public use files available through the world wide web sources. LINC is the State Data Center's online data system and is maintained by the Office of State Budget and Management. County-level data used in the analysis are detailed in **Table 3.2** and include population size, population density, percent of the population over the age of 65, population socio-demographic and economic characteristics, numbers of acute care hospital beds in the county, percent of the population covered by Medicaid, and ratios of physicians, primary care physicians and general surgeons to 10,000 population in the county.

3.4. Measurement

3.4.1. Dependent Variable

The physician's primary practice location was compared in each year to his or her location in the previous period in which the physician was observed. Data were available for active, instate physicians practicing in North Carolina in

1980, 1982, 1984, 1986, 1988, 1990, 1992, 1994, 1995, 1997, 1999, 2001, 2003, 2005. These years were selected because prior to 1994, physicians renewed their licenses biannually in even years and after 1995, physicians renewed their licenses annually. To keep the spacing increments between years consistent, odd years were used after 1995. Thus, except between 1994 and 1995, physicians' practice locations were compared in two-year intervals.

In each period in which the physician was observed, s/he was coded as entering a new county, exiting a county or staying in the same practice location. When data on physician moves were analyzed, it became evident that some physicians appeared to have moved even though they switched practice locations between adjacent counties in consecutive years (i.e. the physician moved from Hyde County in 1990 to Tyrrell County in 1992 back to Hyde in 1994). Because these types of moves are likely either a ZIP coding issue or an artifact of the physician having two different practice locations and reporting them in alternating years, the data were recoded so that if a physician moved between contiguous counties in contiguous years, the data were not counted as real moves. Of the 11,578 moves originally identified in the data, 1,406 (12.1%) were recoded as not real moves. After this data cleaning step, a total of 10,172 observations on physicians entering new practice locations remained in the sample.

While each of the analytic methods employed in this analysis seeks to investigate whether the effect of physician age and gender on the probability of entry into rural practice varies by birth cohort, the dependent variable of interest varies slightly for each of the analytic approaches:

1. In the logistic regression and descriptive analyses, the dependent variable is dichotomous and is coded to 1 if the physician entered a rural county and 0 if the physician entered an urban county for his or her first practice location.
2. In the survival analyses, the dependent variable is physician age and physicians are “at risk” of an event from the age they are first observed in the licensure file until entry into a rural county or exit from the file.

In all the analyses, a physician is coded as being in a rural county if his or her primary practice is located in a rural county. Physicians report a primary practice location county on their licensure renewal form and this address is updated annually. The precision of practice location information is good because physicians who do not report to the North Carolina Medical Board that they have moved are subject to sanctions.

Because a county can change from rural to urban status (and less often from urban to rural) over time, the rural classification that was current at the time that the physician entered practice was used in the analysis. Counties were classified as rural or urban according Office of Management and Budget (OMB) definitions in that year. The OMB classifies counties as metropolitan or non-metropolitan based on census data and census definitions of urban and rural, commuting patterns and business activity. A metropolitan area is defined as a core area with a large, densely settled population that exhibits a high degree of economic and social integration [2].

3.4.2. Independent Variables

Physician-Level Factors

Physician Age and Birth Cohort:

Physicians were assigned to one of seven cohorts based on birth year. **Table 3.2** shows the number of physicians, number of observations, age range, years in practice and percent of the workforce that was female by birth cohort. Years in practice was calculated by the subtracting the year the physician graduated from medical school from the year the physician was observed in the file. **Table 3.3** shows that the first two cohorts (Pre-Depression and Depression) were observed in the latter years of their medical career, the middle two cohorts (Pre-WWII and WWII) in the midpoint of their medical careers and the later three cohorts (Boomer 1, Boomer 2 and Generation X) from the beginning until about the middle of their careers.

The use of birth cohorts is essential to investigate how large-scale changes over time in the context of medical practice and social structures have rippled through the physician population, affecting career decisions to enter rural practice [3].[8] **Figure 3.1** shows the age range for which physicians in the seven birth cohorts are observed in the data. The black notch in the data is the average

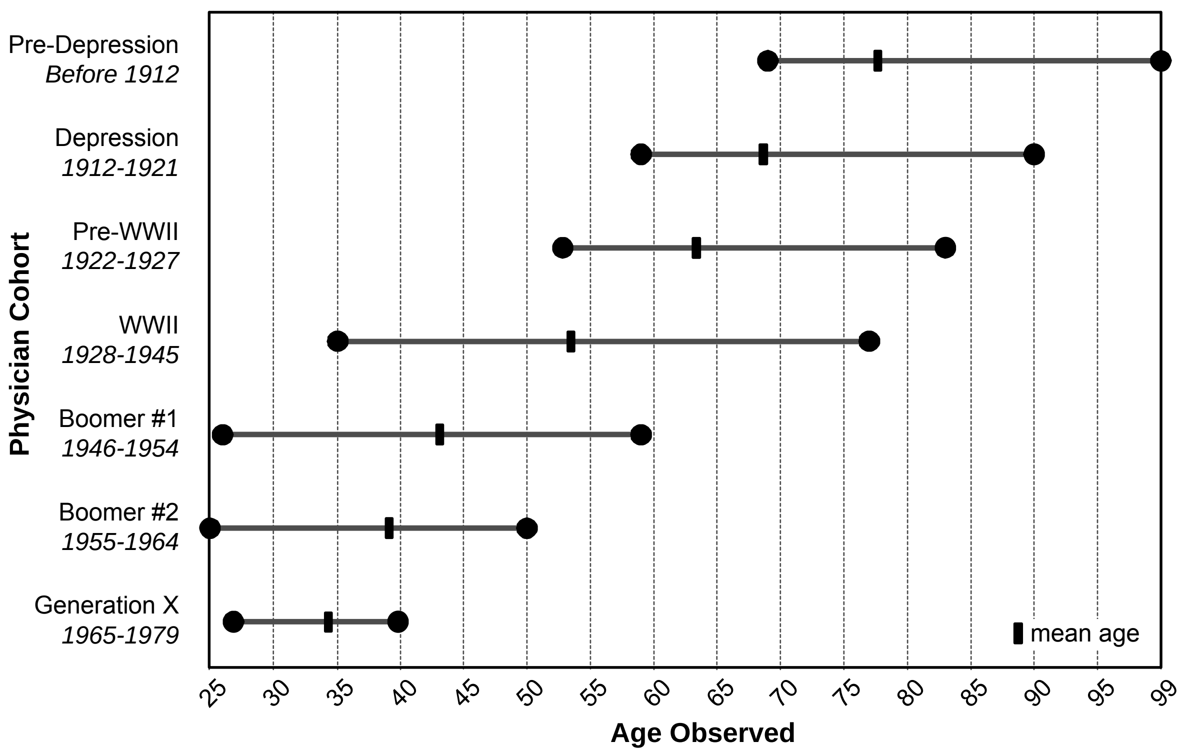
[8] This sentence is paraphrased from a book describing the use of the British birth cohort studies to study period, cohort, age and gender effects of various policy interventions and social change in England. The book is *Changing Britain, Changing Lives: Three Generations at the Turn of the Century*.

Table 3.3. Age, Sex and Years in Medical Practice by Cohort

Cohort (*birth year*)	**# of physicians**	**# of observations**	**Age when observed mean (min-max)**	**Years in practice when observed mean (min-max)**	**% Female**
Pre-Depression (*before 1912*)	1,461	470	77.6 (69-99)	51.2 (29-75)	5.9%
Depression (*1912-1921*)	5,792	1,181	69.1 (59-92)	42.6 (14-68)	5.1%
Pre-WWII (*1922-1927*)	7,786	1,152	64.1 (53-83)	37.8 (13-60)	5.1%
WWII (*1928-1945*)	46,141	5,358	53.7 (35-77)	27.0 (1-55)	6.2%
Boomer #1 (*1946-1954*)	50,684	7,650	43.9 (26-59)	16.6 (1-37)	16.4%
Boomer #2 (*1955-1964*)	45,533	10,417	39.1 (24-50)	11.9 (0-29)	26.8%
Generation X (*1965-1979*)	15,547	7,105	34.0 (24-40)	7.4 (1-20)	39.2%
Total Sample	**172,944**	**33,333**	**46.4 (24-99)**	**19.4 (0-75)**	**17.5%**

Note: 5 physicians were missing birth year

Figure 3.1. Age Range at Which Rural Physicians are Observed by Birth Cohort



age at which physicians in the various cohorts are observed. The figure clearly illustrates the benefit of using longitudinal data on multiple cohorts in that there are overlaps between the cohorts in the ages at which they are observed in the data. The GenX, Boomer 2 and Boomer 1 cohorts are observed from the mid-twenties until their 40s and 50s while the Pre-Depression, Depression and Pre-WWII cohorts are observed in from their mid 50s into their 80s. The WWII cohort is positioned between these 2 groups and is observed over the longest practice trajectory with physicians in this cohort having data from ages 35-77. The fact that multiple cohorts are observed at the same ages affords the opportunity to test hypotheses related to variation in rural entry patterns due to cohort effects. This type of cohort-sequential design has not previously been employed in studies of physician location behavior.

Variable definitions are described below.

- *Physician Sex*: This is a binary variable coded to one for female.
- *Physician Race*: Dichotomous variables were coded to 1 if the physician was white, black, Asian or of another racial/ethnic category. “Other” included physicians reporting American Indian, Pacific Islander, Hispanic and unspecified race/ethnicities.
- *Physician Medical Specialty*: A dichotomous variable for primary care was coded to 1 if the physician reported a primary specialty of general or family medicine, internal medicine, pediatrics and obstetrics and gynecology. A dichotomous variable was coded to 1 if the physician indicated a primary specialty of general surgery. Physicians who reported a primary specialty

other than primary care or surgery were coded with a dichotomous variable as specialists.

- *Physicians Serving National Health Service Corps Obligations*: A dichotomous variable was coded to 1 if the physician was serving either a scholarship or loan obligation with the National Health Service Corps.

3.5. Sample

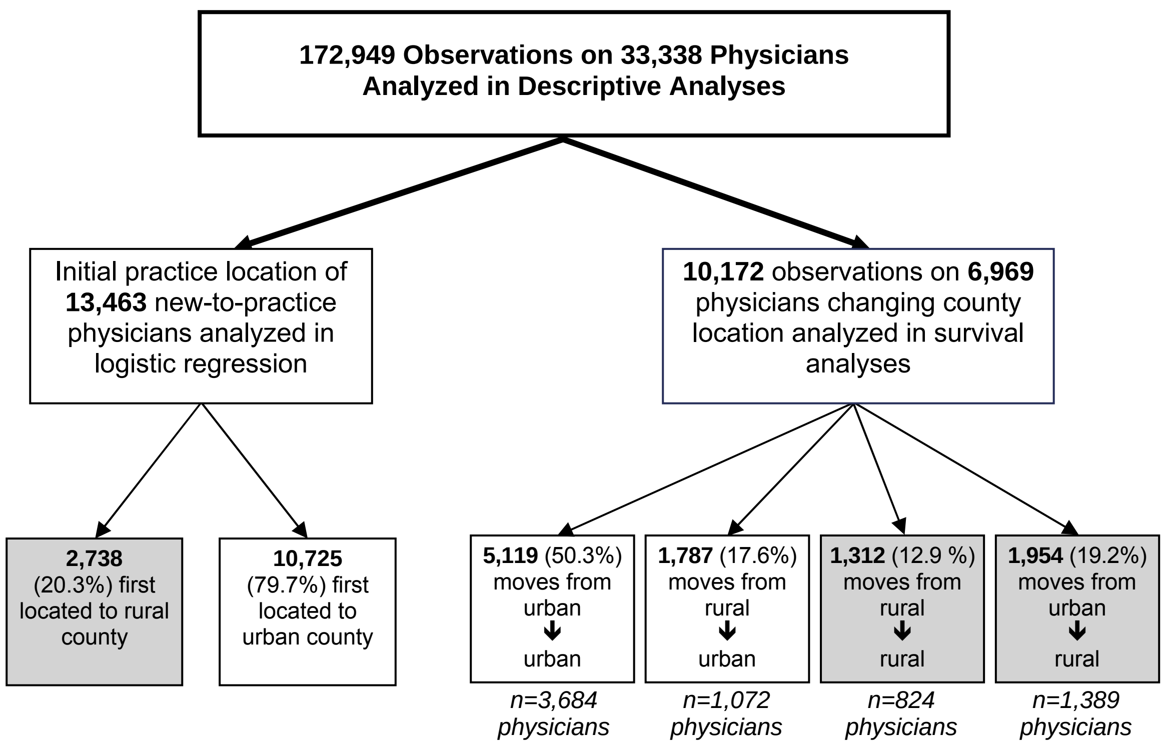
The sample included 172,949 observations on 33,338 physicians. **Table 3.4** shows the number of physicians by count of how many times they were observed in the data. Nearly one in four (24.3%) physicians was observed in just one time period and another 14.2% were observed in just two periods. On average, physicians were observed in 5.2 time periods.

Table 3.4. Count of Times Physician Is Observed in Data

Count	# of physicians	% of physicians
1	8,099	24.3%
2	4,723	14.2%
3	3,131	9.4%
4	2,736	8.2%
5	2,197	6.6%
6	1,362	4.1%
7	1,633	4.9%
8	1,520	4.6%
9	1,409	4.2%
10	1,322	4.0%
11	1,168	3.5%
12	974	2.9%
13	1,014	3.0%
14	2,050	6.1%
Total	**33,338**	**100%**

The sample and two sub-samples used in the logistic and survival analyses are described in **Figure 3.2**. The full sample used in the descriptive analyses included 172,949 observations on the 33,338 active, non-resident-in-training physicians practicing in North Carolina who renewed their licenses in the study years. The sub-sample of physicians analyzed in the logistic regression contained 13,463 new-to-practice physicians in the first year they were observed in the data. The sub-sample of physicians used in the survival analysis contained 139,611 observations on 25,239 physicians who were observed in at least two time periods. Physicians in this sub-sample were observed changing practice locations 10,172 times; 5,199 (50.3%) of these moves were from one urban location to another and 1,787 (17.6%) were from rural to urban counties. A total of 3,266 observations on 2,213 physicians were moves to rural counties, either from another rural county or an urban one.

Figure 3.2. Number of Observations and Physicians Analyzed in Main Sample and Two Sub-Samples Used in Logistic Regression and Survival Analysis



3.6. Overview of Analysis by Research Aim

To undertake workforce research using a life course framework one must have longitudinal panel data that allow the study of physicians over time. Only with such data can one understand how changing lives intersect with the changing rural and medical practice context to produce varying rural career transitions for physicians in different birth cohorts. This type of approach is in contrast to most of the existing workforce research on physician entry into rural areas which has taken more of a discrete choice, point-in-time approach that implicitly assumes that the underlying age and gender processes governing physician location behaviors are static between cohorts and over time.

The dissertation employs three methodological approaches—descriptive analyses, logistic regression and Kaplan-Meier survival curves—to investigate how age, gender and birth cohort affect physicians' decisions to enter rural practice. The analytical strategies used to test hypotheses related to the research aims are detailed below.

3.6.1. Document the changing characteristics of the rural and medical practice context in North Carolina.

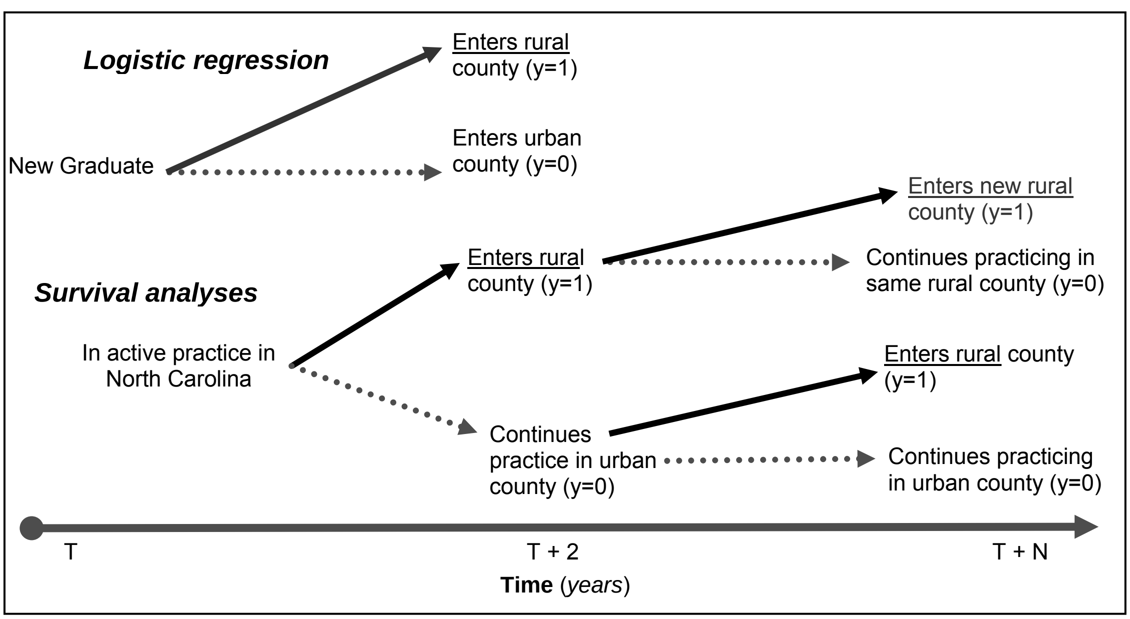
The purpose of this aim was to identify changes in the rural and medical practice context in North Carolina between 1980 and 2005 that may have created historical period effects. Counties were coded as rural using the Office of Management and Budget definition at the time the physician entered practice. Because counties change their rural status over time, cartographic analysis was used to illustrate which counties were classified as rural or urban continuously over the period and which counties switched rural/urban status during the study period.

The demographic and economic characteristics of rural counties in North Carolina were examined between 1980 and 2005 to identify changes that occurred during the study period. As well, changes in the demographic, medical specialty, employment setting and hours worked by physicians in practice in rural counties were examined.

3.6.2. Age, Gender and Cohort Effects: Investigate whether male and female physicians of the same age in different birth cohorts exhibit similar or dissimilar patterns of entering rural practice.

The effect of age and gender for physicians in different cohorts on practice location were first explored using descriptive analyses. Changes in the age, cohort and gender structure of both new entrants to rural areas and of the total rural workforce were examined between 1980-2005. Following these descriptive trends, separate analyses were conducted to identify the relationship of age, gender and cohort to rural practice selection for both new-to-practice physicians and for physicians already in practice. Logistic regression was used to examine the effect of age, gender and cohort on selection of a rural county for an initial practice location and survival analyses were used to examine these effects on the decision to locate to a rural county for physicians already in practice (**Figure 3.3**). Physician moves from rural to urban locations were not considered in this project as the focus is on the choice of a rural practice location.

Figure 3.3. Analytical Strategy



3.6.2.a. Selection of Initial Practice Location

A logistic regression model was used to investigate the relationship of the physician's birth cohort, gender and age to the probability that she or he chose a rural county for a first practice location. A maximum likelihood estimation model was needed because the outcome (i.e. whether or not the physician moved to a rural or urban county for his or her initial practice location) is not continuous and logistic regression is the appropriate model because there are just two independent, non-ranked outcomes—the physician moves to a rural or urban county. To correct for the heteroskedastic errors, robust standard errors were estimated.

