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Analysis of the Geographical Distribution of Primary Care Physicians in Nebraska

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By

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Many articles point out that there is a disparity between rural and urban areas in healthcare service. The disparity is derived from the locational choices of physicians which are influenced by diverse factors such as backgrounds where they grew up or type of facility at which they worked. This study examines physician movements which vary depending on the types of physician and facility in Nebraska. The research dataset are annual practicing records of all primary care physicians and business information of the facilities in Nebraska from 1998 to 2019. The study result shows that there is little difference in physicians' tenure and movements between rural and urban areas. On the other hand, physicians' high school background and facility closure are the most influential factors to cause physicians' movements in the state. The physicians who have out-of-state high school background and have not revealed the high school background show remarkably higher rate of leaving the state or stopping practicing than those of in-state high school backgrounds. The facility closure makes physicians move to other facilities, leave the state, or stop practicing. The factors affect the distribution and demand of physicians in Nebraska. As a result of the research, the study suggests a state level model which can explain the relation of physician type and facility type to physician movement in Nebraska.

Acknowledgement

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Chapter 1 Introduction

While 20% of the U.S. population live in rural areas, only 9% of physicians serve the population in those areas (Hancock, Steinbach, Nesbi, Adler, & Auerswald, 2009). It means that there is a disparity in receiving healthcare service among rural and urban people. The primary care providers of family medicine, internal medicine, pediatrics, obstetrics and gynecology, and general surgery are a backbone of the rural healthcare system (Institue of Medicine (US) Committee on the Future , 1996). Nebraska ranks 19th among states with 155.5 primary care providers per 100,000 people in 2018 which is close to the national average of 156 (Foundation, 2018). However, Nebraska Department of Health and Human Service (DHHS) has designated all counties to one or more health profession shortage areas in primary care providers in 2019 besides metropolitan areas around the cities of Lincoln and Omaha (Nebraska Department of Health and Human, 2019).

A physicians' join to or relocation from practices across the state affect geographical distribution of physicians in the state. Many policies and studies have focused on recruiting physicians into rural practice (Charbonneau, 2018). But, a physician's leaving a practice can cause an immediate instability of healthcare service in the community (Hall, Brazil, Wakefield, Lerer, & Tennen, 2010) (Luther, et al., 2018). To keep physicians in rural communities might have the same weight as inviting them into the communities in response to increasing demand of healthcare service in the areas.

Many articles show several causal factors such as personal background, a facility's strategy, and community engagement which could lead a physician to choose rural practice (Lee & Nichols, 2014) (Daniels, VanLeit, Skipper, Sanders, & Rhyne, 2007).

Some studies also demonstrate that low career satisfaction can be a crucial factor to cause physicians to leave the workplace (Hall, Brazil, Wakefield, Lerer, & Tennen, 2010). However, there are concerns whether these studies can show consistent outcomes on various circumstances since each study experimented on its own specific setting and context (Grobler, et al., 2009) (Globler, Marais, & Mabunda, 2019).

University of Nebraska Medical Center has built Health Professions Tracking Service (HPTS) database which has stored career records of all healthcare providers in Nebraska since 1996. HPTS brings a feasibility to an integrated analysis on the physician and facility records in a term of 22 years within the possible range which it can support.

1.1 Research Questions

The study aims to understand dynamics about physicians' choice of workplace and career relocation among rural or urban areas, which can contribute to improvement of physician retention. Many studies and policies have focused on the factors creating successful recruitment into rural practice, but few studies have researched on the retention issues. If it is difficult or limited to invite physicians to rural communities, retention of existing physicians would decide whether to preserve the capability of healthcare service in the area. A presence of a physician in a rural facility is a collective outcome of personal decision, facility efforts, and community recognition.

There can be various factors affecting a physician's decision of whether to choose or leave the rural workplace. When medical students or spouses have a rural affiliation or expose themselves more often to rural practice educational courses, they are likely to

choose a rural practice. If a physician pursues a life in natural and ease environment, he or she is likely to stay prolongedly in rural communities (Lee & Nichols, 2014).

Facilities play a vital role in recruitment and retention of physicians in a rural community. The management leadership is the key factor to invite and keep physicians. Making a superior strategy in screening candidates, financial incentives, residency offering and linking spouse to local community can create a successful recruitment. Supporting favorable practice environment in equipment, working conditions, and opportunity of professional progression can contribute to physicians' prolonged stay (Lee & Nichols, 2014). Low level of job satisfaction is the critical factor for a physician to leave the workplace regardless of urban and rural facilities. When there is unordered work procedure or conflicts in the relationship among colleagues or staffs, a physician feels low levels of self-satisfaction with their career. Physician burnout, which is attributed to high workloads, can negatively effect one's job satisfaction (Hall, Brazil, Wakefield, Lerer, & Tennen, 2010).

The community engagement plays a significant role in physician retention. The more sense of integration to the community a physician and family feel, the more prolongedly they are likely to remain. There are negative factors such as poor school systems for children or limited social and recreational activities. Also, inferior quality of payer mix and less reimbursement of general rural community are risk factors in financial compensation for physicians choosing and staying at rural practice (Lee & Nichols, 2014).

Backbone of any state healthcare system is a network of facilities employing primary care physicians. Physicians choosing and leaving the facilities over years have

shaped current geographical distribution. Variation of physician existence at each facility influences on healthcare service in the area. Relocation from a practice is the most impactful variation on the community. When a physician leaves a rural practice, the replacement cost exceeds $250,000 besides its difficulty and prolonged lead time (Lee & Nichols, 2014). Where there is high physician turnover, patients' dissatisfaction increases, and it can cause another relocation in the practice. By constantly looking over the variation at all facilities in the state, policy makers can find where and what problems there are with a severity and can perform a further investigation on the facilities.

The above stated description of causal factors is a linkage of many studies discretely done at each scholarly branch. In fact, few studies seem to have explored the interactive effects of the factors on a complex setting and context until now. Grobler and colleagues demonstrate twice that all studies are lacking in scientific evidences on their rural intervention strategies. Because they experimented on specific setting and context, bias or confounding can ensue. (Grobler, et al., 2009) (Globler, Marais, & Mabunda, 2019).

In Nebraska, HPTS (Health Professions Tracking Service) database of UNMC maintains records of all healthcare providers in Nebraska, which stores historical records of a physician about educational background, workplace locations, dates, and surrounding socioeconomic environment. The dataset has in part relevancy to the studies mentioned above, and HPTS supplies opportunity for an integrated analysis on the research subject. Because HPTS does not provide all the relevant information, some causality or relation have to be inferred from the given evidences.

The study pursues the answers to the following research questions about intra or inter relation among factors and its significance. Also, the study aims to build an integrated analytic model to which government agencies or medical schools can continually apply every year.

Study Questions

1) What is the impact caused from each type of physician, facility, and county in Nebraska?
2) What is the interactive relation among factors which strongly influence physician movement statewide?

1.2. Definition and Study Scope

The study stipulates definition and scope of the research objects which are used across the whole research process as follows.

Primary Care Physician

The primary care physician is a physician who serves as the entry point to the healthcare system and provides comprehensive care for the community patients (American Academy of Family Physicians, 2020). The physician has the ability to meet a wide range of patients' needs including chronic, preventive and acute care. The study defines specialties of the primary care physicians as family medicine, internal medicine, general surgery, pediatrics, psychiatry and obstetrics & gynecology which conform to the classification of the Office of Rural Health in Nebraska. The study only researches on the physicians who have the specialties with medical doctors (MD) degree and does not

distinguish the specialties to focus on the determination of the major movements and causes.

Table 1.1 The numer of primary care physicians by specialty

# of Physicians	
Family Medicine	1447 (42%)
General Surgery	280 (8%)
Internal Medicine	636 (19%)
Obstetrics & Gynecology	338 (10%)
Pediatrics	464 (14%)
Psychiatry	308 (9%)
Total	3411* (100%)

*62 physicians have multiple specialties

Health Care Facility

The study defines a facility as Health Care Facility licensed under the Health Care Facility Licensure Act of Nebraska where one more primary care physician had or has worked at (Nebraska Department of Health and Human Services, 2020).

Rurality in Primary Care Facility

There are two guidelines in designation of healthcare shortage area in Nebraska. The one is Nebraska state shortage area and the other is Federal Health Professional Shortage Area (HPSA). Health Resource and Services Administration (HRSA) determines the federal shortage area according to three scoring criteria and incidental indexes (Health Resources & Services Administration, 2019).

1) Ratio of population to providers
2) Percentage of the population below 100% of Federal Poverty Level

3) 30- or 40-minute travel time to the nearest facilities outside the HPSA designation areas

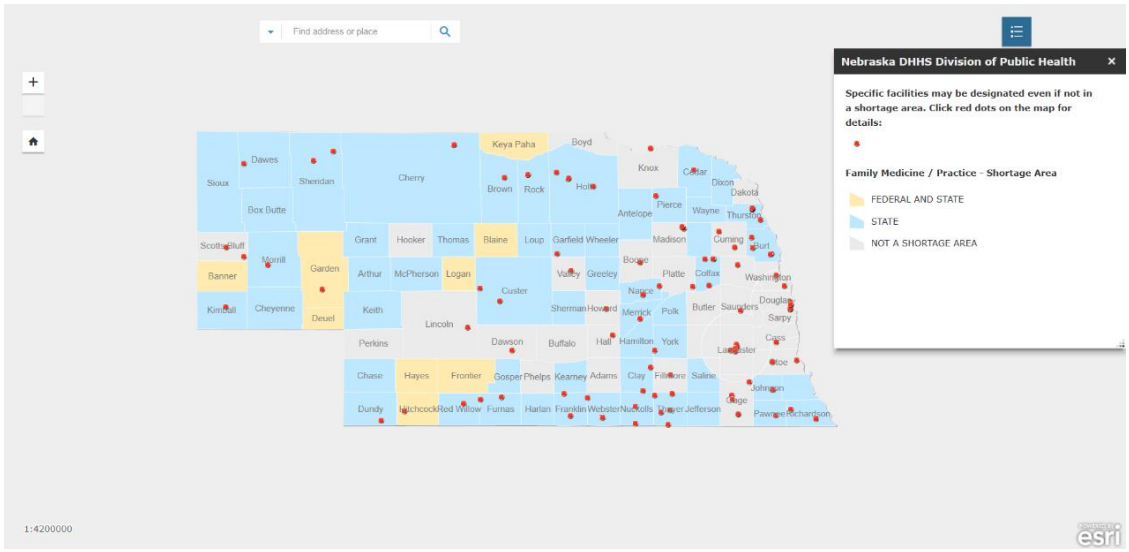
Office of rural health of Nebraska DHHS and Rural Health Advisory Commission judge whether a county is a state shortage area by a ratio of population to physician (Nebraska Department of Health and Human, 2019).