Because physicians of the same age were observed in different cohorts, hypotheses related to variation in initial practice selection due to the effect of age, gender and cohort could be tested. The primary hypothesis tested was whether the physician's birth cohort had an effect on choice of a rural practice location after controlling for age, gender, race, and medical specialty. This hypothesis was tested by including dummy variables for physician cohort in the model. Three additional questions related to the effect of gender on choice of a rural county for an initial practice location were investigated and are detailed below:

1. Past life course research has emphasized that any "theory of age must include a theory of gender [4]." To test whether the effect of age on choice of an initial practice location varied for male and female physicians, the age and female dummy variables were interacted with one another.

2. While women represent an increasingly important component of the physician workforce, research has not focused on whether the influence of gender on physicians' transitions into rural practice varies by birth cohort. Interaction terms were created between the female and cohort variables to test whether the effect of being female on choice of a rural county varied by cohort.
3. The careers of male and female physicians observed in the data unfolded during very different time periods, during which there were different societal expectations both in terms of the role of women as wives/mothers/doctors and in terms of the expectations of both male and female physicians about the need to balance professional and personal lives. Of late, there has been much discussion of younger physicians' desires for a "controllable lifestyle"; such professional desires would not favor rural practice. To test whether the effect of age varied for male and female physicians in different birth cohorts, a triple interaction term was created between the physician's age group, cohort and gender.

Rural location was assigned to counties according to the physician's primary practice location using the Office of Management and Budget (OMB) designations current at the time the physician entered practice. The model included physicians in each study year who were no more than six years post-medical school and who were observed for the first time in the data set. Ideally, one would have used the date of graduation from residency as the way to identify new-to-practice physicians but these data were of poor quality in the more recent data years. Thus, year of medical school graduation was used to determine new-to-practice physicians.

The control variables included in the model were physician race, medical specialty and participation in the National Health Service Corps. Year dichotomous variables were included in the model to allow for time fixed effects (e.g. to capture any time-period specific shocks that occurred during the period). These time-fixed effects adjust, for example, for the increased urbanization of the state over the study period. The model also included a set of dichotomous variables related to the physician's practice characteristics. A dichotomous variable was coded equal to one for primary care if the physician's primary specialty was in family medicine, general practice, internal medicine, pediatrics, or obstetrics and gynecology. Another set of dichotomous variables were coded to one if the physician indicated a primary specialty of general surgery. All other physicians were coded as specialists. There were 118 physicians in the data set who were serving a National Health Service Corps obligation at the time they were observed and a dichotomous variable was coded to one for these physicians.

Race data were problematic in the HPDS file; about 5.3% of observations were missing information on physician race/ethnicity. Because the percent of observations missing race data was higher for physicians locating to an urban area (5.8%) compared to physicians selecting rural areas (3.8%), it was unclear whether to include the race variables. Two approaches were possible—using a complete case analysis that would drop the observations with missing race data or dropping race as a variable in the model. To determine whether the race variable should be included in the model, a Lagrange Multiplier (LM) test was used. The traditional LM test used for Ordinary Least Squares (OLS) regressions was adjusted to account for the non-linearity and heteroskedasticity of the logistic regression. The resulting LM test statistic was $\chi^2_{(3)}$ =22.5, p= .000. The null hypothesis that the restricted model with no race variables should be used was rejected and the race dichotomous variables were included in the model.

Other model specification tests were performed. In reviewing the initial logit results, it appeared that coefficients for Black and other race (includes Native American, Hispanic and unspecified) were similar enough in magnitude that they should be tested to see if the coefficients were equal to each other. The Wald test statistic was $\chi^2_{(1)}$ =.65, p =.4217 and the null hypothesis that the Black and other race categories were equal to each other could not be rejected. Thus, the black and other race variables were combined in the final model.

The reference, or "base case" category, was constructed to reflect the physician who most often moves to a rural county for a first practice location—a white male, 30-39 years of age, in the Boomer 2 birth cohort, who is a primary care physician. Year 2005 was used as the reference year. The base case scenario provided a useful benchmark to which to compare the predicted probabilities that male and female physicians of the same age in different birth cohorts would move to a rural county.

While comparing the predicted probability of moving to a rural county for physicians of different age, gender, and cohort characteristics in the sample is useful, it does not allow one to determine the statistical significance of the marginal effect of being female on choice of initial practice location for physicians of different ages in different cohorts. Because the model contained interaction terms that allowed the effect of gender to vary for physicians in different birth cohorts and age groups one cannot easily interpret the marginal effect of being female from either the regression output or from the predicted probabilities.

Therefore, to calculate marginal effects, the average of the probabilities method was used. More specifically, the probability of moving to a rural county was calculated twice for each observation—once with each observation in the dataset coded as female and once with each observation re-coded to male. This allows one to calculate, for each physician in the data, the marginal effect of being female in a specific age category and birth cohort. These marginal effects were then bootstrapped 500 times to obtain an estimate of the standard error and the confidence interval around the mean.

3.6.2.b. Practicing Physicians Movements to Rural Counties

While choice of an initial practice location is important, physicians often make multiple moves during their careers. **Table 3.5** shows the count of physicians who moved by the number of times they moved and the number of observations contained in the dataset for each number of moves. 67.8% of

Table 3.5. Count of Physicians and Observations by Number of Moves

# Moves	# of Physicians	# of observations in dataset
1	4,723	4,723
2	1,594	3,188
3	439	1,317
4	150	600
5	42	210
6	17	102
7	1	7
8	2	16
9	1	9
	6,969	**10,172**

physicians who moved at all were observed moving just once and 22.9% of physicians moved in two time periods. One physician in the data set moved nine times.

Event history analyses describe the timing of transitions that individuals make between states and thus are well-suited for this study. The relevant transition of interest is the move to a rural county and the timing variable of interest is when, in terms of the physician's biological age, this transition is made. Physician location histories were recoded from cross-sectional year-by-year records into an event history format using Stata's *snapspan* and *stset* commands. These commands reshaped the data into a survival analysis format and defined: 1. the transition of interest as the physician moving to a rural county; 2. the physician's age as the variable for analyzing the timing of the move; and 3. the observation period for which the physician was analyzed (i.e. from when they were first observed in the data to when they exited the dataset). Physicians who entered rural practice multiple times over the period were included in the analysis each time they entered rural practice and were analyzed using repeated event analysis proposed by Allison (1995) [5] and Singer and Willett (2003) [6]. This approach treats the interval between spells of rural practice for each physician as separate observations and these intervals are pooled across individuals.

Censoring and truncation of data are important methodological considerations in event history analyses. Physicians move in and out of the licensure file and thus are only observed for the period in which they are in the data. Right-hand censored data are observations for which the physician was never observed moving to a rural county although she or he was under observation for the entire study period or cases in which the physician left the sample during the study period because she or he was no longer licensed in North Carolina. Right-hand censored data are handled by EHA and are accounted for in the calculation of the physicians “at risk” of entering a rural county at a given age. This is because the denominator of the calculation that measures the rate at which physicians transition to rural counties by age (e.g. the hazard rate) is an approximation of total exposure time: all cases who entered into that age plus half of those who left the age (i.e. half of the sum of # failed + # censored).

Left truncation (e.g. delayed entry) was a potential problem with the data and related to the fact that physicians could enter the licensure file at any age. Thus, it was impossible to know their location histories before they were under observation. Left truncation results in censoring problems because the physician could have moved to a rural county before entering the sample and thus, the transition of interest would not have happened within the study window. Left censoring could be problematic if there were systematic differences between physicians who were left-handed censored and those who were included in the analysis (i.e. are not censored or are right-hand censored). Although left censoring could have biased the results presented in this dissertation, analyses of the age groups at which physicians entered, exited and remained in the sample presented in **Table 3.6** shows that left truncation was not likely to be a major issue. The

Table 3.6. Comparison of Physician's Age When First and Last Observed Compared to Sample

Age	first	%	last	%	sample	%
< 30	2,282	6.8%	800	2.4%	2,433	1.4%
30-39	20,212	60.6%	10,893	32.7%	53,943	31.2%
40-49	5,998	18.0%	8,812	26.4%	56,484	32.7%
50-59	2,829	8.5%	6,284	18.9%	35,208	20.4%
60-69	1,452	4.4%	4,111	12.3%	18,197	10.5%
70 & over	560	1.7%	2,433	7.3%	6,679	3.9%
Total	**33,333**	**100%**	**33,333**	**100%**	**172,944**	**100%**

Note: 5 physicians were missing birth year majority of physicians (67.5%) were first observed when they were less 40 years of age and this is both the period in which they were most likely to move and is the focus of the analyses presented in the results section of this dissertation.

Since the transitions that physicians in different cohorts made to rural counties are compared at the same ages, left truncation could also have been problematic if there were differences in the ages at which the cohorts of study came into the licensure file. Since this dissertation focuses on entry into rural counties and physicians are most likely to enter new counties are younger ages, a decision was made to focus specifically on comparing the entry patterns of the more recent birth cohorts at younger ages.

Analyses of the age at which physicians first came into the analysis file revealed that although Generation X physicians were more likely to be observed at younger ages, there were not large differences between physicians in the Generation X, Boomer 1 and Boomer 2 cohorts in the age that were first observed (**Table 3.7**).

Table 3.7. Age Distribution of Physicians When First Observed

Age	Boomer 1	%	Boomer 2	%	Gen X	%
30	321	11.2%	453	9.9%	494	17.6%
31	349	12.2%	637	13.9%	503	17.9%
32	453	15.8%	596	13.0%	537	19.1%
33	455	15.9%	656	14.4%	387	13.8%
34	456	15.9%	549	12.0%	375	13.4%
35	210	7.3%	558	12.2%	202	7.2%
36	239	8.4%	396	8.7%	165	5.9%
37	193	6.7%	452	9.9%	77	2.7%
38	184	6.4%	271	5.9%	68	2.4%
Total	*2,860*	*100%*	*4,568*	*100%*	*2,808*	*100%*
Avg. Age	**33.4**		**33.6**		**32.6**	

The rate at which physicians moved to rural counties at different ages was first explored by examining the hazard rate. The hazard rate gives the probability that the physician moved to a rural county at a given age. Intuitively, the hazard rate is useful because it can be interpreted as the propensity to transition to rural county at specific ages.

Because the hazard function showed the fastest transition rate for younger physicians, survival curves were then estimated and compared for physicians in the Boomer 1, Boomer 2 and Generation X birth cohorts. Survivor functions provide a visual way to examine inter-cohort differences in the probability that a physician progressed to a certain age before moving to a rural county. Survival curves make intuitive sense because one can imagine a group of physicians who, as they age, make the decision to move to a rural county. Plotting the survival curves of the cohorts together allows one to visually compare the probabilities that the physician moves at various ages between cohorts.

In addition to visually examining the data for differences, four statistical tests are available in Stata to test for equality of the survivor functions between cohorts: the log rank, the Wilcoxon-Breslow-Gehan, the Tarone-Ware and the Peto-Peto-Prentice tests. The null hypotheses were that the survivor functions for the different cohorts and for male and female physicians were statistically equivalent. While all of the tests are appropriate for testing the equality of survivor functions across two or more groups, they differ in the amount of weight given to the beginning versus later portions of the age span when physicians are more “at risk” of entering rural counties [7]. Because in almost all of the analyses conducted the results of all four tests agreed with each other, the log rank test is reported in the results.

Survivor functions were estimated separately for male and female physicians in the different cohorts to investigate two sets of gender-related questions:

1. **Inter-cohort differences**: Did rural entry patterns vary between male and female physicians in different cohorts?; and
2. **Intra-cohort differences:** Did rural entry patterns vary between male and female physicians within the same birth cohort?

To test for inter-cohort comparisons, separate survivor functions were estimated for male and female physicians in the Boomer 1, Boomer 2 and Generation X cohorts. The log rank test was used to test the null hypothesis that there were no differences in between the cohorts. For intra-cohort comparisons, separate survival functions were estimated and compared for male versus female physicians within each of these three cohorts. Again, a log-rank test was used to test the hypothesis that was no difference in the survivor functions between male and female physicians in the same birth cohort.

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4. RESULTS

4.1. Chapter Overview

The results chapter of this dissertation is divided into three main sections. The first section relates to the first research aim and uses descriptive analyses to illustrate how the context of rural and medical practice changed during the study period. This first section also uses descriptive analyses to illustrate how the age-gender-cohort structure of new entrants to rural counties changed between 1980 and 2005. The second section of Chapter 4 reports the results of the logistic regression model and the third section shows the results of the survival analyses. These latter two sections address the question of whether male and female physicians of the same age in different birth cohorts had similar or dissimilar rural entry patterns.

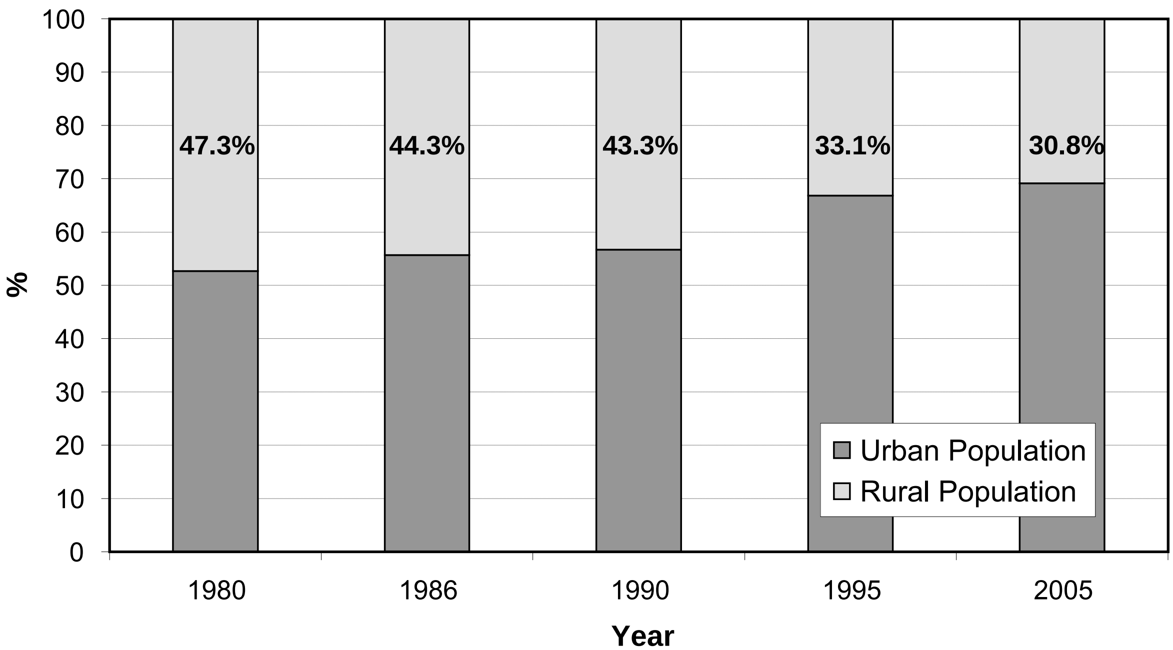
4.2. Historical Changes in the Rural and Medical Practice Context

The goal of this first section of Chapter 4 is to identify changes in the rural and medical practice context in North Carolina that may have created historical period effects for male and female physicians of different ages in the seven birth cohorts.

4.2.1 Demographic and Economic Changes in North Carolina's Rural Counties

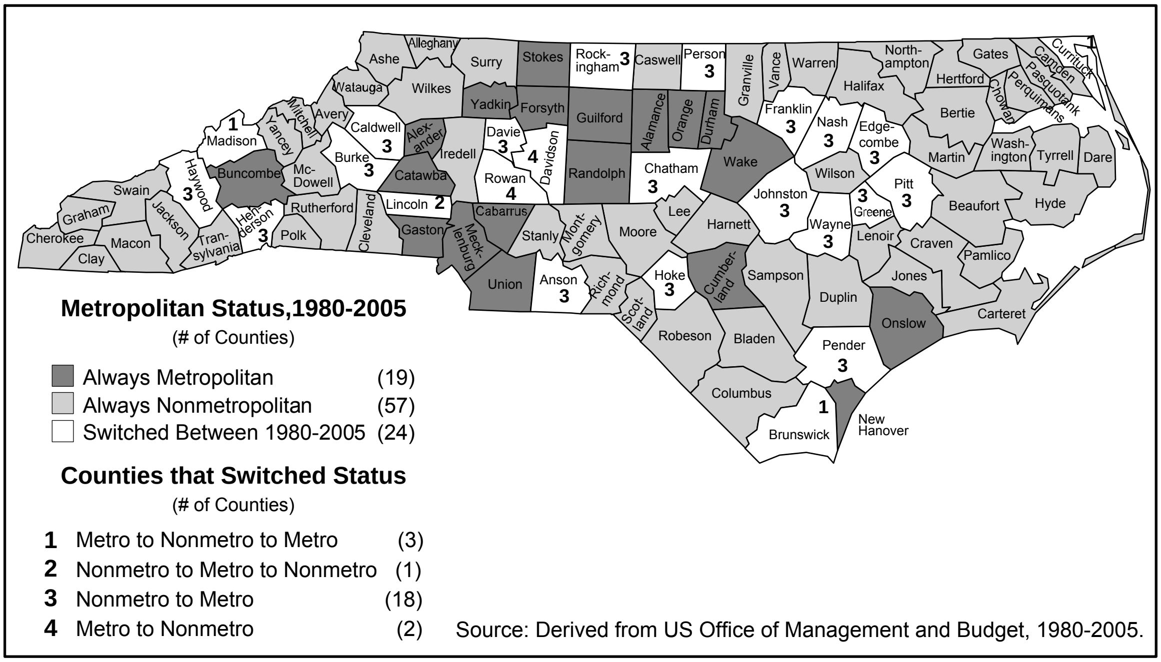
North Carolina's population, economy and health care system underwent significant change during the study period. Between 1980 and 2005, North Carolina's population grew by 47%, increasing from 5.9 to 8.7 million people. While nearly one in every two individuals (47.3%) lived in a rural county in 1980, by 2005 slightly fewer than one in three (30.8%) people did (**Figure 4.1**).

Figure 4.1. Percent of the Population in Rural vs. Urban Counties North Carolina, 1980-2005



Between 1980 and 2005, the number of counties classified as rural by the Office of Management and Budget declined from 75 to 60. The general trend was toward counties changing from rural to urban status as seen in **Figure 4.2**, but four counties switched status multiple times during the study period and two counties switched from urban to rural status.

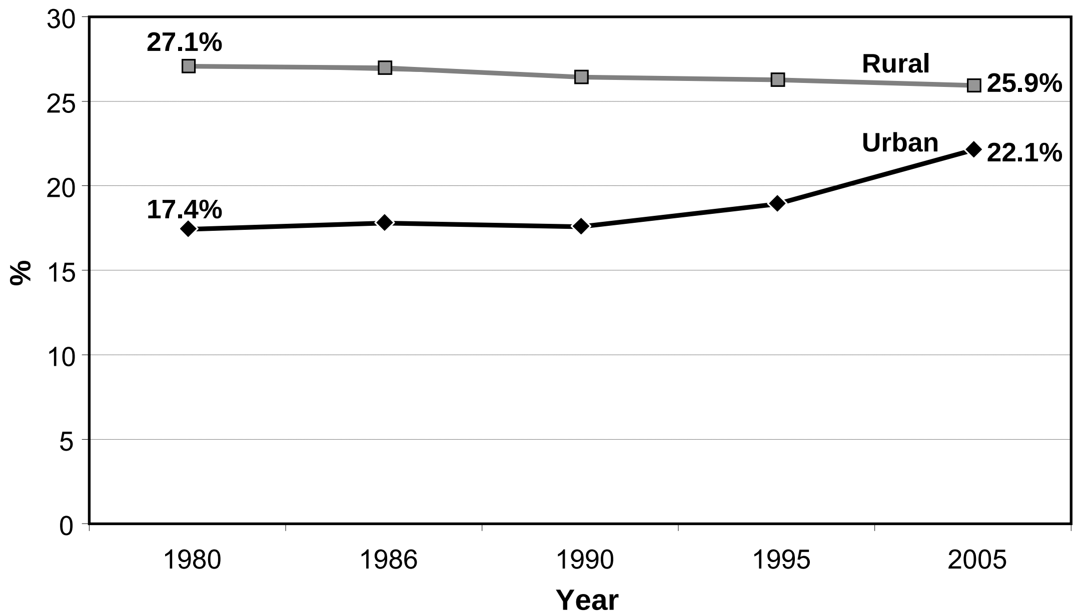
Figure 4.2. Metropolitan Status Change by County North Carolina, 1980-2005



The percentage of North Carolina’s population 65 years of age and older increased from 10.3% in 1980 to 11.9% in 2005. Greater proportions of the elderly tend to live in rural communities and this trend is reflected in the data. Between 1980 and 2005, the population over age 65 in rural counties increased by 3.5 percentage points from 12.1% to 15.6% of the population, compared to urban areas which increased 2.4 percentage points from 10.0% to 12.4% of the population.

North Carolina’s population became increasingly racially/ethnically diverse during the study period. Between 1980 and 2005, urban areas became increasingly more diverse and rural areas slightly less so (**Figure 4.3**). However, there is considerable inter-county variation between rural counties in the percent of the population that is non-white. In 2005, 65% of Robeson and 64% of Bertie counties' populations were non-white compared to 1.1% of Mitchell and 1.2% of Yancey counties' population.

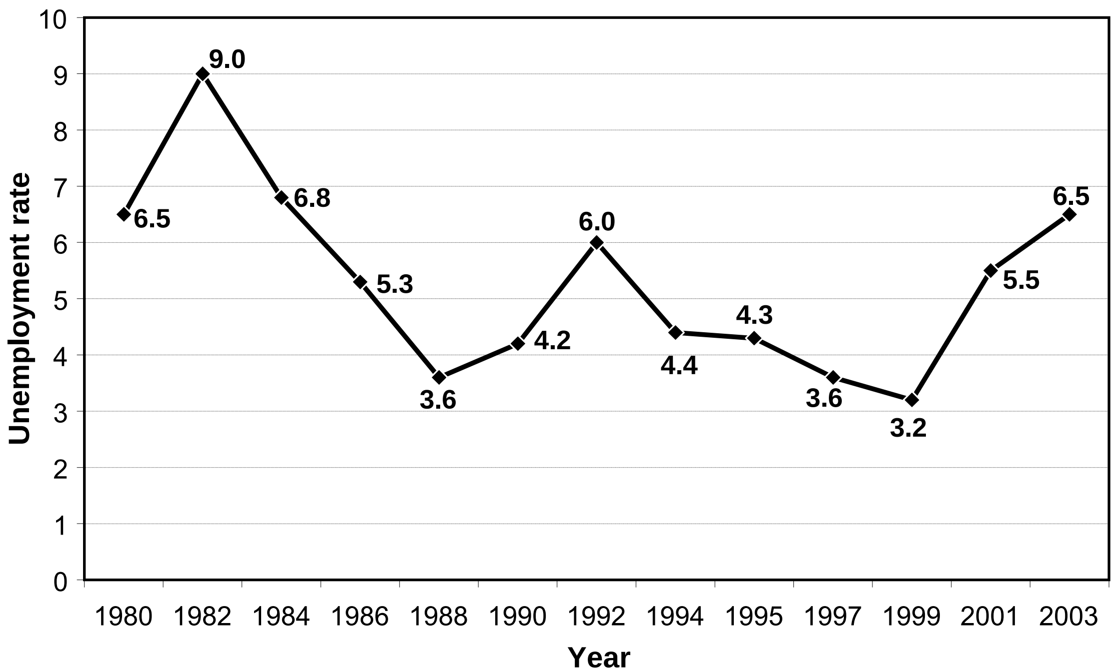
Figure 4.3. Percent of Population that is Non-White: Rural and Urban Counties, North Carolina, 1980-2005



As North Carolina's population grew over the period, so did the State's economy. Average per capita income (in $1980) increased in North Carolina's rural counties by 55% compared to a 45% increase in urban areas. Per capita income in 2005 in rural counties in the mountains and along the coast (areas that tend to be vacation and retirement destinations) was about $35,000 compared to poorer counties like Robeson and Warren counties where it was about $19,000.

During the study period, the State's unemployment rate fluctuated from a low of 3.2 in 1999 to a high of 9.0 in 1982. **Figure 4.4** shows that the unemployment rate declined during two periods of the study, between 1982-1988 and again between 1992-1999. Unemployment rates increased slightly between 88-92 and then more dramatically between 1999 and 2003. Unemployment rates were generally higher in rural areas than in urban ones and the highest unemployment rates tended to be in counties that lost textile, manufacturing and tobacco industries.

Figure 4.4. North Carolina's Unemployment Rate, 1980-2003

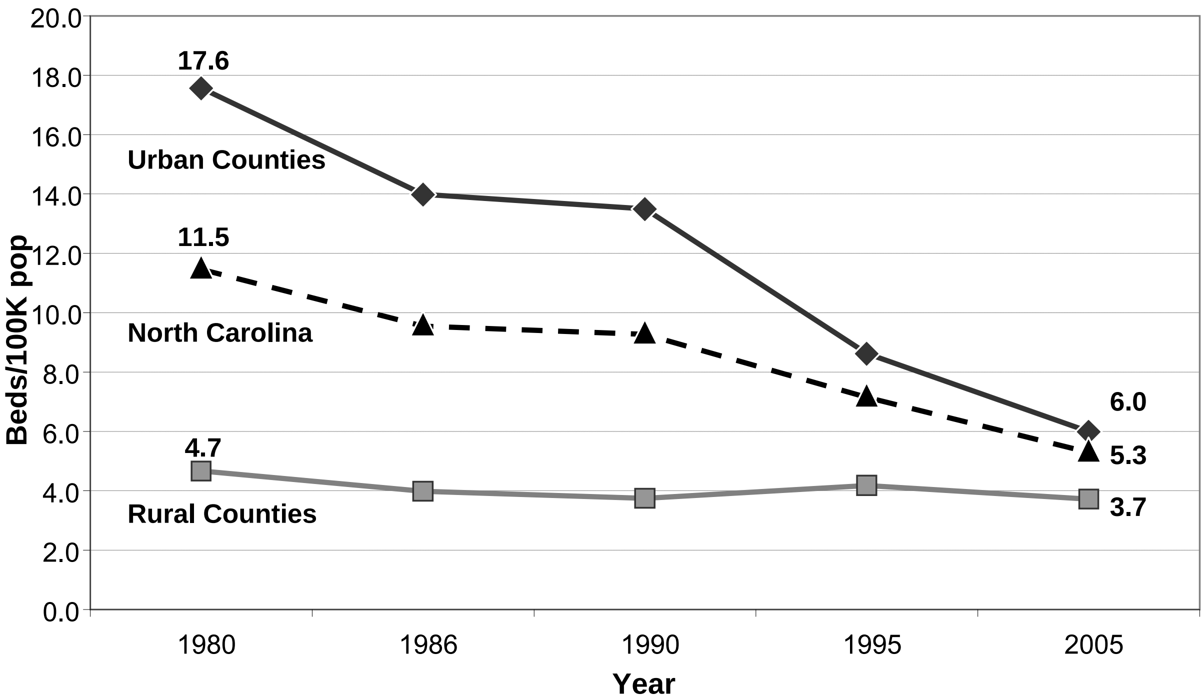


4.2.2 Changes in the Medical Practice Context in Rural Counties

The number of acute care, inpatient hospital beds has been shown to be associated with the supply of physicians in an area [1]. This makes intuitive sense because the number of beds is a good indication of the presence, size, and complexity of the health care infrastructure in a county. The total number of hospital beds declined during the study period by 32% from 674 to 459. After adjusting for population, the ratio of beds per 100,000 statewide decreased 54% from 11.5 to 5.3 (**Figure 4.5**). The supply of hospital beds per population declined more rapidly in urban areas than in rural ones. Relative to population, urban areas had one-third the beds in 2005 that they did in 1980 (17.6 versus

6.0) and rural areas had only slightly fewer beds (4.7 versus 3.7). Thus, the supply of beds in rural counties did not decline as rapidly as in urban ones but the 16 counties with no hospital beds in 2005 were all rural counties. By contrast, four urban counties in North Carolina (Forsyth, Durham, Wake and Guilford) all had over 1,000 beds in 2005 and Mecklenburg County, which is also urban, had nearly 2,000 beds. The result of this clustering of hospital beds in larger, urban centers has resulted in a trend toward greater regionalization of care. Procedures that were formerly done in rural communities are now referred to larger, tertiary care settings.

Figure 4.5. Acute Care, Inpatient Hospital Beds per 100,000 Population North Carolina, 1980-2005



The percent of the population on Medicaid is a proxy for a number of important variables related to physician supply. Counties with higher rates of Medicaid eligibles tend to be poorer, have worse health outcomes, higher infant mortality rates and generally a population with higher health care needs than counties with fewer Medicaid eligibles. Research has also shown that Medicaid recipients in rural areas in the Southeastern US that have a low a density of primary care providers travel farther for care, have difficulty more difficulty contacting medical personnel by phone, are less satisfied with their care and do not feel as welcome where they receive care [2]. Thus, counties with a larger percentage of Medicaid eligibles may have a higher need population that has greater difficulty accessing satisfactory medical care.

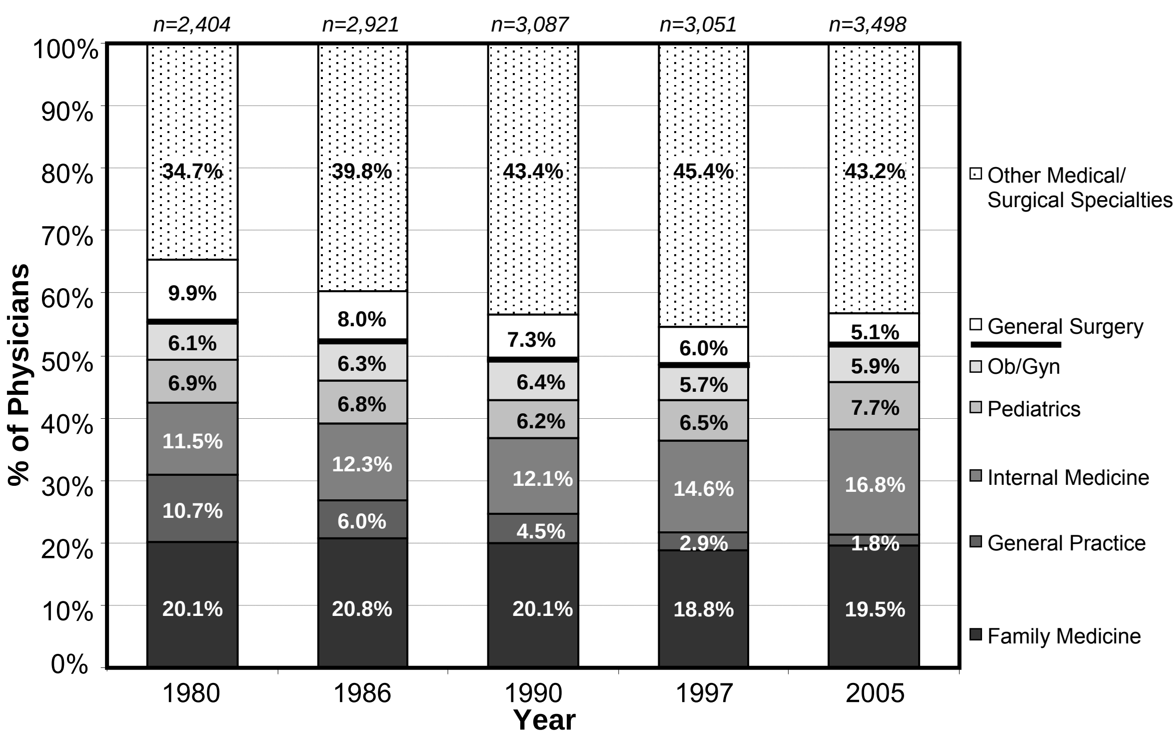
Rural areas consistently had a higher percentage of the population covered by Medicaid during the study period and the percent of the population insured by Medicaid in both urban and rural areas increased between 1980 and 2005. In 1980, 6.4% of the population in urban counties and 9% of the population in rural counties were covered by Medicaid. By 2005 these percentages had risen to 18.5% of the urban population and 22.3% of rural population. The increase in coverage is due in part because in the 1990s, the cutoff to qualify for Medicaid was increased to 200% federal poverty level compared to earlier years when the cutoff was lower and fewer people qualified.

4.2.3. Changes in Rural Physician Practice Characteristics

In 1980 about one in every three doctors in North Carolina (32.8%) worked in a rural county but by 2005, reflecting the growing urbanization of the state, this proportion had dropped to one in five (19.5%). Between 1980 and 2005, the ratio of physicians per 10,000 population increased 43% from 4.7 to 6.8 in rural counties compared to a 59% increase (from 6.3 to 9.8 physicians per 10,000 population) in urban counties during the same period.

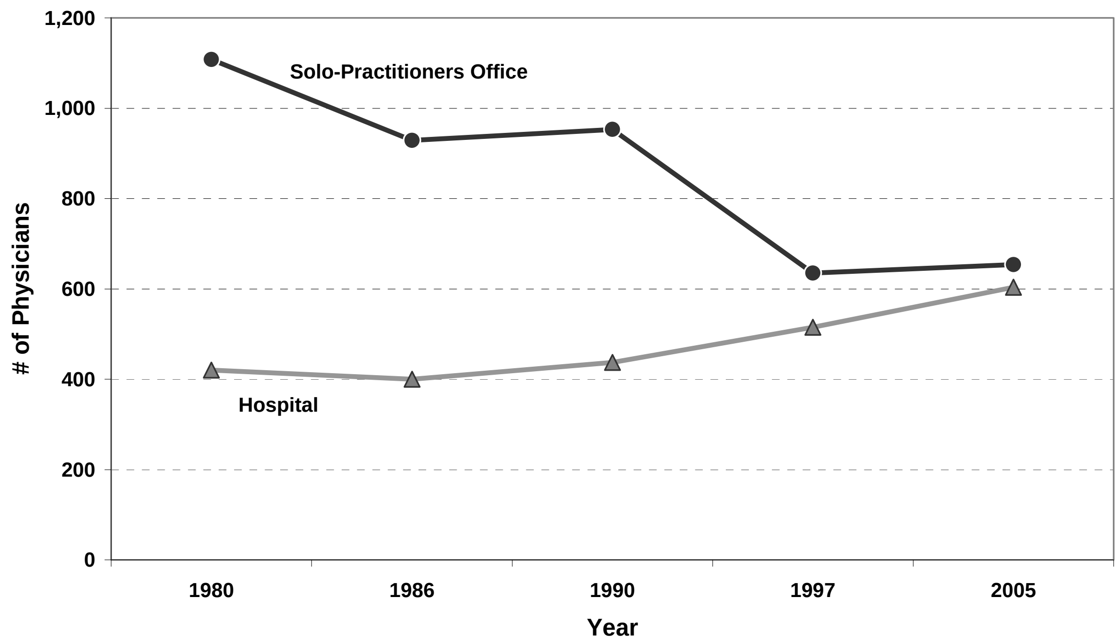
Figure 4.6 shows how the specialties of physicians practicing in rural communities changed during the study period. The most notable trend was toward increasingly specialization of the workforce. In 1980, primary care physicians (e.g. physicians reporting a specialty of family or general medicine, internal medicine, pediatrics and obstetrics/gynecology) and general surgeons comprised 66% of the workforce in rural counties but by 2005, this percentage had dropped to 56.8%. Within primary care, general practice ceased being a recognized specialty during the study period and general practitioners appear to have been replaced by internists in the rural workforce. Percentages of family physicians, pediatricians and obstetricians/gynecologists held relatively steady during the study period.

Figure 4.6. Rural Physicians by Medical Specialty, North Carolina, 1980-2005



Perhaps the biggest change in the medical practice context during the study period was the decline in the number of physicians employed in solo-practitioner offices between 1980 and 2005. **Figure 4.7** shows that in 1980 there were about 2.5 physicians employed in solo-practitioner offices for every one physician employed by a hospital.[9] By 2005, rural physicians were employed in equal numbers in both settings.

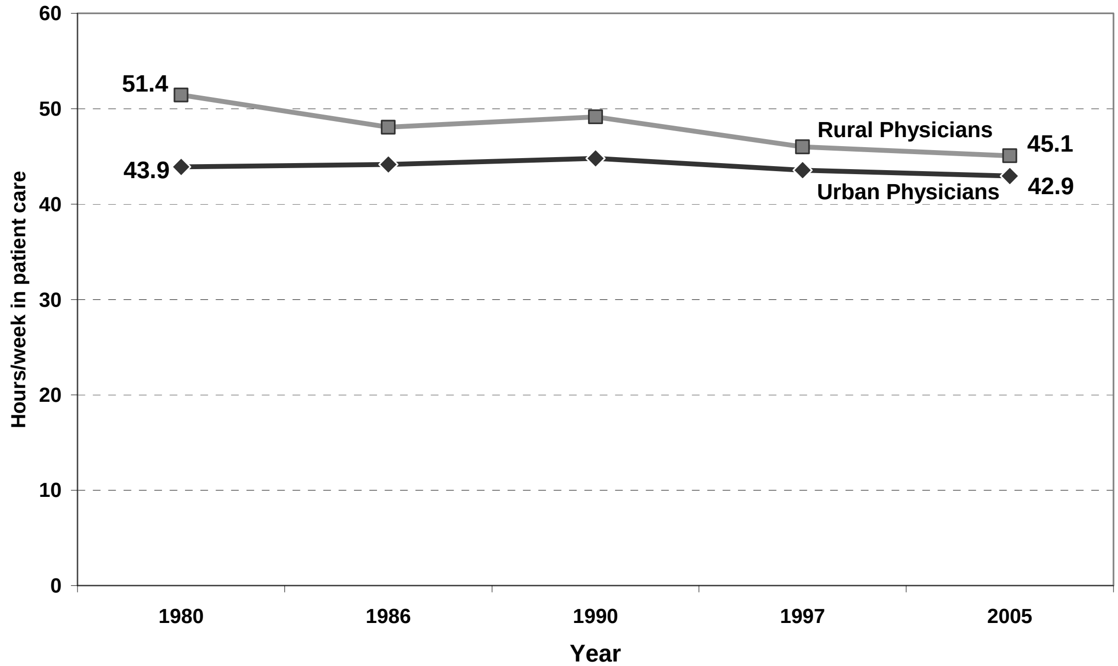
Figure 4.7. Rural Physician Employment in Solo-Practitioner and Hospital Employment Settings, 1980-2005



It is well documented that physicians in rural areas work longer hours due, in part, to more on-call responsibility [3-5], but even when on-call hours were excluded from the analysis, the data showed that rural physicians worked more hours than urban physicians during the study period (**Figure 4.8).** However, the average number of hours spent in patient care per week by rural physicians declined by 6.4 hours, compared to just a one hour reduction by urban physicians.

[9] Note: Hospital employment includes inpatient, outpatient and emergency room settings.