1) In case of family medicine, if there is no physician or ratio of population to physician is greater than or equal to 2,000/1, the area becomes state shortage area. But, counties with more than 15,000 residents, metropolitan statistical area, and areas within a 25-mile radius of the city of Lincoln and Omaha cannot be shortage area.
2) Other medical disciplines have their own guidelines, and the areas within the 25-mile radius of Lincoln and Omaha cannot be shortage area.
    a) General Surgery 10,200/1
    b) General Internal Medicine 3,250/1
    c) Obstetrics and Gynecology 10,000/1
    d) General Pediatrics 9,300/1

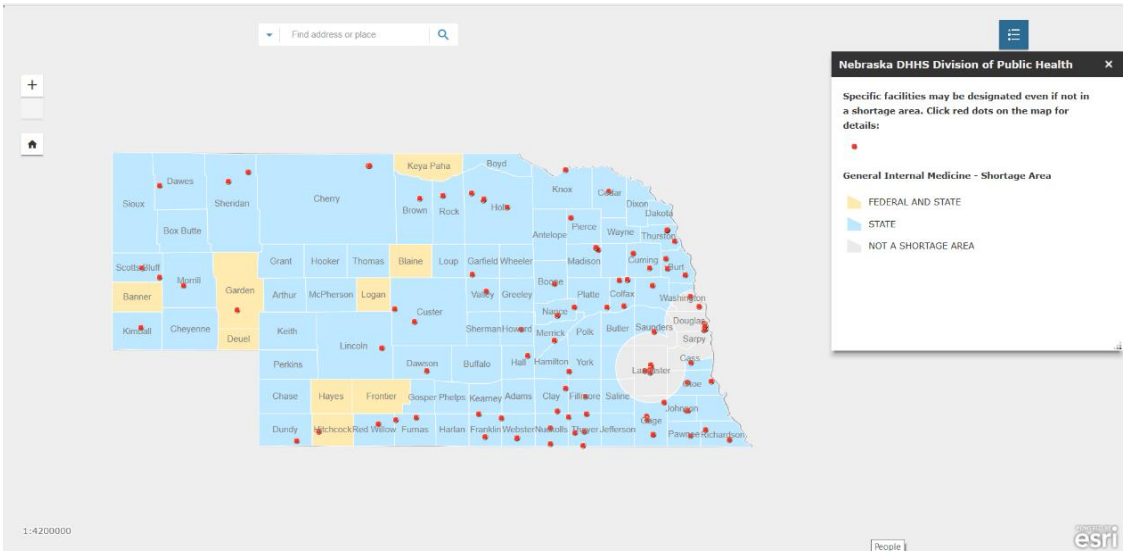
The online look up service of Nebraska DHHS shows current status of the state and federal shortage area designation by disciplines across all counties. The maps show that many counties have different designations depending on the disciplines.

Figure 1 Health Profession Shortage Area designation in Nebraska

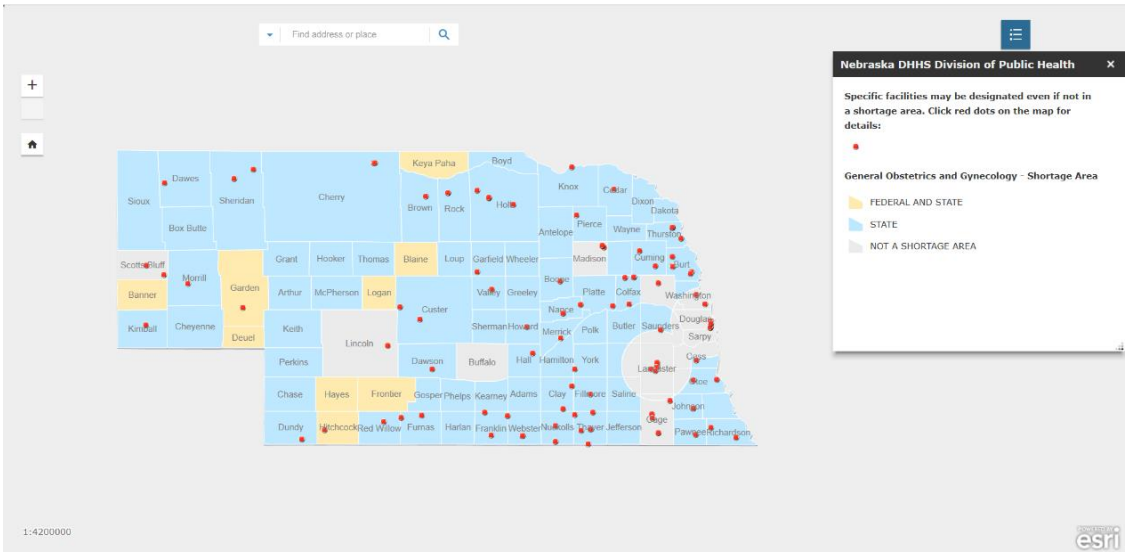
(a) Family Medicine



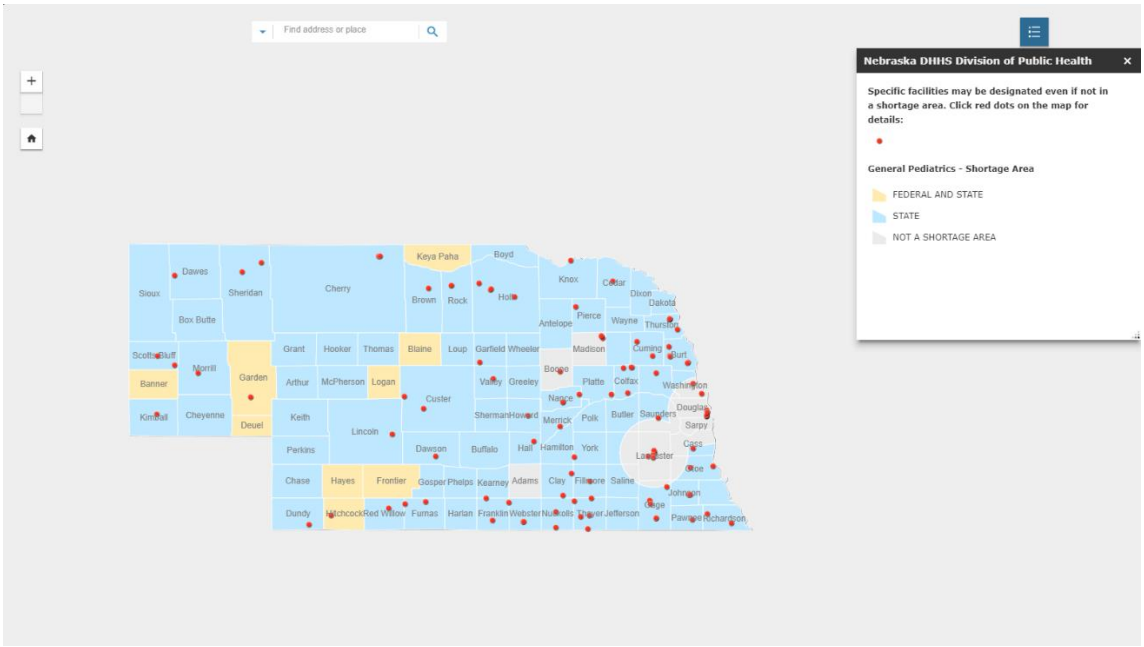
(b) General Internal Medicine



(c) General Obstetrics and Gynecology



(d) General Pediatrics



The study follows the guideline of Nebraska state shortage area designation to determine the rurality. There are various federal governmental definitions of a rural area such as US Census Bureau, Office of Management and Budget, and Rural Urban Commuting Area (RUCA). The study judges that the guidelines of Nebraska state shortage area or federal Health Professional Shortage Area (HPSA) better reflect the degree of accessibility to healthcare service that patients and physicians can have. The distance and means to the nearest facility influence easiness of the accessibility to a healthcare system for the people having lower mobility.

A study (Chan, Hart, & Goodman, 2006) exploring median travel distances of patients' visits to providers in urban and rural areas shows that the urban patients made an one-way trip of 7.0 miles while rural patients' trips varied from 4.6 to 26.9 miles depending on levels of rurality in the RUCA model. The research was done on the practice records of 2,220,841 Medicare patients and 39,780 providers across states of Alaska, Idaho, North Carolina, South Carolina and Washington. While the RUCA model bases commute patterns of economic activities, general healthcare service should serve the people such as the elderly, children, and the people in poverty who have lower mobility. Thus, categorization by the state shortage area is more reasonable to measure the accessibility to facilities than other rural definitions. For example, RUCA model classifies Grand Island and South Sioux City as a metropolitan area, but the state shortage area points out that the areas are currently suffering from deficiency of physicians in one or more disciplines.

Chapter 2 Research Dataset

The study is based on the dataset of Health Professions Tracking Service (HPTS) of the University of Nebraska Medical Center (UNMC). HPTS stores historical records of all primary care physicians and facilities in Nebraska at which the physicians worked from 1998 to 2019. HPTS annually updates its dataset with the latest information which all physicians or facilities report to UNMC every year.

There are two kinds of reports inputting into HTPS. The physician-report records information on personal data, current work status (active, left area, retired), educational background (high school, medical school, residency), and practicing facility data in the year. The facility-report supplies information of business location, average patient waiting for a new appointment, and payment methods by patients. The facility-report also records employed physicians' information at the facility, which helps HPTS crosscheck profession status by use of both reports.

There is a special point to be carefully considered in use of the data source. Although most of the physicians and facilities present the report by the end of a year, a few of them may not. In the case of no data reported in the year, it is impossible to distinguish whether the physician or facility is currently active in the state or not. Thus, the study grants 3 years margin from 2019 to judge the status of a physician or a facility. The study regards a physician or a facility as currently being active in the state despite the absence of any record for 3 years from 2017. This means that the physicians or facilities who/which have not reported since 2017 are still active as of 2019.

The primary data source of HPTS consists of five databases. HPTS manages the information of physicians and facilities on separate databases by each category. The datasets need to be merged and processed in diverse ways depending on each analysis topic. Details about these data processing will be explained at each step of the analyses in the chapter 3 of methods.

GIS shapefiles of cities and 25-mile radius shortage areas in Nebraska are used to determine rurality of cities where facilities or physicians' high schools are sited. GIS shapefiles of counties and Census Decennial dataset of 2000 and 2010 are used for County Analysis. The primary dataset of HPTS includes out-of-state schooled physicians who have or had practiced in Nebraska. To determine rurality of the physicians' high school location in other states, cities of the schools are compared to the RUCA code based on ZIP code.

Table 2.1 HPTS databases

	DB	Data source
1	Physician History	year, personal data, specialty, high school, practicing facility & start year
2	Physician Status	active, left area, retired, deceased, inactive
3	Physician Education	medical school, intern, residency
4	Physician Loan Prog.	incentive program type, obligation period
5	Facility Status	appoint waiting time, payment methods proportion

Table 2.2 dataset for Rurality Identification and County Analysis

	DB	Data source
1	NE Cities, Counties, 25_mile_Urban	GIS spatial data, NE DHHS GIS Database
2	RUCA310_ZIP_UND	RUCA 3.1 mapped to ZIP code (rural health of Univ. of North Dakota)
3	ZIP_CODE_US	free commercial database for research (Simplemaps.com)
4	USPS ZIP code	online ZIP code look-up service (USPS.com)
5	POPULATION_ COUNTY	Decennial Census 2000, 2010 SF1 P1, P001 (U.S. Census Bureau)

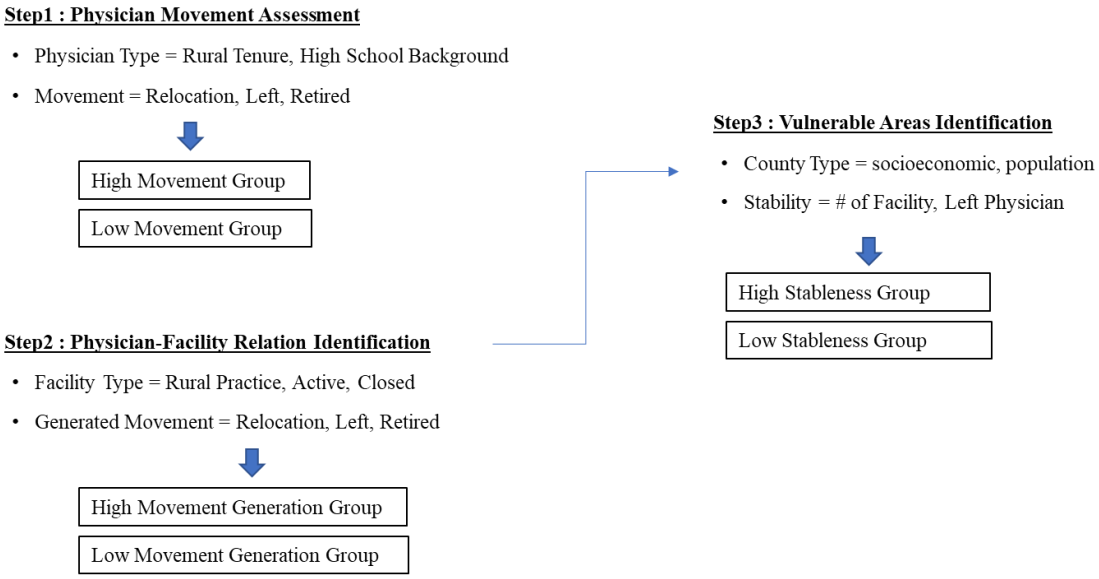
Chapter 3 Methods

3.1. Analysis Framework

A physician's movement might be caused from factors derived from either personal characteristics or surrounding conditions of the facility for which the physician worked. It is necessary to distinguish influential factors which affect stability of physicians practicing in rural areas. This requires measuring and comparing the amount of physicians' relocations in both rural and urban areas by each of the variables which can be related to physicians' movement. The magnitude of physicians' relocations due to a variable could be named as the impact of the variable.