Figure 4.8. Rural vs. Urban Physicians' Hours in Patient Care, 1980-2005



4.2.4. Changes in Rural Physician Demographics

One of the most striking trends in the physician workforce has been the increasing proportion, and number, of women. In 1980, female physicians made up just 6.6% of the total workforce and 5.8% of the rural workforce but by 2005, one in four physicians in North Carolina (25.4%) and about one in five physicians (21.5%) in the workforce was female (**Figure 4.9**).

The average age of rural physicians increased slightly from 48.0 in 1980 to 49.3 in 2005. The increasing proportion of female physicians going into rural areas offset the aging of the male rural workforce. Between 1980 and 2005, the average age of male physicians in rural counties increased by nearly 3 years from 48.1 to 50.8 while the average age of female physicians decreased from 45.4 to 44.0. **Figure 4.10** shows that the percent of the male workforce under age 39 decreased from 32.6% in 1980 to 15.7% in 2005. The percent of male physicians over the age of 60 remained constant but the percent between ages 40-59 increased from 46.8% to 63.9% the period.

Figure 4.9. Female Physicians as Percent of Rural and Total Workforce, North Carolina, 1980-2005

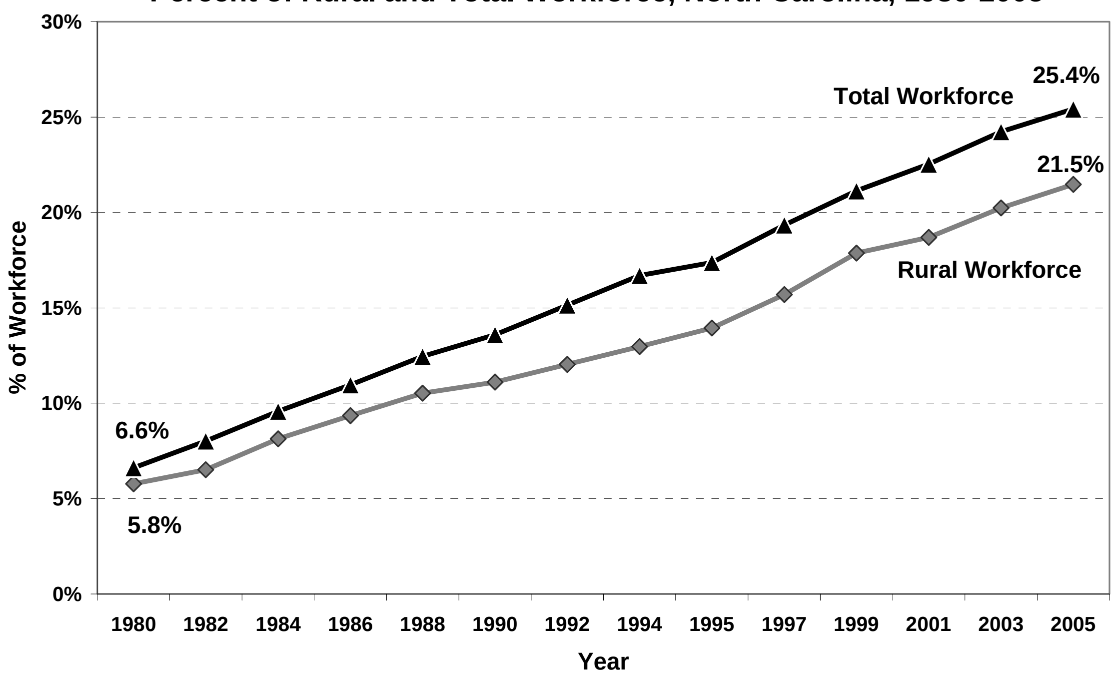


Figure 4.11 shows the age breakdown for female physicians in rural counties during the study period. One striking trend is the large percentage that female physicians younger than 39 years of age comprised of the total female rural workforce in rural counties in 1986 (63.7%) and 1990 (61.5%). These physicians are in the Boomer 1 and Boomer 2 cohorts, the first birth cohorts in which large numbers of female physicians entered the physician workforce. The data in **Figure 4.11** show this group in their twenties and thirties in 1986 and 1990 and then moving into their 40s and 50s in 1997 and 2005 data.

Figure 4.10. Age Distribution of Male Physicians in Rural Counties North Carolina, 1980-2005

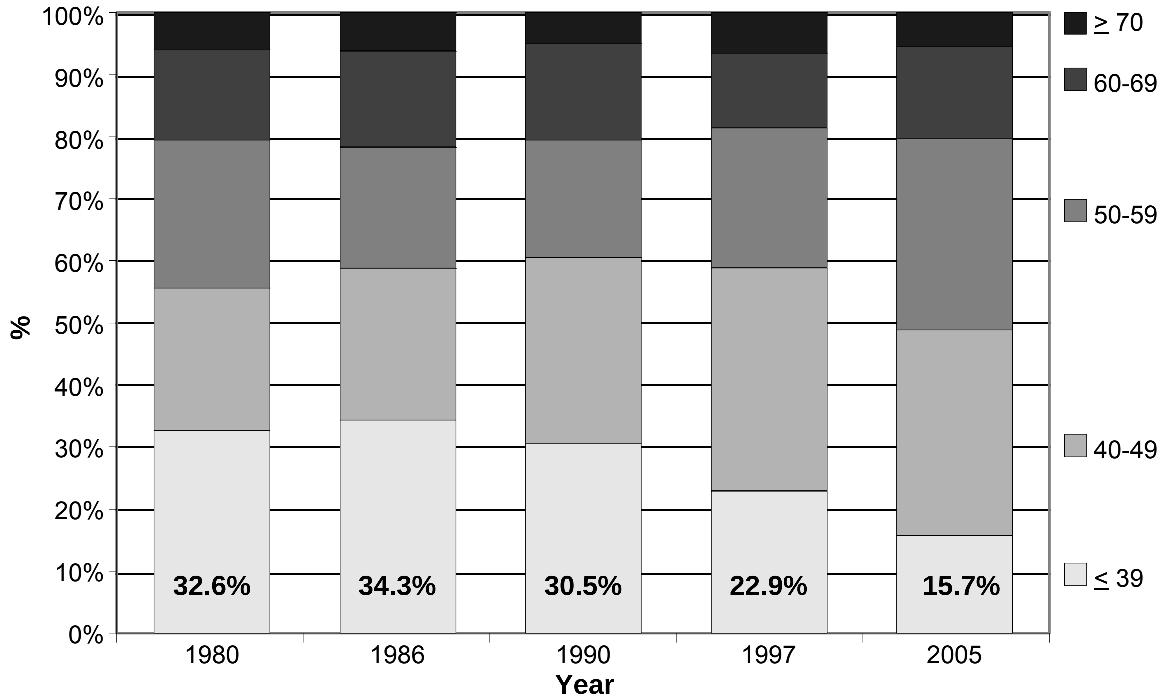


Figure 4.11. Age Distribution of Female Physicians in Rural Counties, North Carolina, 1980-2005

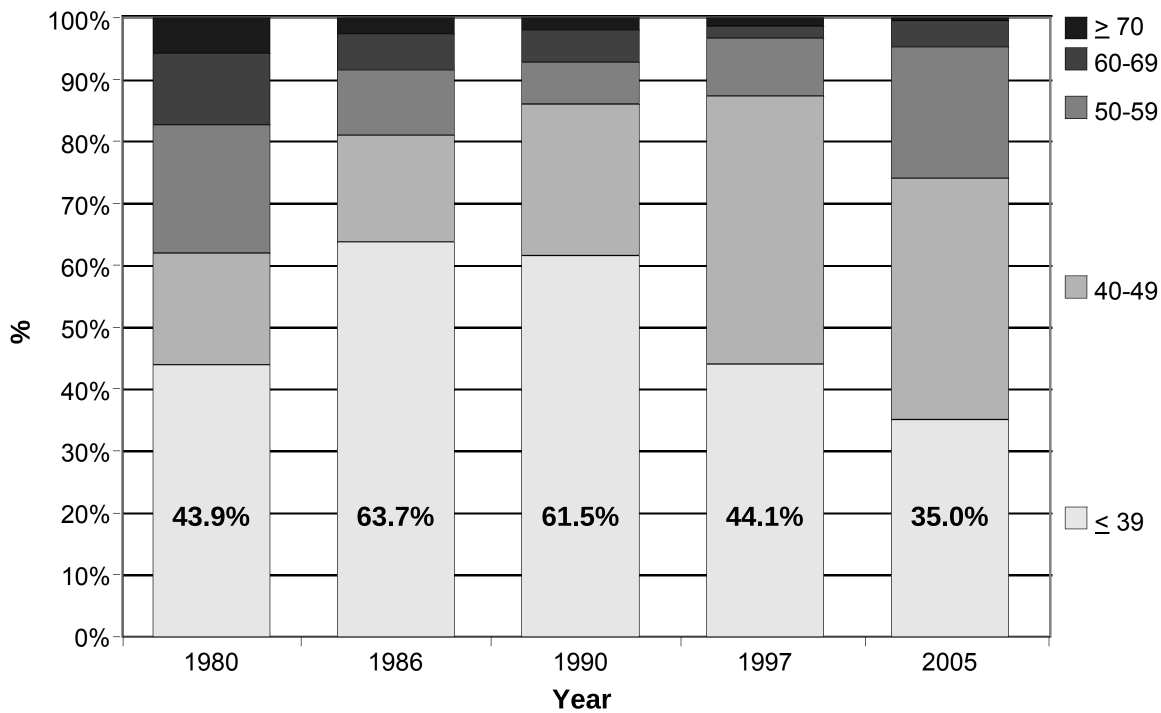


Figure 4.12. Composition of Rural Physician Workforce by Cohort North Carolina, 1980-2005

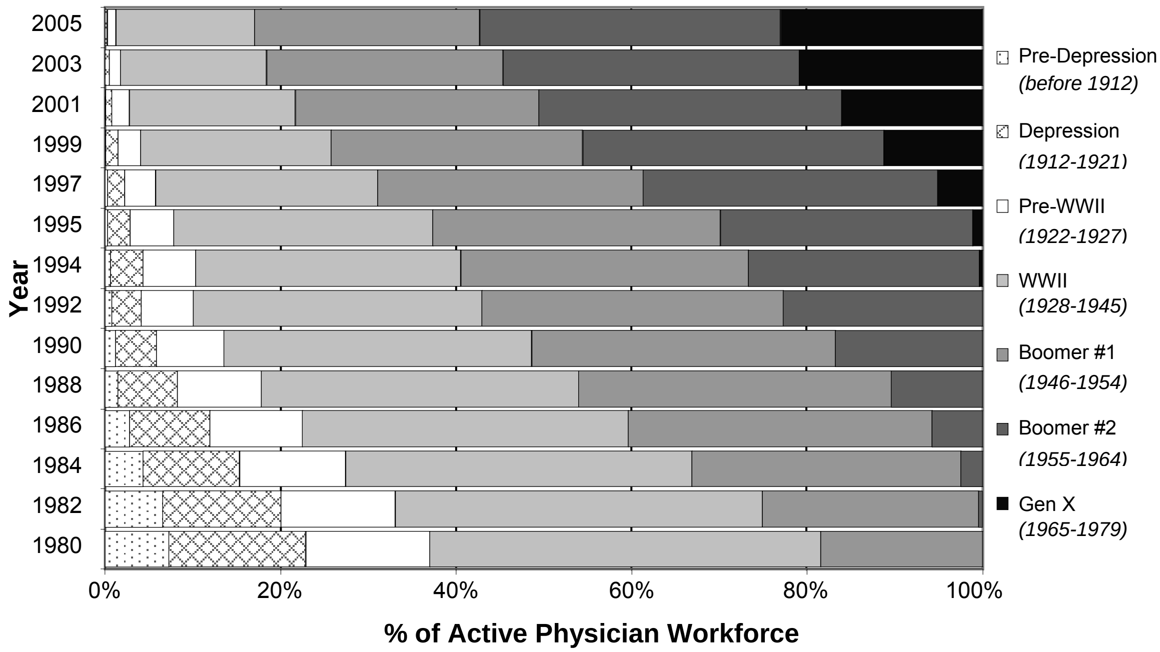


Figure 4.12 shows that, from a generational perspective, the stock of physicians in the North Carolina rural workforce has changed dramatically over time. In the early 1980's the Pre-WWII, WWII and Boomer 1 cohorts comprised the majority of the workforce. The Boomer 2 cohort began to enter practice in the mid- to late-1980s and together the Boomer 1 and Boomer 2 cohorts still comprise nearly 60% of the workforce today. Generation Xers began to enter practice in mid-1990s and comprised about 23% of the active, instate workforce in rural North Carolina in 2005. There has been much discussion among physician workforce researchers about cohort differences in practice behaviors and these discussions have generally centered on differences between the Boomer 1, Boomer 2 and Generation X physicians. The unique contribution of using the HPDS longitudinal data set for this dissertation is that it allows for

testing of differences in rural county entry patterns between male and female physicians of the same age in these three different cohorts.

This section has outlined how the rural practice context changed during the study period. North Carolina's population grew rapidly, become less rural and more ethnically and racially diverse. Health care became more regionalized, the number of hospital beds decreased and the percent of the population covered by Medicaid increased over the period. The demographic and practice characteristics of physicians in rural areas also changed. The average age of the male rural workforce increased while the average age of female physicians in rural areas decreased. The changing age structure of the rural workforce was driven in part by the large cohort of female physicians in the Boomer 1 and Boomer 2 cohorts who began to enter rural practice in the mid-1980s. Rural physicians became more specialized and were less often found in primary care, there were fewer solo-practitioners, more physicians worked in hospitals and the average number of hours worked per week in clinical care declined.

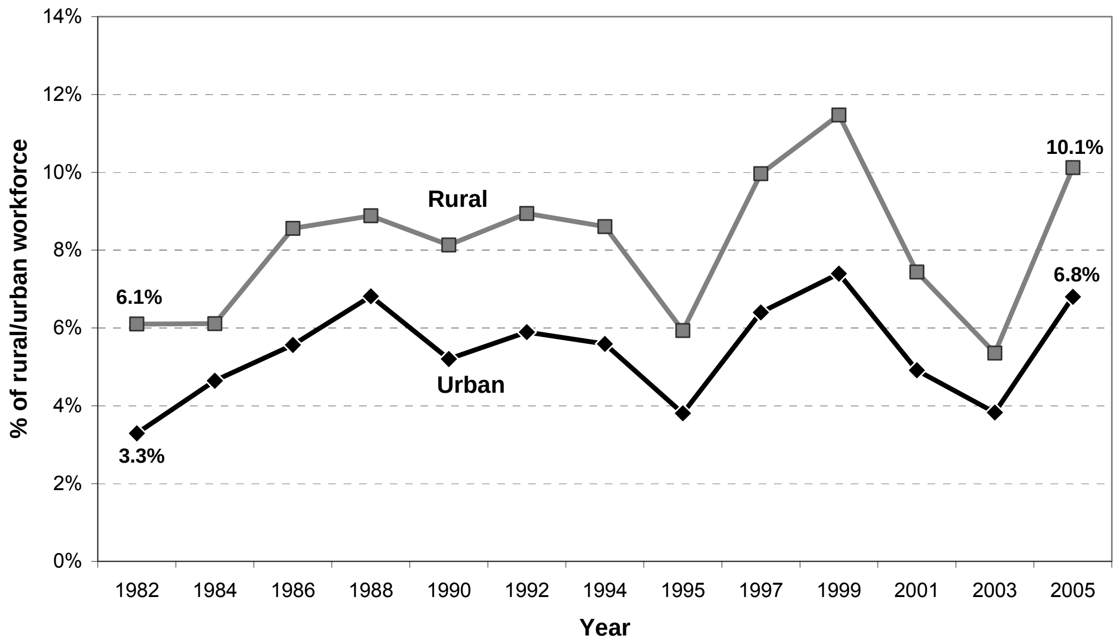
4.2.5 Longitudinal Trends in Rural Physician Mobility

As the rural and medical practice context changes, physicians already in active practice make decisions about whether to stay in their existing county or move to another one. Decisions about whether or not to change practice location are not just a function of the characteristics of rural versus urban communities, but are also related to the age and career stage at which the physician makes the decision. Location decisions are also be related to gender and the prevailing social norms of the physician's birth cohort. The next section of this chapter examines aggregate trends in rural entry patterns during the study period. Were physicians more mobile in recent years than previously? How does mobility into rural areas relate to physician age and gender? Have rural entry patterns changed over time for male and female physicians in different age groups and birth cohorts?

Figure 4.13 shows new entrants as a percent of the total rural and urban workforce by year. Turnover is higher in the rural workforce than the urban one, with new entrants comprising a higher percent of the total workforce in each year in rural compared to urban counties. The percent of physicians entering rural practice was highest in 1999 at 11.5% and lowest in 2003 at 5.4%. The low percentage of physicians entering new practice locations in 1995 should be interpreted with caution since these data are for the one-year period between 1994 and 1995 when the Medical Board switched to biannual licensure on odd years and all other data reflect the percent moving in a 2-year period.

The data in **Figure 4.13** suggest that, in the aggregate, physicians did not become more or less mobile during the study period but that mobility is volatile. This finding is not unexpected because the percent of physicians moving in any given time period is likely the product of period effects as well as the age, gender and cohort structure of the workforce. Thus, it makes sense to “drill down” in the data to determine whether there were trends in mobility by age, gender and cohort during the study period. This is important because the changing age structure of physicians in rural counties (age effects), the increasing number of women practicing in rural counties (gender effects) or differences in the social norms and career expectations of physicians in different cohorts (cohort effects), combined with the period effects outlined above could all combine to produce different trends in rural entry patterns over time.

Figure 4.13. Physicians Observed Entering New Practice Counties as Percent of Total Rural and Urban Workforce, North Carolina, 1980-2005



Tables 4.1 and 4.2 show the age breakdown of the rural physician workforce and the ages of physicians entering and exiting rural practice locations between 1982-2005. The most striking trend is the increased mobility of rural physicians ages 40-49 over the period. Table 4.1. shows that in 1982, physicians in the youngest age category comprised nearly half (47%) of all new entrants to rural areas but by 2005 they made up just 21% of new entrants. By contrast, in 1982, physicians in the 40-49 age category made up just 16% of all new entrants to rural areas but by 2005, 39% of all new entrants to rural areas were aged 40-49. While the increased propensity of the 40-49 age group to enter rural practice reflects the fact that this age group increased as a percentage of the total rural

workforce during the study period, the data in **Table 4.1** show that their increasing representation among new entrants to rural practice outpaced their overall growth in the workforce. Between 1982-2005, physicians in the 40-49 age category increased as a percent of the total rural workforce by 12 percentage points but grew as a percent of new entrants by 23 percentage points.

Table 4.1. Percent of Rural Entrants by Age Group

	≤39		40-49		50-59		60-69		70 & over	
	% of rural workforce	% entering rural	% of rural workforce	% entering rural	% of rural workforce	% entering rural	% of rural workforce	% entering rural	% of rural workforce	% entering rural
1982	34%	47%	22%	16%	22%	18%	15%	13%	7%	6%
1988	36%	42%	27%	23%	18%	17%	15%	13%	5%	4%
1994	27%	38%	35%	33%	19%	15%	13%	10%	7%	5%
1999	27%	35%	36%	36%	21%	17%	10%	8%	6%	4%
2005	20%	21%	34%	39%	29%	23%	13%	12%	4%	5%
1982-2005	**-14%**	**-26%**	**12%**	**23%**	**7%**	**5%**	**-3%**	**-1%**	**3%**	**-1%**

Table 4.2. Percent of Rural Entrants and Workforce by Birth Cohort

	WWII		Boomer 1		Boomer 2		Gen X	
	% of rural workforce	% entering rural	% of rural workforce	% entering rural	% of rural workforce	% entering rural	% of rural workforce	% entering rural
1982	41.8%	35%	25%	39%				
1988	36.1%	30%	36%	43%	10.5%	11%		
1994	30.2%	22%	33%	32%	26.3%	38%		
1999	21.7%	17%	29%	27%	34.3%	41%	11.3%	13%
2005	15.8%	18%	26%	20%	34.3%	36%	23.0%	25%
1982-2005	**-26%**	**-17%**	**1%**	**-19%**	**34%**	**36%**	**23%**	**25%**

When the rural workforce and rural entry patterns are analyzed for the four most recent birth cohorts, the trend for the WWII cohort is both a slowing propensity to enter rural counties and a shrinking representation in the rural workforce as physicians in this cohort age and move through time (**Table 4.2**). It is interesting to note that physicians in the Boomer 1 cohort made up a larger percent of new entrants to rural counties in 1988 when they were between 34 and 42 years of age than earlier in their careers. Similarly, when the Boomer 2 cohort was between ages 35 and 44 in 1999, they comprised a larger percentage of physicians entering rural practice than they did in 1994. The data also show that the Boomer 2 cohort made up a much larger percent of new entrants into rural practice in 1994 and 1999 than their representation in the workforce. These cross-sectional data on the age and cohort structure of the total rural workforce and of new rural entrants suggest that there may be differences in the rural entry patterns of physicians in different birth cohorts.

Analyzing rural entry patterns by gender between 1980-2005 (**Table 4.3**) shows that female physicians comprised a larger share of physicians entering rural practice than their representation in the total rural workforce in every year and that in recent years they have increased as a proportion of new entrants at a faster rate than their growth in the total rural workforce. A next logical step for analysis is to determine whether this increased propensity to move to a rural county is more pronounced in some birth cohorts or age groups than others. Inter-cohort and intra-cohort gender differences in rural entry patterns are explored in the logistic regression and survival analyses that follow in Section 4.3.

Table 4.3 Percent of Rural Entrants and Workforce by Gender

	% of Rural Workforce	% of physicians entering rural
1982	6.5%	10.5%
1988	10.5%	14.3%
1994	13.0%	19.1%
1999	17.9%	23.0%
2005	21.5%	30.5%
1982-2005	**15.0%**	**20.0%**

4.2.6. Summary of Longitudinal Trends in Rural Entry Patterns

The longitudinal analysis of mobility by age, cohort and gender in this section demonstrated that rural physicians were more mobile than urban physicians between 1980 and 2005 and that mobility fluctuated during the study period. Physicians in the youngest age category (30-39 years of age) made up a decreasing proportion of the rural workforce and a declining share of physicians entering rural practice counties. By contrast, physicians aged 40-49 made up a greater proportion of total physicians in the rural workforce and a proportionately larger share of physicians entering rural practice in more recent years. While the data showed a general trend toward a declining propensity to enter rural practice for physicians in older birth cohorts as they age, physicians in the Boomer 1 and Boomer 2 cohorts were more likely to be represented among rural entrants in their mid-30s to mid-40s than at earlier ages. Female physicians comprised a higher percentage of physicians observed entering rural practice than they represented in the rural workforce.

The data presented in this section illustrate that the age, gender and birth cohort structure of the physician workforce in rural areas underwent significant change during the study period. The cross-sectional data presented in this section suggest that may have been an increasing trend toward older physicians and physicians in the Boomer cohorts to move toward rural areas. To fully understand whether these trends represent true differences in rural entry patterns, one needs to compare the timing of the transition into rural practice for physicians of the same age in different birth cohorts.

4.3. The Effect of Age, Gender and Cohort on Physician's Selection of a Rural Practice Location

The decision to locate to a rural county was examined separately for new-to-practice physicians and for physicians already in practice. Logistic regression was used to investigate whether age, cohort and gender affected new-to-practice physicians' choice of initial practice location. Survival analyses were used to investigate when, in terms of biological age, physicians in different birth cohorts who were already in practice entered rural counties. Event history analysis (EHA) methods such as survival curves are well-suited to the aims of this dissertation because they allow one to explicitly model the time that elapses (e.g. in terms of age) before a physician makes a transition from one status to another (e.g. s/he enters rural practice).

4.3.1. Selection of Initial Practice Location

A logistic regression model was used to investigate the relationship of the physician's birth cohort, gender and age and the probability that she or he chose a rural county for a <u>first</u> practice location. The fact that there were physicians of the same age in multiple cohorts in the data set afforded the opportunity to test hypotheses related to variation in initial practice selection due to the effect of age, gender and cohort. The primary hypothesis tested was whether the physician's birth cohort had an effect on choice of a rural practice location after controlling for age, gender, race, and medical specialty. This hypothesis was tested by including dummy variables for physician cohort in the model. Three additional questions related to the effect of gender on choice of a rural county for an initial practice location were investigated and are detailed below:

1. Past life course research has emphasized that any “theory of age must include a theory of gender. [6]” To test this whether the effect of age on choice of an initial practice location varied for male and female physicians, the age and female dummy variables were interacted with one another.
2. While women represent an increasingly important component of the physician workforce, research has not focused on whether the influence of gender on physicians’ transitions into rural practice varies by birth cohort. Interaction terms were created between the female and cohort variables to test whether the effect of being female on choice of a rural county varied by cohort.
3. The careers of male and female physicians observed in the data unfolded during very different time periods, during which there were different societal expectations both in terms of the role of women as wives/mothers/doctors and in terms of the expectations of both male and female physicians about the need to balance professional and personal lives. Of late, there has been much discussion of younger physicians’ desires for a “controllable lifestyle”; such professional desires would not favor rural practice. To test whether the effect of age varied for male and female physicians in different birth cohorts, a triple interaction term was created between the physician’s age group, cohort and gender.

In the logistic regression, the dependent variable was coded to one if the physician chose a rural county for a first practice location. The physician's primary practice location was used and counties were assigned rural or urban status using the Office of Management and Budget (OMB) designations current at the time the physician entered practice.[10] The control variables included in the model were physician race, medical specialty and participation in the National Health Service Corps. Year dichotomous variables were included in the model to capture any time period specific shocks that occurred during the study. These time-fixed effects adjust, for example, for the fact that during the study period North Carolina became increasingly urban and thus the availability of rural practice locations declined. Time fixed effects also control for any other year-specific shocks that have an effect on rural location selection and were the same for all counties in North Carolina (e.g. implementation of state or national policy that affected all counties in North Carolina equally such as changes in reimbursement policy, changes to Medicaid eligibility requirements, and other time-related trends highlighted in Section 4.3.).

Model 1 is summarized below. In the model, *i* indexes the individual physician and *t* indexes the year in which the physician was observed.

$$\text{Physician entered practice in rural county}_{it} = \beta_0 + \beta_1\text{age<30}_{it} + \beta_2\text{age 40-49}_{it} + \beta_3\text{age 50-59}_{it} + \beta_4\text{Female}_{it} + \beta_5\text{Boomer1}_{it} + \beta_6\text{GenX}_{it} + \beta_7\text{WWII}_{it} + \beta_8\text{age<30}_{it}\text{*Female}_{it} + \beta_9\text{age40-49}_{it}\text{*Female}_{it}\ \beta_{10}\text{age50-59}_{it}\text{*Female}_{it} + \beta_{11}\text{WWII}_{it}\text{*Female}_{it} + \beta_{12}\text{Boomer1}_{it}\text{*Female}_{it} + \beta_{13}\text{GenX}_{it}\text{*Female}_{it} + \beta_{14}\text{WWII}_{it}\text{*Female}_{it}\text{*age 40-49}_{it} + \beta_{15}\text{WWII}_{it}\text{*Female}_{it}\text{*age 50-59}_{it} + \beta_{16}\text{Boomer1*age<30}_{it}\text{*female}_{it} + \beta_{17}\text{ Boomer1*age40-49}_{it}\text{*female}_{it} + \beta_{18}\text{ Boomer1*age50-59}_{it}\text{*female}_{it} + \beta_{19}\text{GenX*age<30}_{it}\text{*female}_{it} + \beta_{20}\text{GenX*age40-49}_{it}\text{*female}_{it} + \beta_{21}\text{Asian}_{it} + \beta_{22}\text{Black}_{it} + \beta_{23}\text{other race}_{it} + \beta_{24}\text{National Health Service Corps physician}_{it} + \beta_{25}\text{specialist}_{it} + \beta_{26}\text{general surgeon}_{it} + \beta_{27}1980 + \beta_{28}1982 + \beta_{29}1984 + \beta_{30}1986 + \beta_{31}1988 + \beta_{32}1990 + \beta_{33}1992 + \beta_{34}1994 + \beta_{35}1995 + \beta_{36}1997 + \beta_{37}1999 + \beta_{38}2001 + \beta_{39}2003 + \varepsilon$$

[10] The OMB codes change over time reflecting the relative urban or rural orientation of a county. The use of the county's OMB status at the time of entry into practice is appropriate as it reflects the character of the county at the time the physician made the decision to move.

The reference, or “base case” category is the combination of characteristics that identify the physician who most often moved to a rural county for a first practice location—a white male, 30-39 years of age, in the Boomer 2 birth cohort, who is a primary care physician. Year 2005 is the reference year.

Table 4.4 shows the number of physicians in the sub-sample by age, cohort and gender. Because physicians were only observed between 1980-2005, not all cohorts have physicians in each age group. For example, there were no physicians in the <30 age group in the World War II cohort and no physicians over the age of 50 in the Boomer 2 or Generation X cohorts. There were also small sample sizes in some cells such as in the age 50-59 categories in the Boomer 1 and WWII cohorts, in the age 40-49 categories in the Generation X cohort and in the age 30-39 category for females in the WWII cohort.

Table 4.4. Age, Gender and Cohort of New-to-Practice Physicians in North Carolina, 1980-2005

	< 30		30-39		40-49		50-59		
	Male	**Female**	**Male**	**Female**	**Male**	**Female**	**Male**	**Female**	**Total**
World War II (1928-1945)			118	8	53	15	7	14	215
Boomer1 (1946-1954)	330	78	2,300	550	158	96	9	9	3,530
Boomer2 (1955-1964)	677	263	2,778	1,130	158	101			5,107
Gen. X (1965-1979)	402	342	2,230	1,625	7	5			4,611
Total	**1,409**	**683**	**7,426**	**3,313**	**376**	**217**	**16**	**23**	**13,463**

Summary statistics for the variables used in the logistic regression are provided in **Table 4.5**. The data are displayed for the sample of new-to-practice physicians who moved to a rural versus urban county for a first practice location. The average age and the age distribution of the two groups was similar.

Table 4.5. Summary Statistics for New-to-Practice Physicians, North Carolina, 1980-2005

Variables		Moves to rural county (n=2,738)	Moves to urban county (n=10,725)
Dependent Variable			
	Moves to rural county	1	0
Independent Variables			
Demographics	Physician's age	32.6	32.2
	< 30	13.4%	16.1%
	30-39[a]	80.6%	79.6%
	40-49	5.3%	4.2%
	50-59	0.6%	0.2%
Birth Cohort (birth years)	WWII (1928-1945)	2.6%	1.4%
	Boomer #1 (1946-1954)	34.4%	24.1%
	Boomer #2 (1955-1964)[a]	38.2%	37.9%
	Generation X (1965-1979)	24.8%	36.7%
	Female	25.1%	33.1%
	White [a]	85.7%	85.4%
	Black	7.5%	5.7%
	Asian	2.6%	4.8%
	Other[b]	4.3%	4.0%
Medical Specialty	Primary care physician[a]	64.8%	52.1%
	General surgeon	3.7%	2.8%
	Specialist physician	31.4%	45.1%
	National Health Service Corps	0.5%	2.0%
Year	1980	11.9%	6.8%
	1982	8.0%	5.6%
	1984	8.7%	6.7%
	1986	9.3%	8.0%
	1988	8.6%	8.4%
	1990	7.7%	6.2%
	1992	7.4%	7.7%
	1994	4.3%	6.7%
	1995	2.2%	3.2%
	1997	7.1%	7.4%
	1999	8.9%	9.0%
	2001	6.9%	9.1%
	2003	5.6%	8.3%
	2005 [a]	3.4%	6.8%

[a] *omitted reference category for model*
[b] *Other race/ethnicity includes Hispanic, Native American, Pacific Islander and unclassified race/ethnicity.*

Proportionately more physicians in the Boomer 1 cohort moved to rural than urban counties (34.4% vs. 24.1%) and proportionately fewer Generation X physicians selected rural over urban counties for a first practice location (24.8% vs. 36.7%). Physicians in the Boomer 2 cohort were almost equally distributed among physicians choosing rural and urban counties. Female physicians were less likely to choose an urban versus a rural location (33.1% vs. 25.1%).

Asian physicians were slightly less likely, and African-American physicians slightly more likely, to move to rural counties. Not surprisingly, primary care physicians were more likely than specialist physicians to choose rural practice locations.

The logistic regression results are presented in **Table 4.6**. All the signs on the statistically significant coefficients are in the hypothesized directions. Relative to physicians in the 30-39 age category, physicians younger than 30 years of age were less likely to move to rural counties and physicians in the 50-59 age category were more likely to choose rural locations. Female physicians were less likely than male physicians to choose a rural county and Asian physicians had a lower probability than white physicians of choosing a rural county for a first practice location. Relative to Boomer 2 physicians, Generation X physicians were less likely to select a rural county. Not surprisingly, being a specialist (as opposed to a primary care physician) lowered a physician's probability of choosing a rural county and also not surprising was that serving a National Health Service Corps obligation increased the physician's probability of selecting a first practice location in a rural area.

Table 4.6. Logistic Regression Results for Likelihood of Moving to a Rural County

Variables		Beta[1]		Robust Standard Error
Constant		-1.32	**	0.16
Demographics	< 30	-0.27	**	0.08
	40-49	0.22		0.14
	50-59	1.23	**	0.53
	Female	-0.30	**	0.09
	Asian	-0.35	**	0.13
	Other[b]	0.25	**	0.07
Birth Cohort	WWII (1928-1945)	0.19		0.20
	Boomer #1 (1946-1954)	0.18		0.10
	Generation X (1965-1979)	-0.45	**	0.11
Birth Cohort*Female	WWII*Female	-0.74		1.06
	Boomer #1*Female	-0.27		0.15
	Generation X * Female	0.10		0.13
Age Group*Female	< 30 *Female	-0.08		0.20
	40-49 *Female	-0.26		0.30
	50-59 *Female	0.63		1.32
Birth Cohort*Female* Age[a]	WWII*Female*age40-49	0.08		1.32
	Boomer 1*Female*Age<30	0.17		0.37
	Boomer 1*Female*Age 40-49	-0.04		0.42
	Boomer 1*Female*Age 50-59	-1.66		1.45
	Gen X* Female* Age<30	-0.48	**	0.29
	Gen X* Female* Age 40-49	0.52		1.32
Medical Specialty	General surgeon	-0.01		0.12
	Specialist physician	-0.66	**	0.05
	National Health Service Corps	1.27	**	0.21
Year	1980	0.66	**	0.20
	1982	0.54	**	0.20
	1984	0.50	**	0.19
	1986	0.43	**	0.18
	1988	0.35	**	0.17
	1990	0.53	**	0.17
	1992	0.30		0.17
	1994	-0.08		0.18
	1995	0.07		0.20
	1997	0.48	**	0.14
	1999	0.58	**	0.13
	2001	0.35	**	0.14
	2003	0.23		0.14

[1] Dependent variable=1 if physician moved to rural county for first practice location.
***Statistically significant at 1%. n=13,464, pseudo R^2=0.0466*
[a] WWII∗Female∗Age50-59 had only 14 observations that were dropped due to collinearity with other variables included in the model.
[b] Other race/ethnicity includes Black Hispanic, Native American, Pacific Islander and unspecified race/ethnicity.

In logistic regression, the model constant gives the probability that the dependent variable equals one when all other covariates are set to zero:

$$\text{Probability (y=1|base case)} = \frac{1}{1 + e^{-\beta_0}}$$

In this logit model:

$$\text{Probability (rural|base case)} = \frac{1}{1 + e^{-(1.32)}}$$
$$= .210$$

Thus, the model predicted that a white, male, age 30-39 who is a primary care physician, in the Boomer 2 cohort and was not serving a NHSC obligation had a 21.0% probability of moving to a rural county for a first practice location. This base case scenario was constructed to match the characteristics of the average physician who selected a rural county for a first practice location in the sample and thus is very close to the sample mean of 20.3% (e.g. see **Table 4.5** above). The base case scenario also serves as a useful benchmark to which to compare predicted probabilities for physicians with different demographic and practice characteristics.

Table 4.7 shows the predicted probability of moving to a rural county for a first practice location for male and female physicians with various age, gender and cohort characteristics. Looking across rows, one can see intra-cohort differences in the predicted probability of moving to a rural county by age and gender. Looking down the columns allows one to see inter-cohort differences within age groups and gender.

Table 4.7. Predicted Probability[1] of Moving to Rural by Age, Gender and Cohort of New-to-Practice Physicians in North Carolina, 1980-2005

	< 30		30-39		40-49	
Birth Cohort (birth years)	**Male**	**Female**	**Male**	**Female**	**Male**	**Female**
World War II (1928-1945)			32.4%		34.3%	13.3%
Boomer1 (1946-1954)	28.1%	19.2%	28.8%	19.3%	29.0%	14.6%
Boomer2 (1955-1964)	20.6%	16.0%	21.4%	18.3%	28.4%	18.8%
Generation X (1965-1979)	13.5%	7.3%	15.7%	15.2%		

[1] Predictions suppressed for sample sizes with fewer than 15 physicians. See Table 4.4. for number of observations in each cell.

The general trend is toward a declining probability of moving to a rural county within age groups from older to younger cohorts. This effect persists even though the model contains fixed effect year dummy variables that adjust for when the physician entered practice. One of the most striking inter-cohort comparisons is the effect of being in the Generation X cohort compared to early cohorts. Generation X physicians in each age group had a significantly lower probability of choosing a rural location than physicians in the same age group in earlier cohorts. Under age 30, Generation X male physicians were 7 percentage points and Generation X female physicians were nearly 9 percentage points less likely to move to a rural county compared to the same age group in the Boomer 2 cohort. Another interesting inter-cohort effect is that female physicians aged 40-49 in the Boomer 2 cohort were 4.2 percentage points *more* likely to locate to locate to a rural county than Boomer 1 female physicians of the same age group. This effect runs counter to the overall trend toward declining probabilities from older to younger birth cohorts.

In terms of intra-cohort gender effects, female physicians had a lower predicted probability of choosing a rural location than male physicians in every age category across all the cohorts. However, the overall effect of gender on the probability that a physician will move to a rural county declined in the age 30-39 and age 40-49 categories for successively more recent birth cohorts.

While **Table 4.7** is useful as a way to compare the predicted probability of moving to a rural county for the age, gender, and cohort characteristics of physicians observed in the study, it does not allow one to calculate the statistical significance of the marginal effect of being female on choice of initial practice location for physicians of different ages in different cohorts. Because the model contained interaction terms that allowed the effect of gender to vary for physicians in different birth cohorts and age groups one cannot easily interpret the marginal effect of being female from either the regression output contained in **Tables 4.6** or from the predicted probabilities shown in **Table 4.7**. This is because the marginal effect of being female is different for each observation in the data set depending on the physician's individual characteristics. As well, the marginal effect of the various interaction terms could be non-zero even if their coefficients in **Table 4.6** were zero or close to zero. Finally, the statistical significance of the interaction term cannot be determined with the simple *t* test of the coefficient on the interaction terms.