The study defines the variables and the impacts as (1) types of physicians and total movements of each type, and (2) types of facilities and total movements generated from each type. The joint assessment of these two variables can specifically describe (3) the relation among physician type, types of movements made by both the physician type and facility type. From the joint analysis, (4) vulnerable counties in the state might be showed. The study looks for the crucial factors through the following structural procedure.

Figure 3.1 Analysis Logic Flow



The study will examine the impact by variables related to physicians' movements in the first step and assess the joint effect by each variable of physician and facility in the second step. In the last step, the study measures stability of healthcare service across counties by the identified crucial factors.

3.2 Analysis method

The primary dataset of HPTS consists of five databases by categories of physician practice history, education, final status as of 2019, incentive programs, and facility operation history. The two history databases of physician and facility store the records on a yearly basis, and they play a role of master database. The others of three databases supply complementary information to the history databases. The study builds new master databases of physician and facility from the primary dataset for the purpose of extracting

diverse information. Also, the study defines new variables in each step of the analyses which are necessary for the analysis step but not supported by the primary dataset. All of the yearly records of a physician or a facility in the primary databases are transformed to a single record on which new variables have summarized statistics in the new master databases. The analyses are done on these new summary databases.

The process of transformation requires many times of database joining and pivoting. During the preprocessing stage, it is found that some input data do not coincide with each other, and they are modified manually by judgement of the researcher. Details of the modification to the primary dataset are as follows.

1) There are 30 records missing county names in the facility history databases.

2) There are records of 6 misspelled city names in the facility history database such as Bellevue to Belleuve.

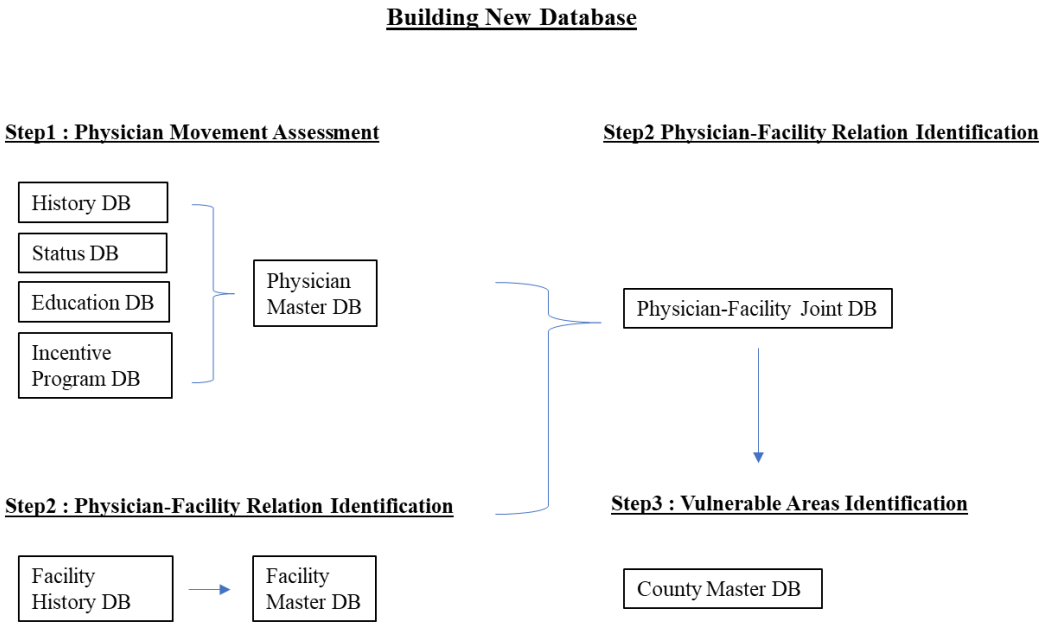
3) The 9 records of no practicing facility information are removed in the physician history database since they cannot supply any meaningful information to the analysis.

4) The 115 physicians and 42 facilities have the same facility code with multiple city names at the urban area of Omaha, which is the case of facility relocation. The city locations are unified to the first city name in the history databases since the relocations had happened only within an urban area and it could not affect the analysis.

5) There are 27 fallacies in the city names of high schools in the physician history database. They are fixed by Google-Map searches and comparisons between the city names.

6) There are 26 mismatches in the relation between city name and county. They are manually fixed in comparison to NE Cities database.

Figure 3.2 New Databases from the primary dataset



Through the above preprocessing phase, new physician master database has 3,411 unique physician records, and new facility master database has 1,446 unique facility records. The joint master database of physician and facility has 5,203 records, and each of the records consists of a physician's practice career per each of the facilities where the physician worked in the past or is working as of now. Each database is used in each step of the analyses, and there is creation of new variables within the databases for the specific research topic of the step.

3.2.1 Step 1) Physician Movement Analysis

The study defines the impact as the number of physicians' leaving an area. In the step, the study would find out (1) how many relocations have happened from rural to urban areas and (2) which type of physicians have had prolonged rural practicing by comparison between tenures in rural areas and those of urban areas. It is the key to answer the main questions of the study to determine the type of physician who has prolonged tenure in rural areas and to figure out the number of relocations which a physician made before leaving to urban areas.

In the perspective of physician's status, a physician can either be actively practicing or have stopped practicing in Nebraska as of 2019. If a physician does not practice anymore, the physician might have one of the possibilities of death, retirement, or leaving the state and practicing in other states. If the physician has moved within the state, the physician's status is still active wherever in the state. If the practices are sited in rural areas at which groups of physicians are working or worked, the sum of all rural tenure and careers of the physicians can show the statistics of rural practicing in company with current statuses of the physicians. Conversely, as the study defines the study area as either urban or rural, the study can figure out the statistics about urban practicing. From the above information, the study could indirectly figure out how many physicians moved to urban areas in the past. To get the actual number of relocations in the past needs more data, and it will be described in the next step.

As discussed, many articles demonstrate that a physician's rural high school background is a strong indicator to choose rural practicing. A physician's rural background can be determined from the location of the high school of the physician.

Also, HPTS supplies the city name of physicians' high school in Nebraska or other states. The information enables the study to form types of all physicians working in the state. When the types of physicians are combined with the current statuses of physicians, the study could find out which type of physicians have prolonged tenure in rural areas or have short total tenure in the state. Besides answers to the questions in this step, various information could be acquired.

3.2.1.1 Step 1) Definition of Key Variables

New variables are defined for the analysis of physician movements, which are not provided by the primary dataset of HPTS.

(1) Rurality and Rural Propensity

Rurality for each facility where a physician has worked is determined by matching the city location of the facility to Nebraska Cities database. Rural Tenure is the sum of all practicing years of a physician in rural facilities. The ratio of rural tenure to total tenure of the physician shows how long the physician has served in rural areas. The index could indicate the physician's propensity to prefer rural practicing.

- RURAL: when the last practicing location of a physician is rural
- URBAN: when the last practicing location of a physician is urban
- TOTAL_YRS: sum of all tenure of service in both rural and urban areas
- RURAL_YRS: sum of all tenure of service in rural practices
- URBAN_YRS: TOTAL_YRS – RURAL_YRS

(2) Work Area

Work Area is a categorical variable about rural tenure determined by the proportion of rural tenure to total tenure. The label is assigned to the summary record of each physician in the physician master database to discern rural propensity of the physician.

- R: when a physician has only rural practicing (proportion = 1)
- U: when a physician has only urban practicing (proportion = 0)
- BOTH: serving both rural and urban practicing, which is determined when RURAL_YRS is less than TOTAL_YRS

Because the study result shows that the proportion of the BOTH physicians is less than 5%, the study uses only RURAL and URBAN classification throughout the research except for examining the number of relocations between rural and urban areas specifically. As the variables of RURAL and URBAN are determined by rurality of the last practice, in the case of the work area of R and U, the rurality is not changed owing to the physician's attachment to either rural or urban areas only. The rurality of the BOTH physicians is classified to RURAL or URBAN depending on the location of the last practice. This is for avoidance of severely imbalanced observation sizes on logistic regression analysis and use of the latest information about the physicians' movements. Among the 4.7% BOTH physicians, 2.7% physicians moved from rural to urban areas, and 2% of physicians moved from urban to rural areas finally.

(3) High School Background

Rurality of the physicians' high schools are determined by the city names in Nebraska Cities database for in-state schooled physicians or RUCA 3.1 database for out-of-state

schooled physicians. The 1,163 physicians among the total of 3,411 have not revealed their high school information for the whole reporting years.

- NE_R: rural-located high school in Nebraska
- NE_U: urban-located high school in Nebraska
- OTHER_R: rural-located high school outside the state
- OTHER_U: urban-located high school outside the state
- CNI: Could Not Identify

(4) Final Status of Physician

The primary dataset of HPTS supply various physician statuses such as Full-Time, Part-Time, Inactive, Left-Area, Unknown, Deceased, and Retired. The definitions of some statuses are clear, but others are opaque to apply to the analysis. In cases of Deceased, Retired, and Left-Area, the dataset supplies additional information of the year in which they happened in several instances, which are affirmed by the facilities or colleagues. It is needed to redefine the final status of physicians with clarity for the analysis.

The physician history database in the primary dataset is built based on the yearly report of physician practicing at a facility. If a record of a physician has not appeared for several years as of 2019, the physician's status can be inferred with one of the possibilities of Deceased, Retired, Left-Nebraska or Doing-other-job. The four statuses can be classified to two categories as naturally Complete the vocation (deceased or retired) and Left the Field (left-state or stopped-practicing). Otherwise, the records should be on the list of 2019. However, some facilities or physicians do not submit the report

every year. So, the study gives three years margin to determine the final status of a physician, which means that although the physician is not on the list from 2017 to 2019, the physician is regarded as still being active in the state. When the physician or facility report again, the status keeps being Active. If more than 3 years have passed by, the status is set to Complete or Left the Field. The history database shows that some physicians have disappeared on the list for years. On any account, more than three years of inactivity cannot be understood as the physician exists in the state as a physician.

When a physician has not been on the list since 2017, criterion to determine whether the physician has retired follows the statistics of the official records telling the year of retirement in HPTS. Physicians in Nebraska averagely retire at the age of 68.5, and standard deviation is 7.3 years. The study set the age of 61 as a cut-off age to judge whether a physician is in retirement, since it is difficult to generally think that the physicians over the age of 60 had relocated to another state for a new job.

Table 3.1 Age statistics of retired physicians who have offical records of the retired year

age_retired.describe()	
count	356.00
mean	68.53
std	7.29
min	38.00
25%	65.00
50%	68.00
75%	72.00
max	94.00

- ACTIVE: When there has been at least one record of practicing since 2017.
- COMPLETE: (a) When there is an official record of Deceased or Retired in HPTS.

  (b) for physicians having had no record since 2017, when the age at the last practicing in Nebraska is greater than or equal to 61.
- LEFT_FIELD: (a) When there is an official record of Left-Area in HPTS.

  (b) for physicians having no record since 2017, when the age at the last practicing in Nebraska is less than 61.

3.2.2 Step 2) Physician Facility Relation Analysis

In the step, the study finds (1) which type of facility shows a high level of physicians' movements, and (2) which type of physician is related to the facility type causing high levels of movements.

A facility can have two statuses of either active or closed as of 2019. In the perspective of possible movement types which physicians can make, the active facility could generate the complete, the relocation, or the left the field by self-decision. On the other hand, the closed facility forces physicians to choose one of the movement types mentioned above. In addition, rurality of facilities might explain a higher amount of movements than urban counterparts. By combining physician type, rurality of facility, and final status of facility, the study might find out the most impactful combinations.