Therefore, to calculate marginal effects, the average of the probabilities method was used. More specifically, the probability of moving to a rural county was calculated twice for each observation—once with each observation in the dataset coded as female and once with each observation re-coded to male. This allows one to calculate, for each physician in the data, the marginal effect of being female in a specific age category and birth cohort. These marginal effects were then bootstrapped 500 times to obtain an estimate of the standard error and the confidence interval around the mean. The bootstrapped standard errors and confidence intervals are displayed in **Table 4.8**. Because the difference between the estimated coefficient from the logistic regression model and the average estimated coefficient from the bootstrapped replications was relatively large and the marginal effects were not normally distributed, the

bias-corrected confidence intervals are reported. They are the most conservative estimates of the confidence interval around the marginal effect and thus, in some cases include 0 even though the bootstrapped marginal effect and standard error indicate a statistically significant result.

Table 4.8. Marginal Effect of Being Female on the Probability of Moving to Rural County by Age Category and Cohort

	Marginal Effect	SE[1]	Z	p	Confidence Interval[2]	
Age <30						
Boomer 1	-0.09	0.05	-1.69	0.09	-0.18	0.03
Boomer 2	-0.06	0.03	-2.17	0.03	-0.11	-0.01
Generation X	-0.07	0.02	-4.04	0.00	-0.10	-0.04
Age 30-39						
Boomer 1	-0.10	0.02	-5.44	0.00	-0.13	-0.06
Boomer 2	-0.05	0.01	-3.29	0.00	-0.07	-0.02
Generation X	-0.02	0.01	-2.12	0.03	-0.05	0.00
Age 40-49						
WWII	-0.21	0.09	-2.33	0.02	-0.34	0.01
Boomer 1	-0.14	0.05	-3.05	0.00	-0.22	-0.04
Boomer 2	-0.10	0.05	-2.07	0.04	-0.18	0.01

[1] Bootstrapped standard error reported
[2] Bias corrected confidence interval reported
Note: Marginal effect calculations suppressed for sample sizes with fewer than 15 physicians. None were statistically significant. See Table 4.4. for number of observations in each cell.

Consistent with the data in **Table 4.7**, the data in **Table 4.8** show that the marginal effect of being female on the probability that a physician will move to a rural county for a first practice location is declining for more recent cohorts in the 30-39 and 40-49 age categories. For example, relative to males in the age 30-39 category, being female lowered the probability of moving to a rural county by 10 percentage points in the Boomer 1 cohort, 5 percentage points in the Boomer 2 cohort and 2 percentage points in the Generation X cohort. The marginal effect of being female also narrowed in the age 40-49 category as females were 21 percentage points less likely than males in the WWII cohort, 14 percentage points less likely than males in the Boomer 1 cohort and 10 percentage points less likely than males in the Boomer 2 category to locate to a rural county.

In summary, the logistic regression showed that physicians younger than 30 had a lower probability and physicians over 50 a higher probability of moving to a rural county for a first practice location than physicians ages 30-39. Even after controlling for age and gender, Generation X physicians had a lower probability of moving to a rural county than the Boomer 2 physicians who preceded them. The marginal effect of being female varied by age and cohort. While female physicians observed in the data were less likely overall to enter a rural county for a first practice location, the marginal effect of being female declined for physicians aged 30-49 in the most recent birth cohorts.

4.3.2. Practicing Physicians Movements to Rural Counties

4.3.2.a. Overview of Hypotheses Tested in Survival Analyses

Building on the findings from the descriptive analyses and the logistic regression, the survival analyses set out in this section of the dissertation test for the presence of inter- and intra-cohort differences in entry patterns into rural counties for physicians *already* in practice. More specifically, the survival analyses test whether there were differences between, and within, cohorts in the rate at which male and female physicians moved to rural counties at different ages.

The rate at which physicians moved to rural counties was first investigated by estimating the hazard function. The hazard function gives the probability that the physician moved to a rural county at a given age. The hazard rate is useful because it can be interpreted as the propensity of physicians to transition into rural counties at specific ages. Survival curves were then estimated to test for inter- and intra-cohort differences. Survivor functions provide a way to compare the transition rates of physicians: 1. between cohorts; 2. between male and female physicians in different cohorts; and 3. between male and female physicians in the same cohort. Survival curves make intuitive sense because one can imagine a group of physicians who, as they age, make the decision about whether or not to move to a rural county. The survival curves report the proportion of physicians by age that have not yet entered a rural county.

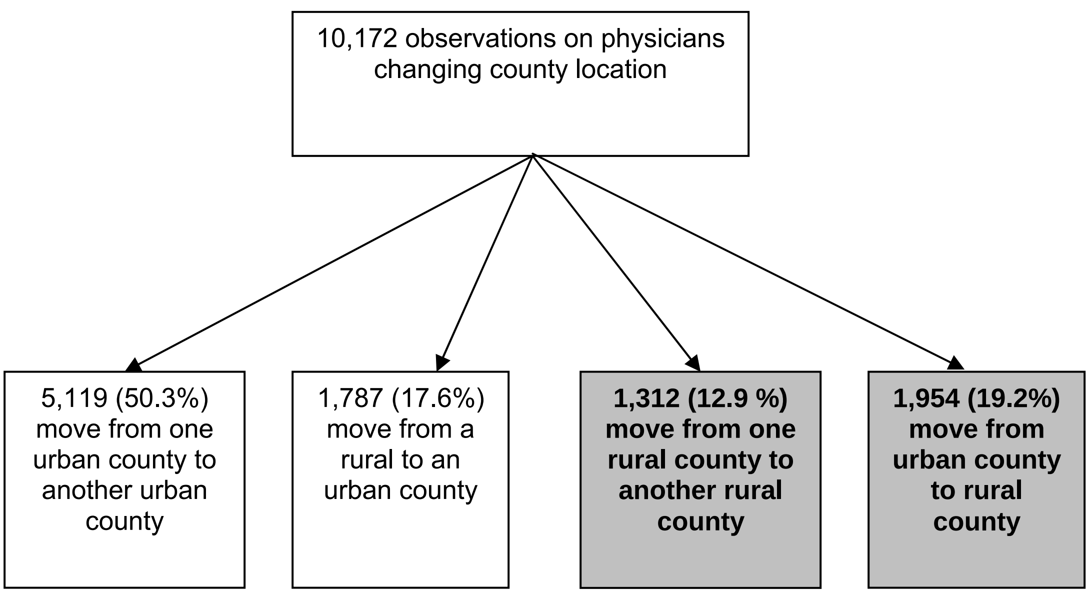
To test for inter-cohort differences, survivor functions were first estimated by cohort and the log rank test was used to test the null hypothesis that there were no differences in the transition rates between cohorts. To test for the presence of inter-cohort gender effects, survivor functions were estimated separately for male and for female physicians in different cohorts to determine if transition rates varied between male and female physicians of the same age in different cohorts. Survival curves were then estimated for male and female physicians in the same cohort to determine if there were intra-cohort gender effects on the transition rate. Log-rank tests were used to test the equality of the survivor functions of male and female physicians within, and between, cohorts.

4.3.2.b. Sample Used in Analysis

The physician workforce is surprisingly mobile. More than one in four physicians in the sample (27.6%) moved at least once while under observation**.** Of the 10,172 times a physician was observed changing practice locations between 1980-2005, 5,119 (50.3%) moves were from one urban county to another urban county, 1,312 (12.9%) were from one rural county to another rural county, 1,954 (19.2%) moves were from an urban to a rural location and 1,787 (17.6%) were from a rural to an urban location (**Figure 4.14**).

While it would be interesting to compare inter-cohort and intra-cohort differences in transition rates between physicians who moved to rural versus urban counties, the focus of this dissertation was on entry into a rural county. The 3,266 observations on physicians who moved to a rural county from either another rural county (e.g. 1,312 observations) or from an urban county (e.g. 1,954 observations) were grouped together in the analysis. This decision was based on a number of considerations. The primary rationale for analyzing the two groups together was that when the physician moved to a rural county she or he was committing to rural practice whether or not she or he came from another rural county or was relocating to a rural county from an urban one. A second factor considered was that when the origin of physicians moving to rural counties was examined by year, the data revealed that the percent of physicians moving to rural counties from other rural counties had held relatively steady at about 40% during the study period (**Figure 4.15**). Thus, the supply of physicians relocating to rural counties from other rural counties was a relatively large and steady proportion of total rural entrants over time and needed to be included in the analysis to get a complete picture of rural moves.

Figure 4.14. Location of Moves Observed in Sample



A final consideration was that the age-specific rate at which physicians located to a rural county (e.g. the dependent variable in this analysis) from another rural county versus from an urban county was not different. **Figure 4.16** compares the hazard functions for physicians moving to a rural county from either an urban county or from another rural county. **Figure 4.16** shows that the age-specific rate at which physicians in the two groups entered rural counties were similar and a log rank test for equality of the survival functions confirmed that they were not statistically significantly different from one another ($\chi^2_{(1)}$=.2, p=.6558).

Figure 4.15. Percent of Moves to Rural Counties from Urban and Rural Counties

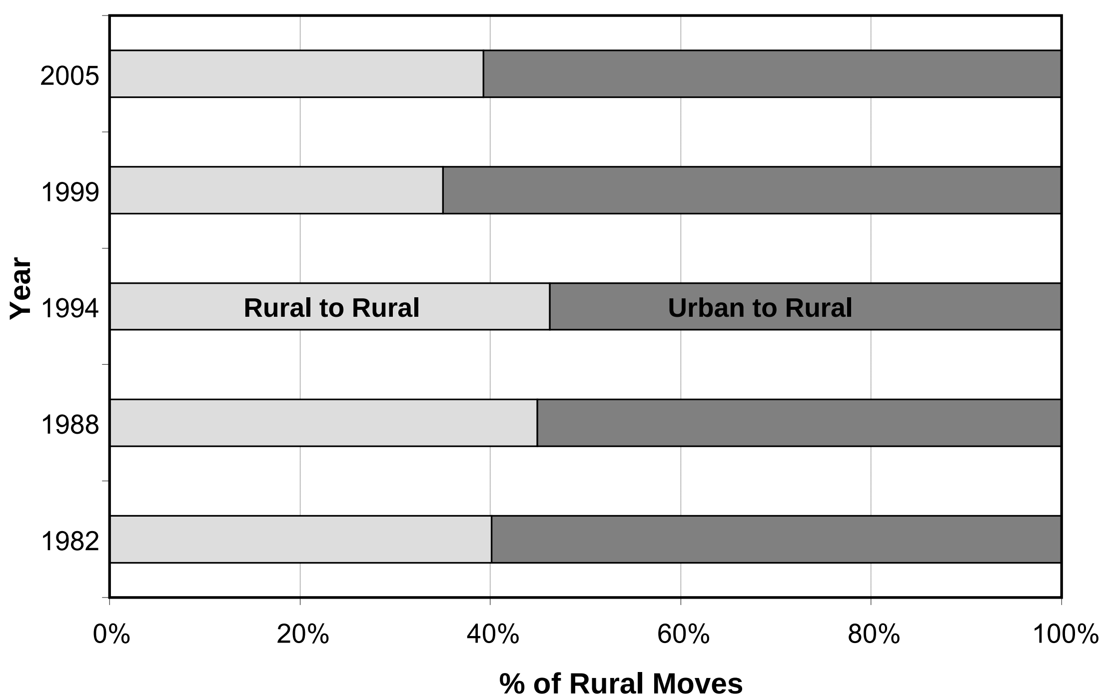


Figure 4.16. Hazard Functions for Rural and Urban Physicians Moving to Rural Counties

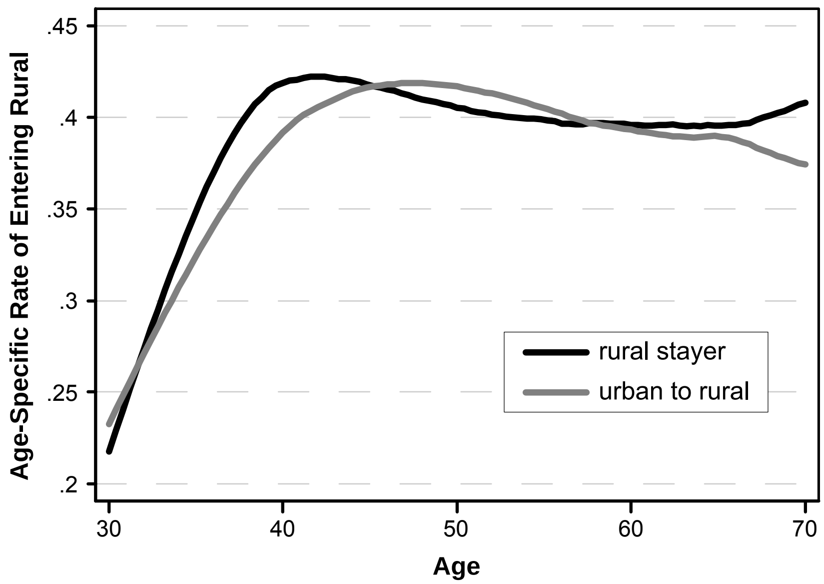
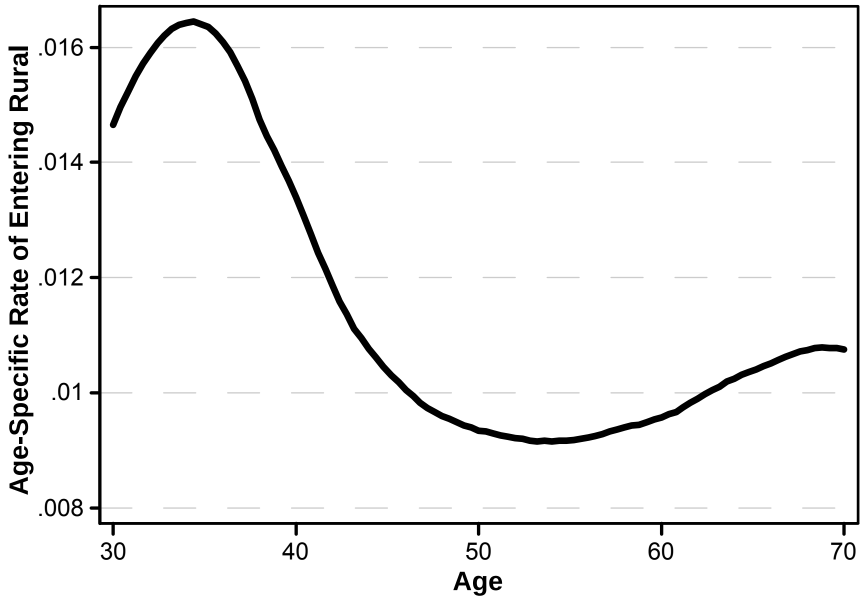


Figure 4.17 shows the hazard function with the two groups combined together, but with the "risk set" including all physicians in the data set. More specifically, the hazard function illustrated in **Figure 4.17** gives the probability that a physician observed during the study period in more than two time periods moved to a rural county at a given age. As would be expected, young physicians are the most mobile and have the highest hazard rates. The hazard rate increases until the mid-30s, declines rapidly until about age 50, is relatively flat until the mid-50s and then increases again until age 70. These transition rates make intuitive sense. Early in the physician's career, she or he is more mobile and by mid-career has generally settled into a practice and thus is less likely to move. The fact that 605 (18.5%) of physicians who entered rural counties during the study period were between ages 50-70 suggests that older physicians will relocate practice locations.

Figure 4.17. Hazard Function for Physicians Moving to Rural Counties

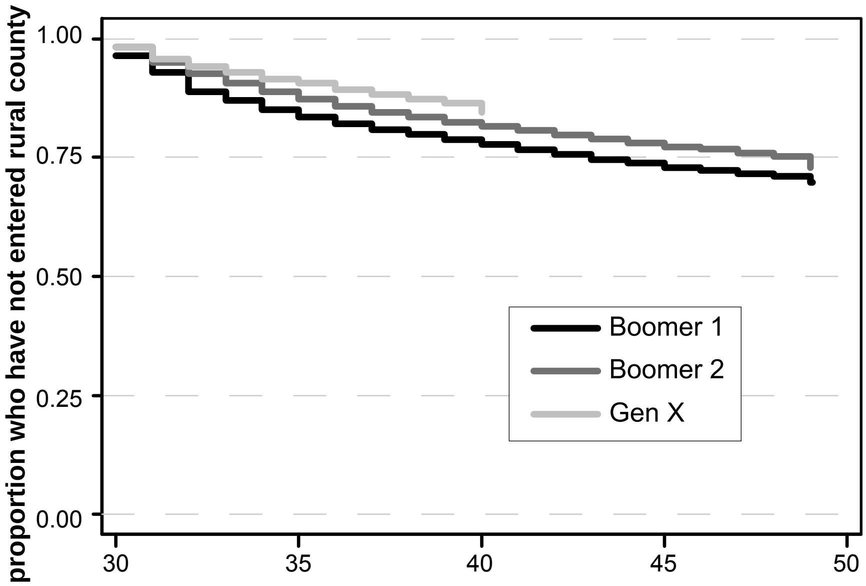


4.3.2.c. Inter-Cohort Differences

Given that the fastest change in the hazard rate occurs between ages 30-50, survivor functions were calculated to compare male and female physicians younger than 50 years of age. **Figure 4.18** shows the survivor function by cohort for physicians aged 30-49. The survivor function reports the proportion of physicians who have not entered a rural area prior to that age.

The data in **Figure 4.18** show that more physicians in the earlier cohorts located to rural counties at each age ($\chi^2_{(2)}$ =26.1, p= .000). This is not unexpected since there were more opportunities for rural practice for physicians in the earlier cohorts. Even though the overall survivor functions illustrate the expected results, inter-cohort differences could exist by gender if rural entry patterns differed for male and female physicians between, and within, cohorts.

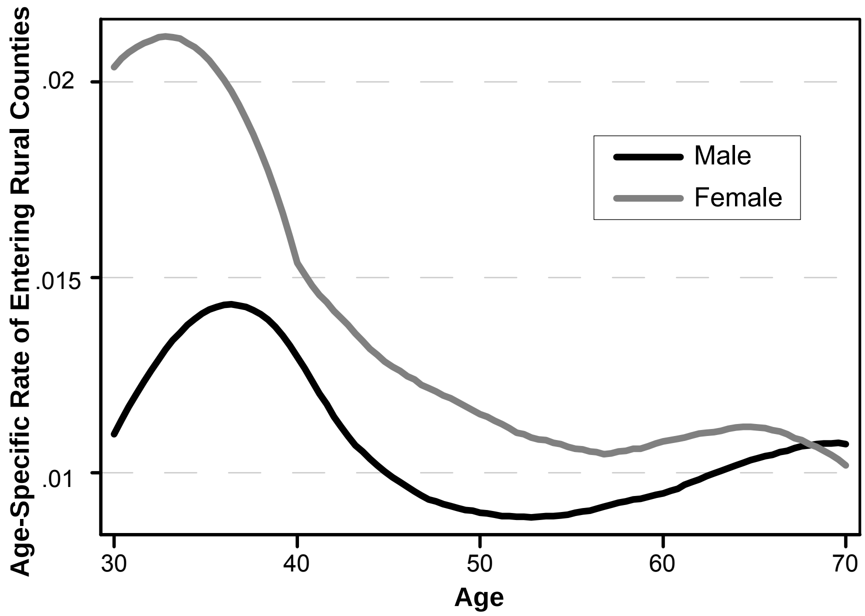
Figure 4.18. Survivor Function for Physicians Younger than 50 Years of Age



4.3.2.d. Gender Effects

Figure 4.19 illustrates the age-specific rate at which male versus female physicians entered rural areas. Specifically, it is the probability that a male versus female physician observed in the data moved to a rural area at a given age. As would be expected, and has been demonstrated by the descriptive analyses presented earlier in this dissertation, female physicians had a higher hazard rate than male physicians at all ages (and particularly before age 40) but the shapes of the two functions are somewhat different. For female physicians, the hazard function increases for only a very short period in the early 30s and then declines rapidly until 40 and keeps declining until the late 50s when there is slight uptick until the mid-60s before another slight downturn. By contrast, the hazard function for male physicians shows an increasing transition rate until the mid- to late-30s when it peaks, a decline until 50 and then another increase until age 70.

Figure 4.19. Hazard Function for Physicians Moving to Rural County



Because there was evidence of gender-related differences in a physician's likelihood to enter a rural county by age, the survivor functions illustrated in **Figure 4.20 and 4.21** were estimated to determine if differences occurred between cohorts in rural entry patterns for male and for female physicians. The survival functions for both male and for female physicians showed the expected pattern of physicians in earlier cohorts having a higher probability of moving to a rural county than physicians in subsequent birth cohorts. Log rank tests were performed to test for equality of the survivor functions. For both male and female physicians the log rank test rejected the null hypothesis of equality between cohorts in the probability of entering a rural county (males: $\chi^2_{(2)}$ =12.9, p=.000; females $\chi^2_{(2)}$ =21.2, p=.000:). While both log rank tests rejected the null hypothesis of equality between cohorts, a closer examination of the graphs in **Figures 4.20 and 4.21** revealed that the survivor functions for male physicians were closer together than those of female physicians. This difference suggests greater inter-cohort differences in the rural entry patterns of female physicians compared to male physicians and leads to the next analysis which compares the transition rates of male and female physicians within the same cohort.

Figure 4.20. Survivor Function for Male Physicians Younger than 50 Years of Age

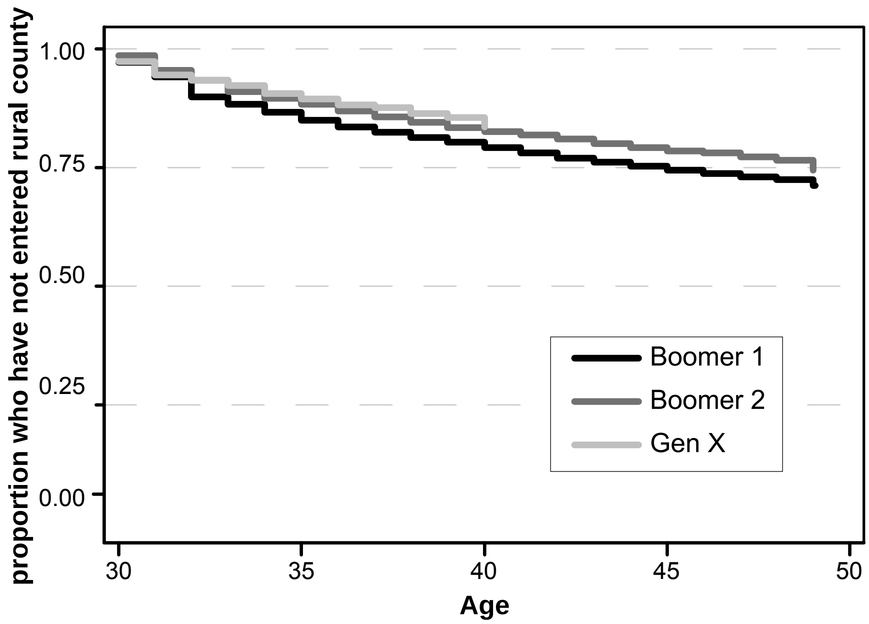
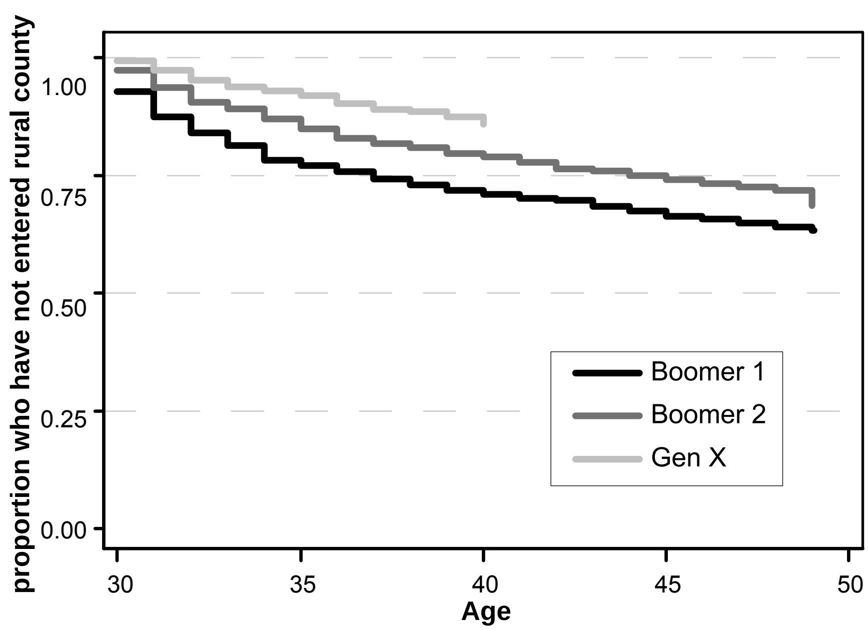


Figure 4.21. Survivor Function for Female Physicians Younger than 50 Years of Age



Survivor functions were estimated separately for male and female physicians in the *same* cohort to test for intra-cohort differences in rural entry transition rates. Survivor functions were only estimated for physicians under the age of 40 because Generation X physicians in the sample were only observed up to age 40. **Table 4.9** summarizes the number of times, by cohort, a physician between ages 30 and 40 had an "event" (e.g. moved to a rural county) or was censored. The term "censoring" is used in survival analysis to mean that the physician was not observed having an event while under observation. Censoring in this study could have happened for a number of reasons: 1. the physician moved to a rural county before she or he was under observation and then did not move again during the study period; 2. the physician was no longer licensed in North Carolina and dropped out of the sample; or 3. because she or he never moved to a rural county. As discussed in detail in Section 3.6.2.b in the Methods chapter, the first type of "left censoring" was not controlled for in the analysis but is not likely to have been an issue in this analysis due to the fact most moves happen in the 30-40 age period right after the physician enters medical practice and this age span is the focus of the analysis below. The second and third scenarios are what is called "right

Table 4.9. Number of Censored and Non-Censored Observations by Cohort

Male Physicians (Ages 30-40)

Birth Cohort	Total Obs	# of Events	Censored	% Censored
Boomer1	9,566	371	9,195	96.1%
Boomer2	13,049	411	12,638	96.9%
GenX	5,103	150	4,953	97.1%

Female Physicians (Ages 30-40)

Birth Cohort	Total Obs	# of Events	Censored	% Censored
Boomer1	1,840	96	1,744	94.8%
Boomer2	5,014	191	4,823	96.2%
GenX	3,280	92	3,188	97.2%

censoring" and are not problematic because they are accounted for in the calculation of the physicians "at risk" of entering a rural county at a given age. This is because the denominator of the hazard rate is an approximation of total exposure time: all cases who entered into that age plus half of those who left the age (i.e. half of the sum of # failed + # censored).

Comparing the survivor functions in **Figures 4.22-4.24** reveals that that while female physicians in the Boomer 1 cohort were more likely to enter rural counties than their male counterparts between ages 30-40, this gender effect was smaller in the

Figure 4.22. Survivor Function for Boomer 1 Physicians Younger than 40 Years of Age

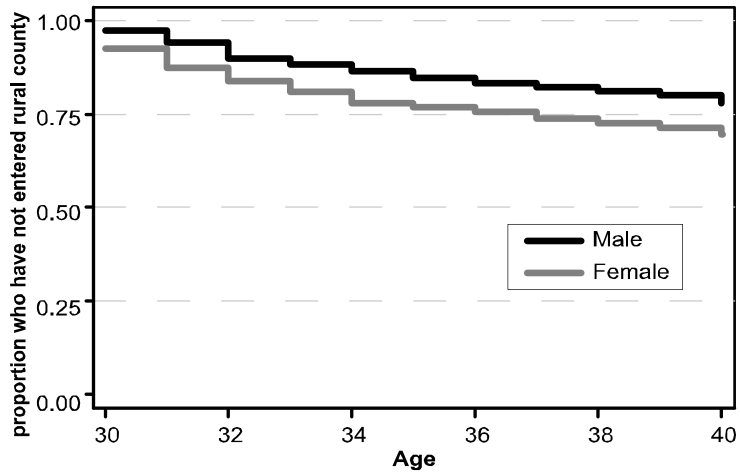


Figure 4.23. Survivor Function for Boomer 2 Physicians Younger than 40 Years of Age

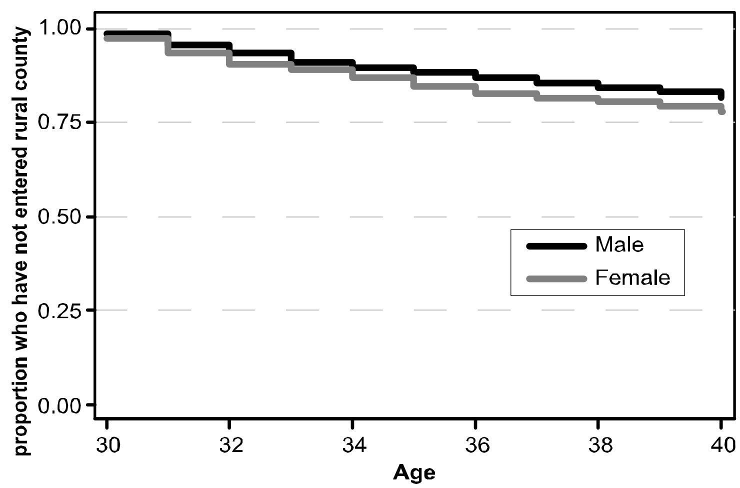
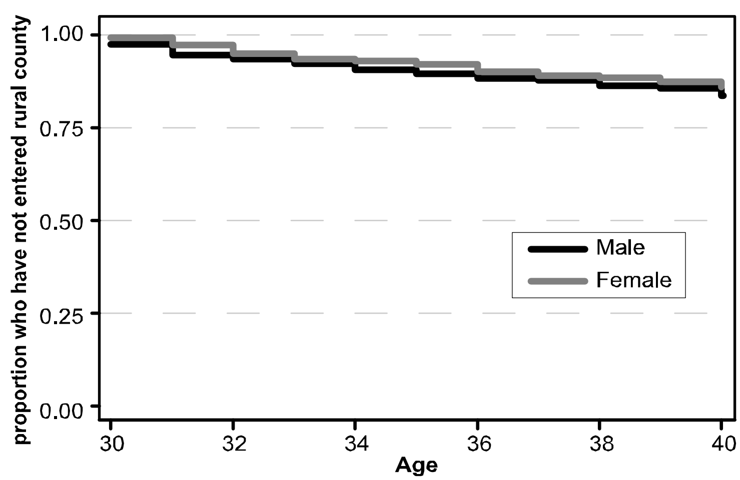


Figure 4.24. Survivor Function for Gen X Physicians Younger than 40 Years of Age



Boomer 2 cohort and basically non-existent in the Generation X cohort.

Log rank tests were performed to test for equality of the survivor functions of male and female physicians in each of the three cohorts and the tests confirmed what is evident from visual inspection of the graphs. The null hypothesis of equality of the survivor functions was rejected at the 5% confidence level for the Boomer 1 cohort ($\chi^2_{(1)}$ =4.82, p=.03) and the Boomer 2 cohort ($\chi^2_{(1)}$ =3.70, p=.05) but was not rejected for the Generation X cohort ($\chi^2_{(1)}$ =.23, p=.63).

The survival analyses illustrated in this section showed that the rate at which physicians transitioned into rural areas is dependent on age. The highest rate of entry was before the mid-30s and after that the rate declined swiftly until age 50. There was another increase in the transition rate between the mid-50s and age 70. Gender differences were evident in the rate at which physicians transition into rural counties by age. The fact that the inter-cohort survivor curves were closer together for male than female physicians suggests a greater similarity of age-structuring in the transition rate into rural counties for males than for females between cohorts. When survivor curves were estimated to examine intra-cohort gender effects, the data showed larger differences between the transition rates of male and female physicians in the earlier birth cohorts than among Generation X physicians. This latter finding is consistent with the results from the logistic regression which showed a steady decline in the marginal effect of being female in the 30-39 age category from the Boomer 1 to the Boomer 2 and from the Boomer 2 to the Generation X birth cohorts.

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5. DISCUSSION

5.1. Summary and Interpretation of Findings

Despite the stable and enduring picture of physician undersupply in rural areas, workforce research to date has not acknowledged how the interplay of two important temporal forces—changing lives and changing social/medical structures—might combine to produce different career decisions for physicians in different birth cohorts. Past research has consistently used cross-sectional or short-term longitudinal studies to identify the effect of age and gender on rural practice selection but, because it has not employed a cohort design, has not been able to identify that these effects may differ between birth cohorts.

This dissertation began by outlining the evolving landscape of the practice of medicine in rural North Carolina. The data showed that between 1980 and 2005, North Carolina's population grew rapidly and became more urban. At the same time, physicians in rural practice became more specialized, were less likely to work in solo-practitioner offices and worked fewer hours in patient care. Health care became more regionalized in large medical centers and the proportion of the population covered by Medicaid increased. These historical shifts formed the backdrop against which successive birth cohorts of physicians moved through their careers in rural counties.

In the early 1980s, male physicians in the Pre-WWII, WWII and Boomer 1 cohorts comprised the majority of the rural workforce in North Carolina. But the Boomer 2 cohort began to enter practice in greater numbers in the mid- to late-1980s and together the Boomer 1 and Boomer 2 cohorts now comprise nearly 60% of the workforce. With the Boomer cohorts came one of the most dramatic shifts in the demographic composition of the rural workforce—the entry of greater numbers of female physicians in the mid-1980s and early 1990s. Behind the Boomers was the Generation X cohort which began to enter practice in mid-1990s and now comprises about 23% of the active, instate workforce in rural North Carolina. One result of these demographic shifts was that women increased from 6% of the rural workforce in 1980 to 25% in 2005 and their increasing representation in rural medicine offset the aging male workforce.

The goal of this dissertation was to identify the degree to which the decision to locate to a rural county for practice exhibited stable or differing patterns for male and female physicians in different birth cohorts. The descriptive analyses, logistic regression and survival analysis together shape a picture of both inter- and intra-cohort differences in location behaviors.

The descriptive analyses illustrated that the age, gender and birth cohort structure of the physician workforce in rural areas underwent significant change during the study period. The data showed that during the study period physicians in the youngest age category (30-39 years of age) made up a decreasing proportion of the rural workforce and a declining share of physicians entering rural counties. By contrast, physicians aged 40-49 made up a greater proportion of physicians in the rural workforce and an even larger share of physicians entering rural practice in more recent years. Analyzing rural entry patterns by gender between 1980-2005 revealed that in recent years female physicians had increased as a proportion of new rural entrants at a faster rate than their growth in the total rural workforce

To fully understand whether these trends represented true differences in rural entry patterns, or simply demographic shifts in the rural workforce, logistic regression and survival curves were used to compare the timing of the transition into rural practice for physicians of the same age in different birth cohorts.

The logistic regression showed that after controlling for cohort and gender physicians younger than age 30 had a lower probability, and physicians over age 50 had a higher probability, of moving to a rural county for a first practice location than physicians aged 30-39. The logistic regression also showed that even after controlling for age, gender and time fixed effects, Generation X physicians had a lower probability of locating to a rural county than the Boomer 2 physicians who preceded them. Finally, the logistic regression demonstrated that while female physicians were less likely to enter a rural county for a first practice location than their male colleagues in every age group and cohort, the marginal effect of being female declined for physicians aged 30-49 in the most recent birth cohorts.

The survival analyses showed that the rate at which physicians already in practice transitioned into rural areas was highest before the mid-30s and declined rapidly until age 50. However, consistent with the findings from the logistic regression model, there was another increase in the transition rate between the mid-50s and age 70. Gender differences were evident in the rate at which physicians transition into rural counties by age. When survivor curves were estimated to examine intra-cohort gender effects, the data showed larger differences between the transition rates of male and female physicians in the earlier birth cohorts than among Generation X physicians. This latter finding is consistent with the results from the logistic regression which showed a steady decline in the marginal effect of being female in the 30-39 age category from the Boomer 1 to the Boomer 2 and from the Boomer 2 to the Generation X birth cohorts.

The empirical findings of this research suggest that the effect of age and gender on entry into rural counties does vary between cohorts and these findings have important implications for the underdeveloped field of workforce modeling which are discussed in the next section.

5.2. Contribution to Science of Workforce Modeling

Workforce researchers and planners have wrestled for years with how to project the future physician workforce needs of the country and how to do so enough in advance to avoid the lurching-from-oversupply-to-shortage syndrome that has been a fixture of US physician supply. While projecting the demand for physician services is understandably difficult given uncertainties about income, insurance coverage, changing morbidity and mortality rates, technological innovation, substitution of physicians by other providers and a multitude of other considerations, it seems that projecting supply should not be that difficult. But, generating accurate supply projections has been an equally daunting task.

This difficulty was perhaps best summarized in a 2002 *Health Affairs* article by Kevin Grumbach in which he described the issue of physician workforce planning as a “vexing” problem and discussed how workforce modelers have had to keep tuning and re-tuning physician supply models in the hopes that “they will finally solve the riddle of physician supply planning. The result is a saga of the history of the U.S. physician workforce that reads like a version of Goldilocks written by Albert Camus: an endless cycle of tasting a physician supply porridge that is too hot, or too cold, but never just right [1].”

In an effort to avoid the Goldilocks cycle in the future, the Association of American Medical Colleges (AAMC) [2], the Bureau of Health Professions (BHPr) [3], health policy researchers and private consulting firms have been working to tweak existing physician supply models to “get it right”. However, a key feature of all of these models is the use of cross-sectional data to identify age and gender effects on supply and the extrapolation of current age and gender effects to physicians in future cohorts. The findings of this dissertation suggest that such methods fail to take into consideration that age and gender effects may not constant over time and therefore may produce biased estimates.

While the empirical findings from the logistic regression suggest that physicians in the Generation X cohort are less likely to enter a rural county for a first practice location than the Boomer 2 physicians who preceded them, the bigger contribution of this dissertation to workforce modeling is the finding of divergent intra-cohort rural entry practice patterns between male and female physicians ages 30-40 in the Boomer 1 and Boomer 2 cohorts, but similar rural entry patterns by age for male and female physicians age 30-40 in the Generation X cohort. This finding is compelling because while it is impossible to know if male and female practice patterns will continue to converge in the Generation X cohort in the future (because we only observe Generation X physicians under age 40 in the data), the finding is consistent with recent work done by Fraher and Ricketts (2009) which found that the difference in hours worked per week between male and female physicians of the same age is decreasing in more recent cohorts [4].