While the status of Active, Complete, and Left the Field stands for what a physician is doing now, relocation is differentiated with the final status by the action which happened in the course of reaching this current status. It is necessary to

distinguish the final status and the relocation in the context of interpretation. The study defines Relocation as a physician's action of movement to another facility in Nebraska whose current status is still Active as of 2019.

Either the closed or active facilities can generate physicians' movements during the operation years, which can be Complete, Left-the-field, or Relocation. The higher level of physician movements a facility generates, the lower stability the facility gets to show to the community. The impact of movement becomes different in its intensity depending on what kind of movement the physician makes. If a physician leaves the state, it is an irrecoverable loss of healthcare capability. A relocation of a physician with prolonged tenure might be different with that of short tenures who are named as High-Movers in the study. Natural aging retirement might deserve admiration as the physician has served for a long time to communities. The index of turnover-rate cannot represent the characteristics of these movements. It considers only the number of leaving the workplace without consideration of any context of tenure, we cannot discern the intensity of the impact of the movement. The study defines a new index to assess the stability of a facility's service in aspects of physicians' average work contribution to the facility during the whole facility operation years.

3.2.2.1 Step 2) Definition of Key Variables

New variables are defined for the analysis of physician-facility relation, which are not provided by the primary dataset of HPTS.

(1) Final Status of facility (Facility Type)

With the same reasons of the final status of physician, there are occasions that some facilities do not submit the yearly report to HPTS. Thus, the study also gives three years of margin to determine status of facility whether it is active or closed.

- ACTIVE: When there has been at least one record on the list since 2017.
- CLOSED: When there has been no record since 2017.

The study uses the term of Facility Type in parallel with the final status of facility in the same meaning for the avoidance of confusion with the final status of physician.

(2) Worked Facility

Worked Facility is a categorical variable of each physician to show whether the physician has served in active, closed, or both facilities. The value of the variable is determined by the final status of the facility at which the physician has worked.

- ACTIVE: when a physician has career records of active facilities only.
- CLOSED: when a physician has career records of closed facilities only.
- BOTH: when a physician has the records in both active and closed facilities.

(3) Stability Index of Facility

A yardstick of stability is necessary to compare how much stability facilities have or had provided to communities. If a physician has worked at a facility for complete years during the whole facility operation years, the work contribution ratio of the physician for the operation years becomes 1. The smaller the ratio gets, the shorter the physician had worked for the facility. When it applies to all physicians who have worked at a facility,

the ratio becomes the level of how much the facility stably provides its service to the community.

- (Total tenure of all physicians worked ÷ the number of all physicians) ÷ facility operation years

(4) Physician Movement

By combining physician and facility databases, the study can recognize not only final status of physicians but also intermediate actions of relocation of the physicians. The final status and the relocation information are not the same state, though they are sitting in the same variable. Not all physicians have the relocation careers because there could be many physicians who have worked for only one facility. On the other hand, some physicians can have multiple career records in the course of reaching their current status. Thus, the two values of the final status and the relocation in the joint database should be separately analyzed in the regression analysis, otherwise the statistical function gets to fail due to multicollinearity or quasi-separation.

- P_MOVEMENTS: Categorical variable of final status and relocation indicator.

  (a) Final Status

  i. 2019_ACTIVE: currently active as of 2019
  ii. IMMEDIATE_COMPLETE: retired in the year of the facility closing
  iii. NORMAL_COMPLETE: retired or deceased at an active facility at the time
  iv. IMMEDIATE_LEFT: left the field in the year of the facility closing
  v. NORMAL_LEFT_FIELD: left the field at an active facility at the time

(b) Relocation action

i. MOVE_ACTIVE: moved and then currently active as of 2019

ii. MOVE_LEFT_FIELD: moved and eventually left the field

iii. MOVE_COMPLETE: moved and eventually retired

(5) Relocation Index

Relocation index is the total number of relocations of a physician. The index is used to examine the relation between the facility type generating a high level of movements and the proportion of the physicians having the high level of movement. The index enables the study to discern at which facility type the high-movers gathered, and it might be helpful to understand why they gathered at the facility type.

- (a) 0 TIME (b) 1 TIME (c) 2 TIMES (d) MORE THAN 3 TIMES

3.2.3 Step 3) Vulnerable Counties Identification

In this step, the study determines (1) which counties are more unstable, and (2) whether the vulnerability of the counties is related to population variation, socioeconomic or workload conditions.

The study measures the instability of a county by rate of facility closings and rate of physicians who had left the county. Because the two factors could cause radical changes in the capability of community healthcare service, the high-level rates of the factors can describe the degree of instability of the healthcare service in the county. Also,

a comparison of the rates across counties could suggest the degree of imbalance in the stability of healthcare service across the counties.

Some articles assert that physician's leaving a practice has little relation to the level of pay, workload or socioeconomic condition (Hall, Brazil, Wakefield, Lerer, & Tennen, 2010) (Linzer, et al., 2015). HPTS supplies information of patients' payment methods in the facility history databases. The payment methods can be categorized to private insurance or social support such as Medicaid, Medicare, and Unpaid Charity Care. As the information is reported by facilities themselves, it might represent the socioeconomic condition of the community. Also, the physician history database supplies information of the average weekly work hours of all physicians per facility. The average work hours of all physicians in a facility can be the average work hours of the facility, which can imply whether physicians of a facility have higher workloads.

(1) Social Support Payment Methods

The payment index presents the proportion of Medicare, Medicaid and Unpaid Charity Care to all payments by the patients of a facility. There are private insurance and uninsured sliding scale payments in the others.

- ASSISTANCE: % of Medicare, Medicaid and Unpaid Charity

3.3 Methods Limitation

The primary dataset of HPTS are preprocessed by Python Programs to produce the master databases of each step described above. After the completion of this

preprocessing stage, the master databases are analyzed by Excel Pivot functions to determine overall relation among variables as a preliminary examination. The Pivot analysis generates significant frequency statistics which can explain the relation since the dataset is a population data of the primary care physicians in Nebraska. Based on frequency study, regression analyses are done to prove the relation among variables which are revealed by the frequency statistics. Because most of the relations are those of categorical variables, the logistic regression is mainly used.

Logistic regression measures the change of log odds ratio of dependent variable responding to a unit change of independent variable. When there are more than two categorical independent variables in a model, the odds of baseline which becomes the denominator of the odds ratio turns to a union of multiple conditional probabilities. The cases require mathematical adjustment to the interactions between the binary variables of the equation. Because the interpretation and the adjustment go beyond the researcher's ability, the study uses only one categorical independent variable in the logistic regression model when it is needed to prove the relation between categorical variables.

All preprocessed databases used in the study have observations from 1,400 to 5,300, which are enough sizes on which the central limit theorem can be effective. To keep a consistency between the frequency statistics and regression result, the study does not transform any data to be fit to regression analysis. Also, the study does not drop any outliers intentionally owing to the large observation size.

3.4 Research Tool

The primary dataset of HPTS need databases merging and data processing to create new databases and variables in each step of analysis. The research is done on the Python programming language ver. 3.74. To infer the relation between the variables, the study uses statistical techniques of Linear Regression and Logistic Regression. To maintain a consistency between data processing and statistical inference, the study uses a statistics package of Scipy Statsmodels ver. 0.10.1 running on Python environment. The whole process is managed on the Jupyter Notebook ver. 6.0.1, and all program sources and results are recorded on html files in the tool.

Generally, most statistical packages provide own specific summary information with a different combination of statistical tests. The followings are examples of notations and tests on the summary table of regression functions. When the tests results satisfy all statistical assumptions of the regression analyses, the study only provides coefficient prediction results in the paper. The summary tables from the tests of the study are listed in Appendix 1.

3.4.1 Linear Regression of Statsmodels

Multivariate Linear Regression Model is used to analyze relation between a continuous dependent variable and independent variables which are continuous or dichotomous. The model has several assumptions for validity of the model, and the summary table of Ordinary Linear Squares (OLS) Regression of Statsmodels presents the

diagnosis results whether to conform to the assumptions. Table 3.2 shows one of the test results in the study as an example.

Table 3.2 Summary table of linear regression of Statsmodels

OLS Regression Results

Dep. Variable:	RURAL_YRS	**R-squared:**	0.153
Model:	OLS	**Adj. R-squared:**	0.152
Method:	Least Squares	**F-statistic:**	93.56
Date:	Mon, 09 Mar 2020	**Prob (F-statistic):**	1.34e-75
Time:	22:57:42	**Log-Likelihood:**	-10875.
No. Observations:	3411	**AIC:**	2.176e+04
Df Residuals:	3406	**BIC:**	2.179e+04
Df Model:	4		
Covariance Type:	HC3		

	coef	**std err**	**z**	**P>|z|**	**[0.025**	**0.975]**
Intercept	1.9518	0.122	15.977	0.000	1.712	2.191
HS_LOC2[T.NE_R]	6.1249	0.321	19.084	0.000	5.496	6.754
HS_LOC2[T.NE_U]	0.3407	0.258	1.322	0.186	-0.165	0.846
HS_LOC2[T.OTHER_R]	0.8126	0.406	2.003	0.045	0.018	1.608
HS_LOC2[T.OTHER_U]	0.2514	0.240	1.048	0.294	-0.219	0.721

Omnibus:	961.674	**Durbin-Watson:**	1.891
Prob(Omnibus):	0.000	**Jarque-Bera (JB):**	2223.269
Skew:	1.591	**Prob(JB):**	0.00
Kurtosis:	5.349	**Cond. No.**	5.18

The assumptions and corresponding items of the table are paired as follows.

1) There are enough observations: The number of observations is 3,287.

2) There is no multicollinearity among independent variables: The Condition number tells whether there exists multicollinearity. A value over 20 indicates a worrisome to the validity of the model to the assumption.

3) The variance of residuals should be the same across all predicted values. (Homoscedasticity): The Heteroscedasticity happens when there is clustering of observations across the entire range of values of independent variables. This model adopts Heteroscedasticity Consistent Standard Errors named HC-3 to fix the underestimation of coefficients' standard errors which can mislead non-significant relation to be statistically significant.

4) The residual errors across predicted values are normally distributed: Omnibus and Jarque-Bera tests examine this normality of residual errors. The null hypothesis is that the distribution of residual errors shows normality. The p-value less than .05 shows that the residual errors are not normally distributed. This means that the model cannot be generalized to explain its population's characteristics which should be assumed as normally distributed.

5) There is no dependency among observations which is called as autocorrelation. (Independence of Residuals): The Durbin-Watson test tells that there is an autocorrelation when the values of the test are less than 1 or greater than 3.

The R-Squared and F-statistics are the same to other packages such as SPSS. R-Squared means the ratio of variance of dependent variable explained by the independent variables. F-statistics test examines whether there exists a relation between dependent variable and independent variables by the variance values of the two distributions. The null hypothesis is that there is no linear relation between dependent variable and independent variables. When p-value < .05, then null hypothesis can be rejected in 95% confident interval and it means that there is the linear relation between the dependent and independent variables.

3.4.2 Logistic Regression of Statsmodels

Logistic Regression Model is used to analyze relation between dichotomous (binary) dependent variable and independent variables which are continuous or dichotomous. The model uses an algorithm called MLE (Maximum Likelihood Estimation), which measures odds ratio of each independent variable independently by how proportionally a unit change of an independent variable causes the change of dependent variable. Logistic regression assumes a general form of distribution of independent variables, and the regression function does not require normality in the distribution of independent variables. The logistic regression model also has assumptions for validity of the model, and the summary table shows the diagnosis results whether to conform to the assumptions.

Table 3.3 Summary table of logistic regression of Statsmodels

Optimization terminated successfully.
Current function value: 0.611126
Iterations 5

Logit Regression Results

Dep. Variable:	RURALITY	**No. Observations:**	3411
Model:	Logit	**Df Residuals:**	3406
Method:	MLE	**Df Model:**	4
Date:	Tue, 10 Mar 2020	**Pseudo R-squ.:**	0.08355
Time:	09:37:12	**Log-Likelihood:**	-2084.5
converged:	True	**LL-Null:**	-2274.6
Covariance Type:	nonrobust	**LLR p-value:**	5.639e-81

	coef	**std err**	**z**	**P>|z|**	**[0.025**	**0.975]**
Intercept	-0.5246	0.061	-8.643	0.000	-0.644	-0.406
HS_LOC2[T.NE_R]	1.2044	0.097	12.413	0.000	1.014	1.395
HS_LOC2[T.NE_U]	-0.7916	0.115	-6.885	0.000	-1.017	-0.566
HS_LOC2[T.OTHER_R]	-0.3090	0.163	-1.900	0.057	-0.628	0.010
HS_LOC2[T.OTHER_U]	-0.4789	0.108	-4.414	0.000	-0.692	-0.266

	2.5%	97.5%	Odds-Ratio
Intercept	0.525402	0.666546	0.591781
HS_LOC2[T.NE_R]	2.757169	4.033091	3.334654
HS_LOC2[T.NE_U]	0.361694	0.567646	0.453116
HS_LOC2[T.OTHER_R]	0.533784	1.009852	0.734195
HS_LOC2[T.OTHER_U]	0.500811	0.766259	0.619477

The assumptions of the model and corresponding items of the table are paired as follows.

1) There are enough observations: The number of observations is 3,411 in this run.

2) Each observation is independent in the prediction on dependent value (no Autocorrelation): They should not be used repeatedly in calculation of the odds at different time points. The Converged indicator signs Fail when there is a violation to the independency.

3) There is no multicollinearity among independent variables: The Converged indicator tells whether there are non-linear combinations among independent variables. When there are either perfect separation (multicollinearity) or quasi separation (strongly correlated), the indicator shows a fail-sign with specific warning messages. This means that the model fails on the Maximum Likelihood Estimation process.

The meaning or interpreting of terms in the table are as follows.

1) Pseudo R-square: The proportion of variation in dependent variable that is explained by independent variables.

2) Log-likelihood: The maximum likelihood value which maximizes the log odds ratio of dependent variable which is calculated from a joint probability of all observations. This

means that the value indicates the log odds ratio of the full model which uses all independent variables in the prediction.

3) LL-Null: The maximum likelihood value which maximizes the log odds ratio of the null model which uses only intercept as a predictor rather than all independent variables.

4) LLR p-value: The p-value of Log Likelihood Ratio test. The Log Likelihood Ratio is the ratio of odd ratios between the full model and the null model. It is approximately the same to the Chi-squared test. The null hypothesis is that the coefficients of the full model are zeros, which means that there is no difference in the explanatory powers between the full model and null model.

5) Odds Ratio and Confident Interval: The coefficients are log value of odds ratio. As Statsmodels does not supply the original odds ratio, the study by itself transforms the coefficients values to the odds ratio by exponential operation.

Chapter 4 Findings

4.1 Physician Movement Analysis

In the step, the study determines (1) how many relocations have happened from rural to urban areas and (2) which type of physicians have prolonged rural practicing through a comparison of physicians' movements in rural areas and those in urban areas.

4.1.1 Overall Physician Distribution

From the analysis, the study can figure out overall status of physicians as of 2019.

Table 4.1 Primary care physicians in Nebraska by final status

# of Physicians		**final status (sum of row = 100%)**		
	Total	**Active**	**Complete**	**Left-Field**
Urban	2188 (64.1%)	1108 (50.6%)	294 (13.4%)	786 (35.9%)
Rural	1223 (35.9%)	591 (48.3%)	227 (18.6%)	405 (33.1%)
Total	3411 (100%)	1699 (49.8%)	521 (15.3%)	1191 (34.9%)

Table 4.1 shows that high proportion of the total physicians had left the field and there is little difference between urban and rural areas. From 1998 to 2019, there have been a total of 3,411 physicians in Nebraska. Based on rurality of the last practice for which physicians worked, 35.9% of the total physicians have practiced in rural facilities, and 64.1% of physicians have worked in urban areas. Among 3,411 of the totals, 15.3% physicians have retired or deceased, and 34.9% physicians have left the state or stopped

practicing as of 2019. The rural physicians show a little higher rate of the complete than the urban ones.

Table 4.2 The number of relocations by physician group in the number of times

# of Relocations		physician group (sum of row = 100%)		
	Total	**1-Time**	**2-Times**	**≥ 3 Times**
Urban	1441 (73.0%)	523 (36.3%)	480 (33.3%)	438 (30.4%)
Rural	534 (27.0%)	237 (44.4%)	160 (30.0%)	137 (25.7%)
Total	1975 (100%)	760 (38.5%)	640 (32.4%)	575 (29.1%)

Table 4.2 shows that the number of relocations by the physicians who have moved more than once. The figures conclusively tell that the high-movers of more than two times had made major portion of the total relocations. The physicians who have one more relocation have made a total of 1,975 relocations in Nebraska. 73% of all relocations have occurred in urban areas, and the figure is proportionally 10% higher than 64.1% urban physicians of the totals in Nebraska. The physicians moving more than two times have made 61.5% of the total relocations, and the physicians with more than three times have made around 30% of all relocations.

Table 4.3 The number of physicians by relocation times

# of Physicians		# of relocation (sum of row = 100%)				Relocation per physician
	Total	**No Moved**	**1-Time**	**2-Times**	**≥3 Ttimes**	
Urban	2188 (64.1%)	1300 (59.4%)	523 (23.9%)	240 (11.0%)	125 (5.7%)	0.7
Rural	1223 (35.9%)	868 (71.0%)	237 (19.4%)	80 (6.5%)	38 (3.1%)	0.4
Total	3411 (100%)	2168 (63.6%)	760 (22.3%)	320 (9.4%)	163 (4.8%)	0.6

When the relocations are viewed in the perspective of physician's movement tendency, Table 4.3 suggests that only a few physicians of the high-movers have made a majority of the relocations. The physicians with more than two times are only 14.2% to the total physicians of 3,411. The high-movers, 14.2% of the totals, have made 61.5% of the total relocations, and 4.8% physicians with more than three times have made 29.1% of total relocations. On the other hand, 63.6% of the total physicians have not moved at all, and 22.3% of the totals have made only one time of relocation. It can be said that these low-movers contribute to a stability of healthcare service to communities. The physicians who have worked at rural facilities show relatively low relocation frequencies than the urban physicians by 0.4 and 0.7 times each per physician.

However, the number of relocations does not include the status of left the field which can be inferred only by the elapse of time from the year of the last practicing. Though a physician had left the field after working for only one facility, the physician's record just shows that there is no relocation on the career list. Thus, in the assessment of the impact by physicians' movement, the status of left the field should be considered along with the actions of relocation. Moreover, it needs to be considered that the physician groups which have two or more relocations could have certain inevitable reasons such as facility closing which coerces physicians to move or to choose other options.

Table 4.4 The number of physicians by high school background

# of Physicians		High school background (sum of row = 100%)		
	Total	**CNI** (Could Not Identify)	**Nebraska**	**Other State**
Urban	2188 (100%)	758 (34.6%)	810 (37.0%)	620 (28.3%)
Rural	1223 (100%)	404 (33.0%)	601 (49.1%)	218 (17.8%)
Total	3411 (100%)	1162 (34.1%)	1411 (41.4%)	838 (24.6%)

Table 4.4 shows high school backgrounds of the primary care physicians in Nebraska. It suggests that the majority of physicians did not grow up in the state. A group named CNI (Could Not Identify) are the physicians who consistently have not revealed the city names of their alma mater at all in the reports. Although the study cannot get any schooling information about the physicians, the study assigns a unique label of CNI to the group since the group shows noticeable behaviors throughout the research. The proportion of the physicians who are schooled in Nebraska is 41.4% to the total physicians. In rural areas, the proportion of in-state schooled physicians is 49.1% which is far higher than 37.0% that of urban areas.

4.1.2 Movement between Rural and Urban Areas

A rurality of a physician indicates whether the physician has tenure of rural practicing during her or his whole careers. Also, the rural propensity shows how prolonged a physician has served in rural areas in comparison to the total tenure. From the information, the study can figure out the total number of physicians who have worked in rural areas and figure out how strongly they have been attached to rural practicing.

Table 4.5 Rural propensity of physicians

Worked Area	**n=3411**		
	Physicians	**Rural Propensity (rural yrs ÷ total yrs)**	**Rural Tenure (Average)**
Both	162 (4.7%)	0.5	6.3
Rural	1154 (33.8%)	1.0	9.5
Urban	2095 (61.4%)	0.0	0.0

Table 4.5 shows that there are mere relocations between rural and urban areas. From 1998 to 2019, among the total of 3,411 physicians in Nebraska, only 5% of physicians have worked at both urban and rural practices. 34% of the totals only have careers of rural practicing, and conversely 61% of the total physicians have only worked in urban areas. Each group of the physicians in both areas tends not to move each other's area at all. That means that once physicians have started their careers in either rural or urban areas, they tend to have stayed or moved within the area only. The physicians having both careers show that they have worked a half of the total tenure at rural practices on average.

Table 4.6 Physician relocation in rural and urban areas

# of Physicians		**# of relocations (sum of row = 100%)**			
	Total	**No Moved**	**1-Time**	**2-Times**	**≥ 3 Times**
Both	162 (4.7%)	0	73 (45.1%)	55 (34.0%)	34 (21.0%)
Rural	1154 (33.8%)	868 (75.2%)	204 (17.7%)	55 (4.8%)	27 (2.3%)
Urban	2095 (61.4%)	1300 (62.1%)	483 (23.1%)	210 (10.0%)	102 (4.9%)
Total	3411 (100%)	2168 (63.6%)	760 (22.3%)	320 (9.4%)	163 (4.8%)

Table 4.6 suggests that the physicians who have careers in both rural and urban areas tend to move more often than those only working in rural or urban areas. 55% of the BOTH physicians have moved more than two times within the state. Table 4.7 shows that more than half of the high-movers are the in-state schooled physicians.

Table 4.7 High-movers and high school background

# of Physicians	**High school background (sum of row =100%)**			
	Total	**CNI** (Could Not Identify)	**Nebraska**	**Other State**
2-Times	320 (66.3%)	85 (26.6%)	163 (50.9%)	72 (22.5%)
≥ 3 Times	163 (33.7%)	37 (22.7%)	81 (49.7%)	45 (27.6%)
Total	483 (100%)	122 (25.3%)	244 (50.5%)	117 (24.2%)

4.1.3 Tenure in rural practicing

The statistics of overall physician distribution presents that the factors which influence physicians' tenure in rural or urban practicing are the relocation and the left the field. The analysis of physician movement between rural and urban areas shows that there are tiny movements between the two areas. In this analysis, the study examines which physician group is likely to have prolonged rural tenure and sensitively respond to the factors of the relocation or the left the Field. The high school backgrounds of all physicians can be subdivided in detail, and the study defines these categories as the Physician Type.

Table 4.8 The number of physicians by high school background with rurality

# of Physicians		High school background with rurality (sum of row =100%)				
	Total	**CNI**	**Nebraska Rural**	**Nebraska Urban**	**Other State Rural**	**Other State Urban**
Urban	2188 (64.1%)	758 (34.6%)	300 (13.7%)	510 (23.3%)	150 (6.9%)	470 (21.5%)
Rural	1223 (35.9%)	404 (33.0%)	482 (39.4%)	119 (9.7%)	58 (4.7%)	160 (13.1%)
Total	3411 (100%)	1162 (34.1%)	782 (22.9%)	629 (18.4%)	208 (6.1%)	630 (18.5%)

Table 4.8 shows that major physician type in rural areas is the physicians who have in-state and rural high school background. In urban areas, the proportion of the in-state schooled physicians is 37% by sum of the Nebraska Rural and Urban type, which is lower than that with 50% in rural areas. The remarkable point is that proportions of the CNI type are much higher than all other types in both rural and urban areas except for the case of the Nebraska Rural type in rural areas.