These results are important because much ado is made about gender effects in the physician workforce and gender effects are assumed to be a static component of future physician supply. More specifically, workforce analyses have fallen into the “fallacy of cohort-centrism” and made the assumption “that members of all cohorts will grow older in the same fashion as members of our own cohort [7].” Workforce research that examines the practice patterns of a single cohort over time and then abstracts findings to all cohorts ignores the fact that the organization of medicine and society change over time and these changes result in different age and gender effects for different cohorts of physicians The limitation of current research and policy is that it has examined the physician population at a given point in time and assumed that a static process governs how male and female physicians’ careers will develop.

5.3. Policy Implications

Policy interventions aimed at improving physician supply have met with limited success. One reason for this limited success may be that existing research, and the policy levers based on this research, is founded on an incomplete understanding of how the geographic preferences and practice behaviors of male and female physicians in different birth cohorts vary in different historical periods. The findings from this study provide evidence of Maltida Riley's cohort principle [5] which states that because society changes, members of different cohorts cannot age in precisely the same way. Applied to the physician workforce, and specifically to this study's findings, her principle means that because the social and medical context changes over time, different cohorts of physicians who practice in different historical periods will have different rural location patterns.

These insights have much to offer existing workforce policies aimed at increasing physician supply in rural areas. Despite significant investments of state and federal dollars in programs such as the NHSC, AHEC, loan repayment, scholarships and other programs, the inadequate supply of physicians in rural communities remains a persistent problem. These programs have been designed based on cross-sectional research which has prevented them from being as dynamic as the physicians' career trajectories they seek to influence. Findings from this dissertation suggest that policy makers need to design incentives that work across the physician's career trajectory and that the "one size fits all" type strategies currently in place may not be as effective as they could be due to inter- and intra-cohort differences in geographic mobility patterns.

Most programs aimed at recruiting physicians to rural communities are directed toward affecting location decisions in the early practice trajectory.

Federal and state initiatives generally seek to offset the physicians' medical school debt in return for obligated service in a rural area. Despite these initiatives, the logistic regression showed that physicians in the Generation X cohort were less likely to enter rural practice for a first practice location than physicians in the Boomer 2 cohort that preceded them. These findings were consistent with the descriptive analyses which showed that physicians ages 30-39 made up a decreasing proportion of physicians entering rural counties during the study period. By contrast, the logistic regression also showed that, holding other factors constant, physicians ages 50-59 were more likely to enter a rural county for an initial practice location than physicians in the 30-39 age group. A similar trend was seen for physicians already in practice. During the study period, 605 (18.5%) of physicians who entered rural counties were between ages 50-70 and the survival analyses showed an increase in the transition rate between the mid-50s and age 70. Taken together, these findings suggest that older physicians will move to rural counties and that perhaps even more older physicians could be recruited to rural areas.

Why would a physician move to a rural county later in life? By the mid-50s, physicians may move to rural locations as retirement destinations. Or, they may decide to move back home to a rural county where they grew up since their children have moved out of the house and they no longer have to consider the quality of the schools. Older physicians may also move to rural counties out of a sense of altruism and a desire "to give back to the community" after a successful medical career. An interesting avenue for future research would be to examine the reasons these physicians move, the characteristics of the counties where they move, the types of practices they select into, and the number of hours they work per week after moving. Future work could also focus on the demographic and practice characteristics of physicians most likely to undertake a move later in life. Such analyses would provide valuable information about the types of physicians most likely to move and the counties most likely to attract such physicians.

Policies aimed specifically at physicians later in the career trajectory are basically non-existent among current initiatives designed to recruit physicians to rural counties. Pathman et al (1996) identified that there were only eight “direct financial incentive” programs in place that were aimed at recruiting physicians already in practice to rural communities. While there is some anecdotal evidence [6] that policy makers are aware of the need to craft policy that focuses on mid- as opposed to early-career physicians, there are limited programs at the state-level (and none at the federal-level) that are designed specifically to attract older physicians to rural counties. One option would be to expand the direct financial incentive programs currently in place to other states and to a national program.

But, the findings also suggest other modifications to existing workforce policy initiatives such as shifting the focus from physician age and gender to cohort. Like workforce modelers, workforce policy makers have focused on cross-sectional age and gender effects and not on cohort effects. The fact that that Generation X physicians were less likely to enter rural areas than the Boomer 2 physicians and that the gender effect was converging for Generation X physicians already in practice under age 40 suggests that future workforce policy and research needs to be focused less on initiatives targeted toward attracting female physicians and more on identifying the reasons that male *and* female Generation X physicians are less likely to choose rural practice than their predecessors.

Because this analysis used secondary data to identify inter- and intra-cohort differences in the selection of rural practice, it is impossible to know the underlying reasons these differences exist. As discussed in the next session, additional quantitative and qualitative study is needed to uncover the mechanisms generating these observed differences. While some of these differences are likely related to factors not easily influenced by policy (e.g. the quality of the school systems in rural areas may be a deterrent), others may be more malleable to policy intervention (e.g. developing practice support systems that reduce call burden and support the Generation X physician's need for a work-life balance).

5.4. Limitations and Future Extensions of Dissertation Analyses

This dissertation has taken a first step in identifying the importance of using life course methods to analyze physician career transitions in the context of changing times and changing lives. The different rural location patterns of the Generation X cohort and the fact that the gender differential in rural entry patterns diminishes in the Generation X cohort raise interesting questions that require more qualitative and quantitative research. As Giele (1998) noted, "whatever the patterns of innovation that are uncovered, the theoretical challenge is to explain why they occurred in one period rather than another and in some groups and not others [7].”

Why does the gender differential basically disappear between male and female physicians in the Generation X cohort? Was the Generation X cohort less likely to enter rural counties because of concerns about work-life balance? Did the entry into the medical workforce of such a large group of female physicians in the Boomer 2 cohort fundamentally altered existing medical structures and/or expectations about work-life balance for the Generation X physicians who followed? Were the women in the Boomer 2 cohort what Giele (1998) calls innovating pioneers [7]? These questions highlight what Ryder (1965,1992) identified as the benefit of studying social change through cohort analysis since “cohort analysis is peculiarly appropriate for the study of long-term normative change, whether in reproductive institutions…or elsewhere in society…[because] [e]ach new cohort is simultaneously a threat to social stability and an opportunity for social transformation [7].”[11]

Because this study has been generally descriptive in nature, it has not identified the underlying processes generating differences in rural entry patterns. The first part of this dissertation highlighted the importance of embedding the physician’s career in the context of the changing rural and medical context but the analyses presented did not specifically link these historical changes to the observed cohort differences in physician location behaviors. Life course scholars have shown that individuals are particularly impressionable early in the life

[11] From Ryder NB (1992). Cohort Analysis. In E.F. Borgatta & M.L. Borgatta (Eds), Encyclopedia of Sociology (volume 1, pp 227-231) as cited by Giele JZ. (1998) “Innovation in the Typical Life Course”

course. It is possible that the historical and social context encountered by the Generation X physicians differed from earlier cohorts and it was this difference in the formative years of their medical careers that shaped their propensity to less frequently enter rural areas.

More rigorous analytical methods such as Cox proportional hazard modeling are needed to describe the "mechanisms that theoretically generate the distribution of the timing of events [8]." Such analyses will grapple with the issue of separating age-period-cohort effects that has been a persistent methodological challenge for life course scholars. As Glen noted in a 2004 essay in the *Handbook of the Life Course*, the "age-period-cohort conundrum is a special case of the 'identification problem' which occurs whenever there are three or more independent variables that may affect a dependent variable and when each of those variables is a perfect linear function of the other ones [9]". In his essay, Glen reviews the various statistical methods that have been undertaken to separate age-period-cohort effects and concludes that none are satisfactory, recommending that researchers "skip the statistical model testing and proceed directly to more informal means of distinguishing age, period and cohort effects. These methods are fallible of course, but they are generally recognized as such and, hence, are less likely than formal model testing to lead to dogmatic, overly confident conclusions [9]". With Glen's pessimism about the value of statistical modeling in mind, this dissertation serves as a first analysis of age-period-cohort effects on the physician workforce that has used more "informal means". But, the analysis raises important questions about the specific contributions of age, period and cohort on variation in physician location behaviors that would undoubtedly benefit from more statistically rigorous methods. [25,26]

For example, this analysis did not consider the effect on location decisions of what life course researchers call “linked lives”. A physician’s decision to locate to a rural area is not only a function of individual preferences and historical/contextual context but is also related to the individual’s relationships to others both in the personal and professional domains. The licensure data used in this analysis did not contain information on marital status, presence of children in the household and other unobserved family-related factors that affect career decisions.

This dissertation has not informed the question of how differences in rural entry patterns between cohorts affected the longer-term career trajectories of the physicians within those cohorts. More work is needed on how the different rural entry patterns ultimately affected retention in rural practice since attracting the physician to a rural county is only part of the challenge—keeping him or her in place is the ultimate goal.

The concepts of transitions and trajectories are key concepts in life course theory and they elucidate the reason that the timing of transitions, in terms of the physician’s biological age and career stage, may have an important effect on his or her long-term trajectory. A transition represents a change from one state to another, in this case a physician’s entry into rural practice. Transitions are embedded in trajectories: the latter give meaning and shape to the transition experience [10]. Seminal work on the influence of an individual’s age on the effect of transitions on long-term trajectories has been done by Sampson and Laub in relation to entry into the military service [11]. Their research found that men who entered military service in World War II at an early age gained important human capital that was of use when they were discharged into the booming economy of the 1950s and 1960s. The timing of military entry, for these men, coincided with an important developmental state in their career trajectories. Additionally, the expanding economic times of the historic period and the G.I. bill resulted in better occupational outcomes for early versus late military entrants. These findings were paralleled by those of Elder and Chan (1999) who found that late military entry was a disruptive transition with long-term negative effects [12]. The authors' research revealed that "the meaning of recruitment and wartime events is contingent on when they occur in a person's life…the likelihood of disruption increases with age at entry." Compared to non-veterans, men who entered the military at a later age experienced higher rates of divorce, lower life time incomes, and worse health outcomes.

The idea that transitions can generate life-long advantages or disruptive outcomes is a potential model for understanding physician entry into rural practice. Elder's work (1974, 1986) introduced the importance of this concept by showing that the age at which children experienced economic deprivation in the Great Depression had a long-term effect on the life course [13]. At what point in a physician's career does he or she perceive a rural move in terms of maximizing advantage and minimizing disruption? Early in their careers, physicians may want to keep their career options open but as they progress toward their 50s and

60s and children have moved out of the house, their expectations of their career trajectory relative to the demands and needs of their family and community may change. The mid-50s may be a turning point in a physician's career when she or he is more likely to enter rural practice.

This study narrowly focused on whether there were age-related differences in physician location behaviors but not on whether there were differences in rural entry patterns at different stages of the physician's career trajectory. Although age and stage in medical career are highly correlated, some physicians enter medical school at a later point in life. **Table 5.1** shows that 69 observations on physicians aged 50 and older in the sample had only been in medical practice 6 or fewer years when they were observed and another 219 had been in practice for between 7-10 years. The logistic regression showed, that all things being equal, the 50-59 year olds were more likely than physicians ages 30-39 to enter rural practice. It would be interesting to know if, because these physicians made the decision to enter a rural county at a later point in their career, if they were ultimately more likely to be retained in rural practice.

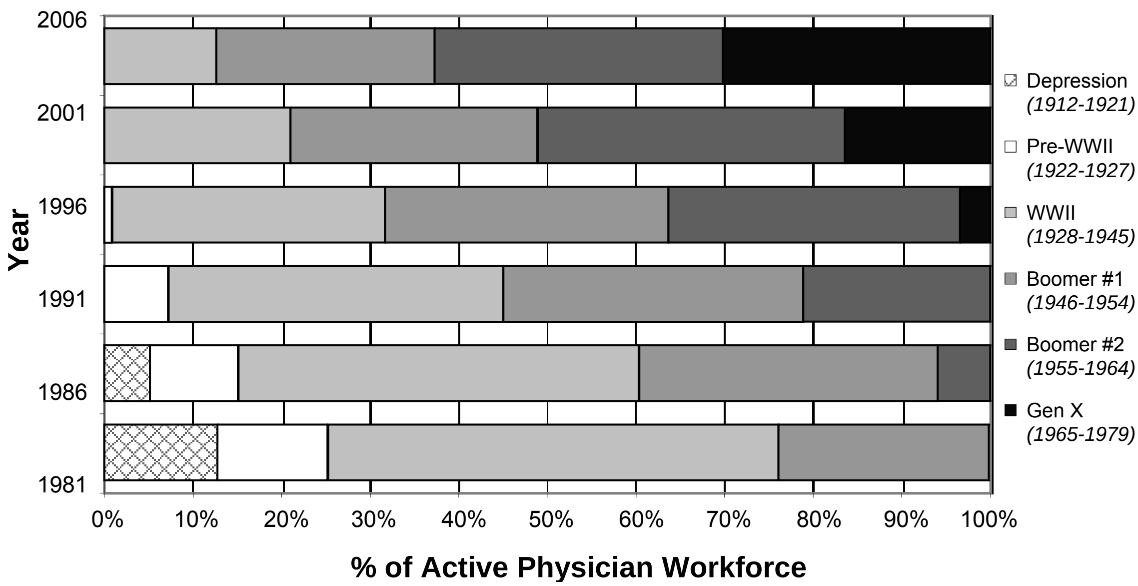
Table 5.1. Physician Age and Years in Practice

	New to practice ***≤6 years***	**Early practice** ***7-10 years***	**Mature practice** ***11-27 years***	**Later practice** ***28-37 years***	**End of practice** ***≥38 years***	**Total**
< 30	2,430					2,430
30-39	16,361	22,907	14,610			53,878
40-49	1,047	3,140	52,247			56,434
50-59	68	204	18,542	16,371		35,185
60-69	1	15	368	9,123	8,689	18,196
70 & over	0	0	8	159	6,512	6,679
Total	**19,907**	**26,266**	**85,775**	**25,653**	**15,201**	**172,802**

Note: 5 physicians were missing birth year and 142 physicians were missing years in practice.

Table 5.1 demonstrates the reason that future analyses should incorporate the life course concept that age-related transitions can occur early, late or on-time in relation to social expectations [14]. Because these “off-time” physicians made transitions in their medical careers (i.e. setting up a first practice location) at an older age than most physicians, variations in their location patterns may be the result of both their age and their stage in their medical career.

Figure 5.1. Composition of US Physician Workforce by Birth Cohort, 1981-2006



An important limitation of this analysis is that was undertaken at the state-level and may not be generalizable to other states or the nation as a whole. There are reasons to believe that the findings would be generalizable since the age and gender distribution of the North Carolina physician workforce is generally similar to the US physician workforce. **Figure 5.1** shows the cohort progression of the US physician workforce from 1981-2006 and demonstrates that an analysis replicating the one done in this dissertation would be possible using US physician workforce data from the American Medical Association’s Masterfile. Such an analysis would be very useful to test the degree to which this study’s findings are generalizable to the US physician workforce.

Another reason to suspect that these findings may be generalizable outside the State is that North Carolina has characteristics that can be extrapolated to many parts of the United States—isolated, rural, low density areas, fast-growing once rural suburbs, declining “traditional industry” towns. Finally, there is no reason to believe that whatever mechanisms are generating the disappearance of the gender effect in the Generation X cohort would be any different for physicians in North Carolina than elsewhere in the United States. In fact, it would be interesting to know whether gender convergence in the Generation X cohort is evident in the practice behaviors of physicians in other countries. International comparisons of career trajectories have revealed interesting patterns of convergence and divergence that have shed light on the unique contribution that different social and economic structures play in shaping careers and job mobility [24].

A very broad definition of rural was used in this analysis. **Table 5.2** shows select economic and health care indicators for rural versus urban counties in the State in 2005 and clearly demonstrates the high degree of heterogeneity that exists within both county types. Future analyses may want to use a more fine-grained definition of rural or may want to divide counties into typologies by how they fared during the study period to determine if there are associations between the trajectory of the county’s economic and health care infrastructure and the rural career trajectories of physicians in the county.

Table 5.2. Selected Statistics for Urban and Rural Counties in North Carolina, 2005

	North Carolina	Rural		Urban	
		Min	Max	Min	Max
Physicians/10,000 population	20.7	1.7	27.8	2.1	88.5
Primary Care Physicians/10,000 population	8.8	1.7	13.6	2.1	31.8
Unemployment rate	5.2	2.1	14.0	2.2	10.4
Acute care, inpatient hospital beds	20,338	0	424	0	2,029
Percent Medicaid	18.0	8.8	33.9	7.7	36.0
Per capita income	30,713	17,967	32,224	17,342	37,503

5.5. Beyond Studying Physician Location Behaviors

Empirical findings aside, the real contribution of this dissertation is that it illustrates how much workforce researchers have to gain from using life course theory as a way to frame our understanding of physician's career transitions and trajectories. While this analysis sought to capture the common elements of behavior across different birth cohorts of the same age and to describe these common behaviors, it did not identify the specific historical or societal changes that generated these differences. This is a rich area for future investigation. As Elder and Pellerin note (1998), a cohort-sequential design, like the one employed in this analysis, "allows estimation of the relative influence of historical effects but generally leaves the meaning of these estimated effects open to speculation…Without being certain about which aspects of the environment are salient, it is impossible to be certain about the mechanism by which the environment alters the course and substance of lives" [15].

Future workforce studies would benefit from using the approach employed by Elder in his work on the Iowa Farm project [16, 17] and in *Children of the Great Depression* [13]. Such an approach emphasizes understanding the proximal and distal effects of a particular historical event, in the former the impact of the decline in the farm population in Iowa and the latter the effect of the Great Depression, on successive birth cohorts of individuals. This type of study design would be well-suited to studying important workforce issues like the effect of the implementation of the 80 hour/week cap on residents-in-training. The duty hour restriction was implemented in 2003 and has affected not only those whose hours are restricted but the entire physician workforce.

The life course perspective frames a number of important questions for future research about the proximal and distal effects of this policy change. There are concerns, particularly among surgeons, that because the cap reduces training time, that the new crop of residents trained under the restrictions will not have the same competence as physicians trained in earlier periods [18, 19]. Others have expressed concern that since residents no longer have to work the grueling hours that their predecessors did while training that this will carry forward as reduced productivity throughout the physicians' career. Critics of cap are also concerned that the new system will not ingrain a necessary sense of accountability and professionalism in today's residents [20, 21].

Using a sequential cohort design to study the effects of implementation would also bring into focus the important question of how physicians more advanced in their career trajectories have been affected by the work hour restrictions. There is some literature suggesting that because more senior doctors have to fill in for the reduced productivity of residents that they have less time for research and other activities [22].

A critical contribution of life course theory to workforce research is that it emphasizes the importance of embedding physician career decisions in the context of changing medical and social structures. Such a perspective suggests the need for study designs that illuminate important period effects related to the organization of medicine and society that influence health professionals' practice decisions. This latter contribution is essential due to rapid changes underway in the health care delivery such as the emergence of new providers like hospitalists, payment reform strategies that reward cost-savings and quality, and the proliferation of alternative care models such as the medical home. At the clinical-level, the effects of changes in disease prevalence rates and new technological innovations on the health care workforce might also be the subject of focused study. For example, cholecystectomy, the most common abdominal operation was done with laparotomy and 5-7 days of hospital time until about ten years ago. Now over 80% are done laparoscopically, usually in an outpatient setting. Vascular interventional radiology use has also exploded as has the use of cardiology/electrophysiology. Such studies would be beneficial to understanding how rapid changes in technology, the organization and funding of health care, insurance coverage policies, and other macro-level initiatives have rippled through the health care workforce affecting career decisions and trajectories [23].[12]

[12] The "ripple" metaphor was borrowed from pg. 9 in *Changing Britain, Changing Lives: Three Generations at the Turn of the Century*.

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