Table 4.9 The relationship between rural practicing and high school background

		Logit Regression Results						Odds Ratio		
Dep. Variable	**Ind. Variables**	**coef**	**std err**	**z**	**P-value**	**[0.025**	**0.975]***	**[0.025**	**0.975]**	**Odds Ratio**
Rurality	**Intercept**	-0.6293	0.062	-10.215	0.000	-0.750	-0.509	0.472	0.601	0.533
	NE Rural	1.1034	0.096	11.502	0.000	0.915	1.291	2.498	3.638	3.014
	NE Urban	-0.8260	0.119	-6.942	0.000	-1.059	-0.593	0.347	0.553	0.438
	Other S. Rural	-0.3209	0.166	-1.928	0.054	-0.647	0.005	0.524	1.005	0.725
	Other S. Urban	-0.4483	0.110	-4.063	0.000	-0.665	-0.232	0.515	0.793	0.639

* 95% Confidence Interval

In Table 4.9 of the logistic regression, the predicted value of dependent variable is measured by a change of odds ratio of each independent variable with other independent variables held constant. In the case of a continuous independent variable, a predicted odds ratio is the ratio of the conditional probability which satisfies true condition of dependent variable when the independent variable is increased by one unit to the conditional probability which satisfies true condition of the dependent variable when there is no increase in the independent variable (Pearson, 2010) (Wannacott & Wannacott, 1990) (Massaron & Boschetti, 2016). In the case of a binary independent variable, a change of odds ratio is based on that the value of independent variable becomes true condition instead of an increase of a unit, because there are only two values of true or false which the independent variable can take.

Thus, if a value of odds ratio (coefficient) of an independent variable equals to 1, these two conditional probabilities are the same regardless of an increase of one unit in the independent variable. This means that there is no effect on the condition of the dependent variable by a change in the odds ratio of the independent variable. If the odds ratio is greater than 1, it means that a unit change of the independent variable causes an increase of the likelihood of the true condition of the dependent variable by the amount of odds ratio of the independent variable. When the odds ratio of the independent variable is less than 1, it means that a unit change of the independent variable decreases the likelihood of the dependent variable conversely.

The summary table shows that when a physician has rural high school background in Nebraska, the likelihood of serving rural practices becomes 3 times in comparison to other physician types who are not. Conversely, the likelihood of the physicians of urban

high school background in Nebraska shows the lowest plunge with -56%. This means that the NE type physicians tend to choose practicing locations by following their grown-up backgrounds.

When all variables are held constant, the value of Intercept becomes the variable of the CNI (Could Not Identify) type. The physicians of the CNI, the other state rural, and the other state urban types show higher preference of urban practicing regardless of their rurality of high school background than that of the NE rural type.

An information about total tenure by physician types suggests how prolonged they had or have practiced in Nebraska. The information conversely implies which physician type is likely to have left the state or stopped practicing.

Table 4.10 Average total tenure of physicians by high school background

Total Tenure	**average**					
	CNI	**Nebraska Rural**	**Nebraska Urban**	**Other State Rrural**	**Other State Urban**	**Averge**
Years	5.9	12.8	12.1	10.6	9.3	9.5

Table 4.11 The relationship between left the field and high school background

		Logit Regression Results						**Odds Ratio**		
Dep. Variable	**Ind. Variables**	**coef**	**std err**	**z**	**P-value**	**[0.025**	**0.975]***	**[0.025**	**0.975]**	**Odds Ratio**
Left the field	**Intercept**	0.1899	0.059	3.222	0.001	0.074	0.305	1.077	1.357	1.209
	NE Rural	-2.0427	0.120	-17.030	0.000	-2.278	-1.808	0.103	0.164	0.130
	NE Urban	-1.5742	0.116	-13.600	0.000	-1.801	-1.347	0.165	0.260	0.207
	Other S. Rural	-0.8047	0.157	-5.133	0.000	-1.112	-0.497	0.329	0.608	0.447
	Other S. Urban	-0.6086	0.101	-6.054	0.000	-0.806	-0.412	0.447	0.663	0.544

* 95% Confidence Interval

Both Table 4.10 and Table 4.11 present that the CNI type is the most likely to leave the field in the state, and Other State is the second. When all variables are held constant, the Intercept becomes the CNI type variable. A physician of the CNI type gets 21% higher likelihood to leave the field than other physician types. On the other hand, other physician types show declined likelihoods with other variables held constant. The NE rural type shows 87% decrease in the likelihood to leave the field, as a result the CNI type has 2 times higher likelihood to leave the field than the NE-rural type in consequence. Also, the other state types have more than 30% higher likelihoods to leave the field than all the NE types. The NE rural type is the least likely to leave the state.

Table 4.12 The relationship between rurality and left the field

		Logit Regression Results						Odds Ratio		
Dep. Variable	**Ind. Variables**	**coef**	**std err**	**z**	**P-value**	**[0.025**	**0.975]***	**[0.025**	**0.975]**	**Odds Ratio**
Rurality	**Intercept**	-0.5155	0.081	-6.397	0.000	-0.673	-0.358	0.510	0.699	0.597
	Left the field	-0.1394	0.087	-1.599	0.110	-0.310	0.031	0.733	1.032	0.870
	Total years	-0.0019	0.005	-0.345	0.730	-0.013	0.009	0.987	1.009	0.998

* 95% Confidence Interval

As seen in Table 4.12, an examination of relation between rurality and physician status of the left the field shows that there is indifference in the rate of the left the field or the total tenure between urban and rural areas. The table shows insignificant p-values in both variables of the left the field and the total tenure, which means that the likelihoods of the left the field in rural and urban areas are indifferent. Similarly, total tenure is not significant between rural and urban areas.

4.1.4 Findings of Physician Analysis

The exploration of physician databases enables the study to pick up some key factors that influence physician distribution in the state and the impact which causes a physician to leave an area.

1) The most impactful factor is the left the field. Consequently, 34.9% of the total physicians had left the field or stopped practicing in the state. The left the field factor has mostly happened from physicians of the CNI (Could Not Identify) type and the other state type in company with shorter tenure than those of NE types in the state.

2) The relocation is another factor causing the impact. There have been 1,975 relocations, but the majority portion with 61.5% relocations was driven by a few 14.2% high-movers of the total physicians.

3) There are few relocations by physicians between rural and urban practices. The physicians who graduated in rural high schools in Nebraska are the majority of the physicians who have prolonged practicing tenure in rural areas.

4) There is little difference in the left the field factor and total tenure between rural and urban areas.

From the findings, it can be said that the left the field caused by the physicians of the CNI type and the other state type are the most impactful factors to the physicians' distribution across entire Nebraska.

4.2 Physician-Facility Relation Analysis

In this step, the study aims to reveal (1) which facility type shows more intense impact than other types, and (2) which physician type is strongly related to the facility type causing a high level of impact.

4.2.1 Overall State of Facility

The facility database supplies information of overall status of facilities as of 2019.

Table 4.13 The number of facilities by rurality and facility type (final status)

# of facilities		**rurality (sum of row =100%)**	
	Total	**Urban**	**Rural**
Active	650 (45.0%)	419 (64.5%)	231 (35.5%)
Closed	796 (55.0%)	515 (64.7%)	281 (35.3%)
Total	1446 (100%)	934 (64.6%)	512 (35.4%)

Table 4.13 shows that the total number of closed facilities is more than currently active facilities, and there is indifference in the rate of the closed facilities between rural and urban areas. For 22 years, a total of 55.0% facilities were closed, and 45.0% of the total facilities are currently active. In comparison with rural and urban areas, each proportion of active and closed facilities are almost the same as 64.6% and 35.4%.

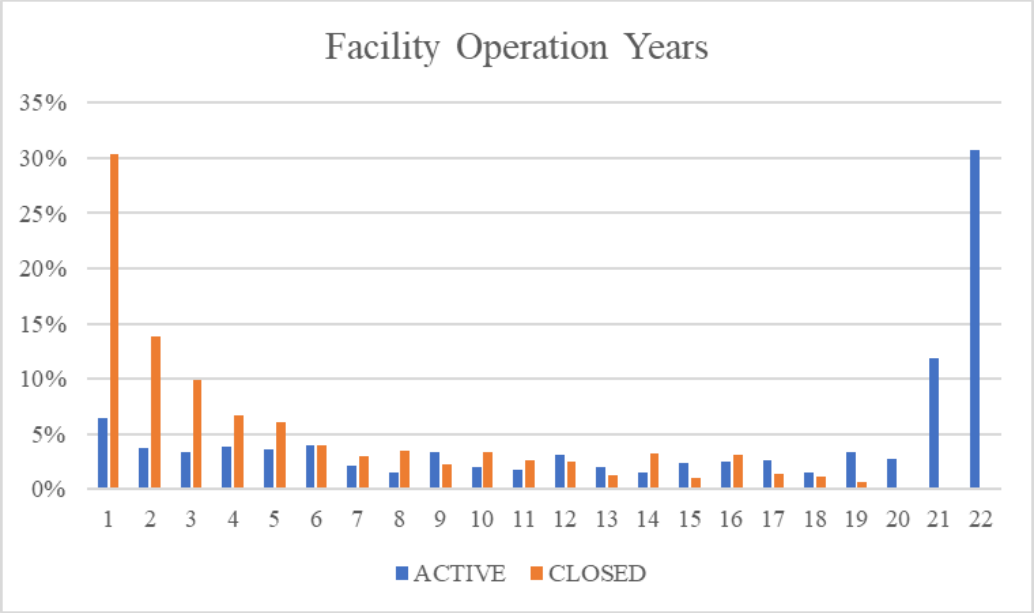
Table 4.14 Difference in facility operation years and the number of physicians per facility by rurality

operation years per facility (average)			
	Urban	**Rural**	**Average**
Active	17.9	19.5	18.5
Closed	7.4	7.4	7.4
Average	14.8	16.1	15.3

# of physician per facility (average)			
	Urban	**Rural**	**Average**
Active	14.5	9.8	12.9
Closed	4.6	3.0	4.1
Average	11.6	7.9	10.4

However, the closed facilities had relatively shorter operation years and a smaller number of physicians than active ones in Table 4.14. In details of operation years, Figure 4.1 below presents that proportion of the closed facilities which had operated less than 3 years is over 50%, and furthermore, 30% of the closed facilities operated only one year. This is antithetical to 58% of the total active facilities which operated more than fifteen years. Extremely short operation years surely can cause a job security for the physicians to be very unstable.

Figure 4.1 The relation between operation years and facility type (final status)



As the graph plots in Figure 4.1, the closed facilities with short operation years caused many physicians to leave the field without any relocation to other active facilities due to the truly fleeting period. This can be inferred that many new clinics commence business every year but 67% of them might close the business within 5 years due to management or profit issues. The newly opened facilities might face competitions with existing facilities, or they might have management challenges due to lack of patients. Because there are few explanatory data in the primary dataset, further study is needed to understand the causes of the facility closure.

Overall, closed facilities show few physician relocations during the operation years. Thus, the records of these facilities can make misleading as if they seemed to show high stability in the service to communities, and consequently make distortions in the analysis of stability or turnover rate. Thus, the study does not analyze the stability analysis of physicians in facilities anymore.

4.2.2 Impact caused by Facility Factors

The closing of a facility forces physicians to make a certain movement among retirement, relocation, stopping practicing, or leaving the state. The relocation and the left the field are the most impactful factors causing physicians' absence from the communities as demonstrated in the Physician Analysis. The joint database of physician and facility information enables the study to determine relation among the impact factors and final status of facilities (facility type).

Table 4.15 The number of physicians by final status of physicians and facility type

# of physicians		**final status of physicians (sum of row =100%)**		
	Total	**Active**	**Complete**	**Left-Field**
Active	2707 (79.4%)	1699 (62.8%)	316 (11.7%)	692 (25.6%)
Closed	704 (20.6%)	0	205 (29.1%)	499 (70.9%)
Total	3411 (100%)	1699 (49.8%)	521 (15.3%)	1191 (34.9%)

Table 4.15 presents that the closed facilities had a total of 704 physicians who had completed or left the field. If a physician does not have a record after practicing a closed facility, it means that the physician chose the complete or left the field after the closure. By comparison of the last practicing year of the physicians with the last operation year of the closed facility, the study could determine whether they had acted at once at the same year of the closure.

Table 4.16 The number of physicians by final status of physician movements and facility type

# of physicians		**final status of physician movements**				
	Total	**2019 Active**	**Immediate Complete**	**Immediate Left the Field**	**Normal Complete**	**Normal Left the Field**
Active	2707 (79.4%)	1699 (62.8%)	0	0	316 (11.7%)	692 (25.6%)
Closed	704 (20.6%)	0	205 (29.1%)	499 (70.9%)	0	0
Total	3411 (100%)	1699 (49.8%)	205 (6.0%)	499 (14.6%)	316 (9.3%)	692 (20.3%)

Table 4.16 shows that a total of 704 physicians had at once chosen the complete or the left the field after the closure, which is distinct from the normal complete and the normal left the field at active facilities. While the normal complete and the normal left the field are the movements chosen by physician's self-decision, the immediate complete and the immediate left the field are the coerced choice regardless of physicians' intent or mind. The complete or left the field cause immediate loss of healthcare capability in the state which is differentiated with the relocation which the state can keep the capacity anywhere in the state.

Table 4.17 The relationship between facilities closure and final status of physicians

		Logit Regression Results						Odds Ratio		
Dep. Variable	**Ind. Variables**	**coef**	**std err**	**z**	**P-value**	**[0.025**	**0.975]***	**[0.025**	**0.975]**	**Odds Ratio**
Facility closure	**Intercept**	-1.5993	0.049	-32.554	0.000	-1.696	-1.503	0.183	0.222	0.202
	Complete	1.4722	0.086	17.096	0.000	1.303	1.641	3.682	5.160	4.359
	Left the field	1.3009	0.070	18.512	0.000	1.163	1.439	3.200	4.215	3.672

* 95% Confidence Interval

Table 4.17 confirms that the physicians who worked for closed facilities show higher levels of choices of the complete or the left the field than those of active facilities. When a physician retires or leaves the field, the likelihood that the physician worked at a closed facility soars from 4 times to 5 times than other physician statuses. This means that retirement, leaving the state or stopping practicing are highly likely to happen when a facility closure happens.

Another factor of the impact is the relocation. The joint database enables the study to break the relocation down in detail based on facility status (facility type). Table 4.18 shows all physicians who worked at active or closed facilities including the ones who moved between them. When a physician has moved from an active facility to a closed one, the presence of physician is counted twice in both active and closed facilities.

Table 4.18 The number of relocated physicians and relocations by Worked Facility

# of physicians			# of Relocations
	Total	**Relocated (% of Total)**	
Active	2166 (63.5%)	497 (22.9%)	646 (32.7%)
Both	670 (19.6%)	670 (100%)	1234 (62.5%)
Closed	575 (16.9%)	76 (13.2%)	95 (4.8%)
Total	3411 (100%)	1243 (36.4%)	1975 (100%)

Table 4.18 shows that the majority of the relocation was made by the physicians who had worked at both closed and active facilities. Among a total of 3,411 physicians in the state, 2,166 and 575 physicians worked at only either active or closed facilities. 670 physicians have careers on both facility types. The 575 physicians who had worked only at the closed facilities had at once completed or left the field after the closures.

In combination with the final status of physician in Table 4.15, among 670 physicians who worked at the both facilities, 129 physicians had chosen the complete or the left the field after the facility closures. The remaining 541 physicians of the 670 physicians at the both facility type had moved to active facilities after the closures. Among the physicians of the active or the closed type, each of the 497 and 76 physicians had just moved only within each active or closed facilities.

The 670 physicians of the both facility type had moved across active and closed facilities. 62.5% of total relocations were made by only 19.6% the BOTH type physicians of the totals. This implies that the physicians of the both facility type are the high-movers. As a result, 67.3% of total relocations which are done by these physicians who

worked are the closed and the both facility type, and the relocation is strongly related to facility closures in the state.

Table 4.19 The relationship between facility closure and relocations

		Logit Regression Results						Odds Ratio		
Dep. Variable	**Ind. Variables**	**coef**	**std err**	**z**	**P-value**	**[0.025**	**0.975]***	**[0.025**	**0.975]**	**Odds Ratio**
Facility closure	**Intercept**	-1.3468	0.042	-31.835	0.000	-1.430	-1.264	0.239	0.283	0.260
	Relocation	1.0871	0.062	17.522	0.000	0.966	1.209	2.626	3.349	2.966

* 95% Confidence Interval

Table 4.19 proves that relocation has strong relation to facility closing. When a relocation happens by a physician, the likelihood that it occurs in the closed facilities are 3 times higher than that of active facilities.

Table 4.20 The relationship of facility closure and high mover physicians

		Logit Regression Results						Odds Ratio		
Dep. Variable	**Ind. Variables**	**coef**	**std err**	**z**	**P-value**	**[0.025**	**0.975]***	**[0.025**	**0.975]**	**Odds Ratio**
Facility closure	**Intercept**	-1.2074	0.051	-23.664	0.000	-1.307	-1.107	0.271	0.330	0.299
	1 Time	0.3285	0.076	4.323	0.000	0.180	0.478	1.197	1.612	1.389
	2 Times	0.5329	0.085	6.254	0.000	0.366	0.700	1.442	2.014	1.704
	More than 3	0.8008	0.091	8.816	0.000	0.623	0.979	1.864	2.661	2.227

* 95% Confidence Interval

Table 4.20 also demonstrates that the high-movers are highly likely to be the closed facility type rather than the active facility type. When a physician has two or more

relocation careers, the likelihood of a relocation occurring at the closed facilities are higher than active facilities by 2 times on average.

However, the interpretation of causality needs cautiousness about whether the high-movers prefer to work at the closed facilities or a facility closing increases the number of relocation careers of the physicians belonged to. As discussed above, most of the closed facilities are newly opened ones. The facilities may need new physicians to work. Some physicians might begin their first career at the facility, or other physicians might come from existing facilities. When the facility is closed, some may get retired or leave the field, and others may move to active facilities at the time. The closure of a facility operating for a short time period gives rise to inevitable transition of physician status for those who work at the facility. This explains why the likelihoods of two or more relocations highly increase at the closed facility type.

Consequently, it could be said that relocation itself plays a positive role to redistribute physicians from closed facilities to active ones.

4.2.3 Physician Type and Facility Closures

By examination of the combination of physician type and facility closure, the study could find out which choice each of the physician types makes in response to the facility closure.

Table 4.21 The relationship of facility closure and physician type

		Logit Regression Results						Odds Ratio		
Dep. Variable	**Ind. Variables**	**coef**	**std err**	**z**	**P-value**	**[0.025**	**0.975]***	**[0.025**	**0.975]**	**Odds Ratio**
Facility closure	**Intercept**	-1.0874	0.047	-23.016	0.000	-1.180	-0.995	0.307	0.370	0.337
	CNI	0.3549	0.071	5.019	0.000	0.216	0.493	1.241	1.638	1.426
	Other state	0.3139	0.075	4.183	0.000	0.167	0.461	1.182	1.586	1.369

* 95% Confidence Interval

Table 4.21 shows that when a physician is either the CNI type or the other state type, the likelihoods that the physician worked at closed facility are 43% and 37% each higher than those of the NE types. This might explain that closed facilities tend to recruit more physicians of the CNI type or the other state type than those of the NE type when they open. The physicians of the NE type are likely to have jobs on active facilities with 66% higher likelihood than closed facilities. The higher proportion of the CNI type or the other state type physicians could be one of the causes to generate more impact on the communities, since their choices after the closure are different from the relocation to other facilities which most of the NE type physicians choose.

Table 4.22 The relationship of the CNI-other state physician type and physician movements

		Logit Regression Results						Odds Ratio		
Dep. Variable	**Ind. Variables**	**coef**	**std err**	**z**	**P-value**	**[0.025**	**0.975]***	**[0.025**	**0.975]**	**Odds Ratio**
CNI-Other S. type physician	**Intercept**	-0.0196	0.033	-0.594	0.553	-0.084	0.045	0.919	1.046	0.981
	Immediate left	1.4034	0.117	12.036	0.000	1.175	1.632	3.238	5.114	4.069
	Normal left	1.4647	0.102	14.328	0.000	1.264	1.665	3.541	5.286	4.326
	Immediate complete	0.0879	0.144	0.612	0.540	-0.194	0.369	0.824	1.447	1.092
	Normal complete	-0.3911	0.120	-3.272	0.001	-0.625	-0.157	0.535	0.855	0.676

* 95% Confidence Interval

Table 4.22 shows what choices the CNI type and the other state type physicians tend to choose. The immediate left the field and the normal left the field are the most decisions chosen by the physicians. The immediate complete is statistically insignificant among these physician types.

The CNI type and the other state type is 4 times more likely to choose the left the field than the NE types at either active or closed facilities. The high rate of the immediate left the field shows how each of these physician types differently responds to the facility closure. They tend to decide to leave the state or stop practicing instead of the relocation to active facilities in the state when their facilities are closed. When the left the field occurs, it directly results in immediate loss of healthcare capacity in the state.

Table 4.23 The relatioinship between the NE physician type and the high-movers

		Logit Regression Results						Odds Ratio		
Dep. Variable	**Ind. Variables**	**coef**	**std err**	**z**	**P-value**	**[0.025**	**0.975]***	**[0.025**	**0.975]**	**Odds Ratio**
NE type physician	**Intercept**	-0.5187	0.044	-11.681	0.000	-0.606	-0.432	0.546	0.649	0.595
	1 Time	0.4028	0.068	5.931	0.000	0.270	0.536	1.310	1.709	1.496
	2 Times	0.5562	0.078	7.098	0.000	0.403	0.710	1.496	2.034	1.744
	More than 3	0.4808	0.086	5.591	0.000	0.312	0.649	1.366	1.914	1.617

* 95% Confidence Interval

Table 4.23 suggests that the high-movers are likely to be the NE physician type. The likelihood of a physician who has moved more than two times to be the NE type are each 62% and 74% higher than those of the CNI type and the other state type. This means that most of the high-movers are the physicians who graduated high school in the state.

As discussed in the previous section, 67.3% of the total relocations are directly related to facility closings, and the relocation itself plays a positive role to redistribute physicians from closed facilities to active ones. The responses of the NE physician type to facility closure appears to depart from the left the field by other physician types. This can be the essential point to preserve the total capability of healthcare service in communities or areas. It is necessary to reduce the total amount of the left the field by the CNI type and other state type in the perspective of a policy.

4.2.4 Findings of Physician-Facility Relation Analysis

The joint analysis of physician and facility databases enables the study to concretely delineate relation and the impact among key factors of the physician type and the facility type.

1) The closed facilities are more than active ones with 55.0% and 45.0% each to the total facilities. The average operation years of closed facilities were remarkably short with 40% of that of active facilities.

2) Active facilities have kept more physicians as 63.5% of the totals, while the proportion of physicians of closed facilities are only 36.5%. However, the physicians who worked at closed facilities made a greater number of the left the field and the relocation with 42% of the total left the field and 67.3% of the total relocation after the facility closure. There are far higher figures in comparison to the physicians' proportion with 36.5% to the total physicians in the state.

3) Among a total of 1,245 physicians at closed facilities, 40.2% of the physicians had at once left the field without any relocation after the closure. Also, 43.4% of the physicians had moved to active facilities after the closure.

4) The physicians who are the CNI (Could Not Identify) type and the other state type are 5 times more likely to choose the left the field than the physicians of the NE type at both closed and active facilities.

5) At closed facilities, the high-movers who have more than two times of the relocation careers are twice as likely to work at the closed facilities than others who have zero or one relocation career. The high-movers are likely to be the NE physician types with the probability of 60% and 70% each.

In results, it can be said that the facility closure is the most impactful facility factor across the entire state of Nebraska. The facility closure causes high volumes of the left the field among the physicians of the CNI type and the other state type, and the relocation by the NE physician types.

4.3 County and Impact Factors Relation Analysis

The impact factors which are determined by the analyses of physician type and facility type can be essentialized as the facility closure and the physician's left the field. The factors need to be examined in relation to counties in the state to find out whether there is a geographical relation between the factors and counties. However, as the primary dataset supplies a little information about the counties which is necessary in this

research, there are limitations to examine many possibilities. More advanced research and information collection are necessary.

The county analysis examines relation among the impactful factors, population variation from 2000 to 2010, socioeconomic and workload conditions.

Table 4.24 Facility closures in counties and factors of non NE-Physicians and population

Facility Closure(%)	**# of Counties**	**Non NE-Physicians (%)**	**Population 2000 (average)**	**Population 2010 (average)**	**Population Variation (%)**	**1000 people per 1 physician**
0%	12	34%	5402.8	5130.6	-5.3%	1.6
< 40%	12	37%	9176.3	8841.2	-5.2%	1.3
< 60%	25	47%	29481.3	32612.2	-0.2%	1.5
< 90%	25	48%	30677.3	32543.2	-4.7%	1.3
100%	5	68%	3547.8	3294.2	-8.1%	1.4
No Facility	14		1043.6	951.8	-9.0%	
Total	93	45%	18400.7	19638.1	-4.5%	1.4

Table 4.24 shows that 14 counties have never had a facility or a physician, and 5 counties have no facility and physician as of 2019 due to the facility closings. The 19 counties have remarkably small or highly diminishing populations except for a few counties. However, although the data shows that there is no facility in the counties, there could be a possibility that there are a few facilities which are currently running without giving the report to HPTS for many years. Thus, to have no facility may not mean that the people are not currently able to receive any healthcare service, but it is obvious that there exits deficiency in the service provision by comparison to the population. The population variation indicates that populations of the counties averagely decreased across

most range of facility closure rate. According to the Census Decennial dataset, from 2000 to 2010 only 24 counties show the increase in population size among 93 counties.

Table 4.25 Physicians of left the field in counties and factors of non NE-Physicians and population

Left Physician (%)	# of Counties	Non NE-Physicians (%)	Population 2000 (average)	Population 2010 (average)	Population Variation (%)	1000 people per 1 physician
0%	11	22%	5528.0	5257.7	-4.8%	1.5
< 30%	31	34%	20952.6	22054.9	-2.1%	1.2
< 50%	25	56%	36015.1	39590.2	-2.8%	1.3
≤ 100%	12	73%	7161.3	6810.4	-8.2%	2.1
No Physician	14		1043.6	951.8	-9.0%	
Total	93	45%	18400.7	19638.1	-4.5%	1.4

Table 4.25 shows proportion of the left the field physician type to the total physicians in a county. While 12 counties show a high proportion of the physicians with greater than 50%, 42 counties show low level with less than 30%. Also, there are 14 counties never having had a facility.

Table 4.26 The relationship of facility closing and surrounding conditions

Linear Regression Results							
Dep. Variable	**Ind. Variables**	**coef**	**std err**	**z**	**P-value**	**[0.025**	**0.975]***
Facility closure rate	**Intercept**	0.6454	0.218	2.961	0.003	0.218	1.073
	non-NE-physician rate	0.3134	0.150	2.094	0.036	0.020	0.607
	Social assistance	-0.2475	0.305	-0.811	0.417	-0.845	0.350
	Population variation	-0.3043	0.403	-0.755	0.450	-1.094	0.485
	Work hours	-0.5285	0.409	-1.293	0.196	-1.330	0.273

* 95% Confidence Interval

Table 4.26 shows results of a linear regression analysis in an examination of relation between facility closure and surrounding conditions. The result of tests satisfies all assumptions of the linear regression. Among variables of the surrounding conditions, only the variable of proportion of the CNI and the other state physician types shows significant relation. As 1% increase of proportion of the non-NE physician type, the proportion of facility closure to the total facilities in the county increases 0.3%.

Table 4.27 The relationship of left the field physicians and surrounding conditions

Linear Regression Results							
Dep. Variable	**Ind. Variables**	**coef**	**std err**	**z**	**P-value**	**[0.025**	**0.975]***
Left the field proportion	**Intercept**	0.1368	0.171	0.800	0.424	-0.198	0.472
	non NE-physician rate	0.5547	0.091	6.118	0.000	0.377	0.732
	Social assistance	-0.0577	0.120	-0.481	0.630	-0.293	0.177
	Population variation	-0.1678	0.234	-0.716	0.474	-0.627	0.292
	Work hours	-0.1960	0.540	-0.363	0.717	-1.255	0.863

* 95% Confidence Interval

** The test results show that there are autocorrelation and non-normality of residual errors.

The result of linear regression of Table 4.27 also shows that only the proportion of the non-NE physician type has significant relation to the rate of the left the field physicians to the total physicians. As 1% increase of the rate of the non-NE physician type, the proportion of the left the field physicians increases 0.6%.

The regression analyses show that the impactful factors of facility closure and the left the field have little relation to population variation, socioeconomic and workload conditions. The analyses also support that high school background of a physician has relation to the impact factors in the geographical study. Although the regression analyses

show that there is little relation among the decrease in population, facility closure rate, and proportion of the left the field physicians, Table 4.24 and 4.25 suggest that the counties which experienced decrease in population with more than 8% between 2000 and 2010 show high-level rates of facility closure or physician who left the field.

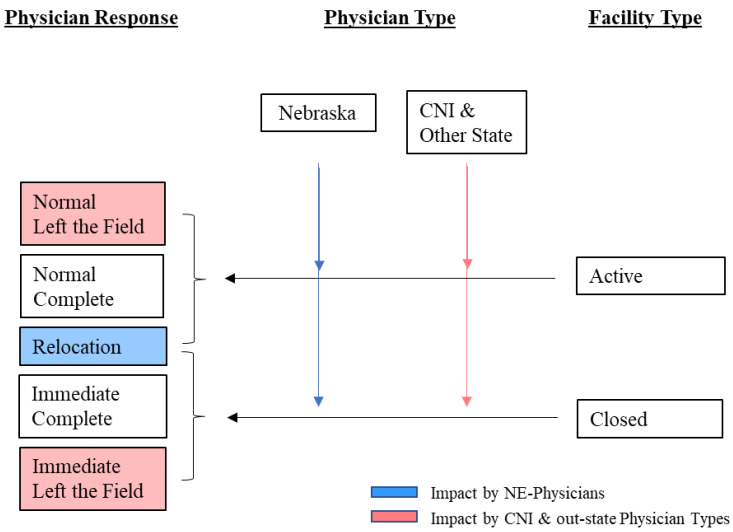
Chapter 5 Discussion

The article points out that all studies of rural intervention strategies on physician practicing could have bias or confounding as the experiments were done on specific setting and context (Grobler, et al., 2009) (Globler, Marais, & Mabunda, 2019). This study could recognize dynamics among the factors which impact physicians' movements at the whole state level. The dynamics play a role as an underlying force to influence a substantial part of the behaviors of physicians in Nebraska. A framework of physician and facility factors can be useful to explain the specific phenomena with provision of the whole view on the research findings.

5.1 Impact Factors

A framework of associations among the factors which impact physician's movement is illustrated in Figure 5.1.

Figure 5.1 Association of Impact Factors



There are the factors which cause physician movements and influence physicians' distribution in the state. Each of the physician type or the facility type has its own factors which interact with each other. Facility types provide physicians a momentum by which an individual physician decides a change on personal career plan. The physician type characterizes the way in which a physician tends to respond to the momentum. The responses which a physician can choose at a circumstance can be categorized to Complete, Relocation, or Left the Field.

The complete is the natural choice as a physician gets aging. It cannot be controlled by any manners of planning or policy. Rather, it can be a good signal that a physician has served for a long time for the community in her or his vocational life. The relocation can be interpreted as a rearrangement of healthcare capability in the state. Although there can be various causes to trigger the relocation in general, it could be understood as a response to specific conditions or troubles of a facility or a community from the findings. The analysis shows that many of the in-state high-school background physicians respond to a facility closure by moving to other facilities. If there were not enough facilities to absorb these relocation needs, the physicians would have no choice but to move out of the state. The left the field is the most impactful response from physicians. Once it happens, it diminishes the total capability of healthcare service in the state at once. Thus, the choices of the left the field should be reduced to keep physicians within the state.

The facility type can be explained as either to be actively running or to have closed. The group of closed facilities show distinct difference with the active facilities in aspects of operation years, the number of physicians belonged to, and composition rate of

physicians' high school backgrounds. The analyses show that the facility closure is the most impactful factor to cause the relocation and the left the field of physicians in the state.

Table 5.1 Impact of facility closure by physician movements and worked facility

# of Physicians		**Physician movements (sum of column = 100%)**	
Worked facility	**Total**	**Left the Field**	**Relocated**
Active	2166 (63.5%)	692 (58.1%)	497 (40.0%)
	1245 (36.5%)	499 (41.9%)	746 (60.0%)
Both	670 (19.6%)		670 (53.9%)
Closed	575 (16.9%)		76 (6.1%)
Total	3411 (100%)	1191 (100%)	1243 (100%)

In Table 5.1, 42% of the total left the field and 60% of the total relocation are caused from the closed facilities. When we focus only on the physicians at the closed facilities, among a total of 1245 physicians at the closed facilities, 499 (40%) physicians had left the field immediately after the closure in the same year. On the other hand, 692 (31.9%) physicians had left the field by self-decision at the active facilities.

The physician type could explain what response each physician group tends to show at a moment of choice such as facility closure. There might be various attributes to explain the characteristics of an individual physician or group of physicians. The study found that a high school background of physicians best classifies the tendency of their responses to the change. Although 34.1% of physicians have not revealed their high

school background, they show consistent responses to all factors as a group. The study names the group as CNI (Could Not Identify). Another physician type of the other state also well represents similar responses to the CNI type at the time to choose a movement. The physician type of the NE (in-state high school background) shows stable behaviors with prolonged tenure and less relocations toward other states. It can be said that the NE type physicians are currently the mainstay of the state healthcare system despite numerically being in the minority.

The following three tables present the kernel of this study. Table 5.2 shows that more physicians of the CNI type and the other state type worked at the closed facilities than the active facilities. It seems that when the closed facilities newly opened, they actively recruited physicians from the other state or the CNI type. Most of the 265 physicians of the CNI type who had only worked at the closed facilities have just one or two career records. This implies that the facilities might be their first workplace in the career, and many of them had left the field without any relocation to other facilities within the state.

Table 5.2 Distribution of physicians by physician type and worked facility

# of Physicians		**High school background (sum of row = 100%)**		
Worked facility	**Total**	**CNI** (Could Not Identify)	**Nebraska**	**Other State**
Active	2166 (63.5%)	713 (32.9%)	950 (43.9%)	503 (23.2%)
	1245 (36.5%)	449 (36.1%)	461 (37.0%)	335 (26.9%)
Both	670 (19.6%)	184 (27.5%)	307 (45.8%)	179 (26.7%)
Closed	575 (16.9%)	265 (46.1%)	154 (26.8%)	156 (27.1%)
Total	3411 (100%)	1162 (34.1%)	1411 (41.4%)	838 (24.6%)

Table 5.3 The number of left the field physicians by physician type and worked facility

# of left the field physicians (n=1191)		**High school background (sum of row = 100%)**		
Worked facility	**Total**	**CNI** (Could Not Identify)	**Nebraska**	**Other State**
Active	595 (17.4%)	327 (55.0%)	110 (18.5%)	158 (26.6%)
	596 (17.5%)	309 (51.8%)	122 (20.5%)	165 (27.7%)
Both	188 (5.5%)	83 (44.1%)	46 (24.5%)	59 (31.4%)
Closed	408 (12.0%)	226 (55.4%)	76 (18.6%)	106 (26.0%)
Total left the field	1191 (34.9%)	636 (53.4%)	232 (19.5%)	323 (27.1%)
Total physician	3411 (100%)	1162 (34.1%)	1411 (41.4%)	838 (24.6%)
% of left the field to total physician	34.9%	54.7%	16.4%	38.5%

Table 5.3 provides that physicians of the CNI type and the other state type tend to choose the left the field in response to a change of circumstances instead of the relocation regardless of active and closed facilities. In total, 55% physicians of all the CNI type and 39% physicians of all the other state type had chosen to leave the field in the state. As seen on the analyses, physicians of the NE type tend to choose relocation to other facilities when the circumstance changes. With narrowing the focus to the closed facilities, high proportion of the physicians had left the field in consequence.

Table 5.4 The number of left the field physicians at closed facility by physician type

# of Physicians		High school background (sum of row = 100%)		
	Total	**CNI** (Could Not Identify)	**Nebraska**	**Other State**
Left the Field	596 (100%)	309 (51.8%)	122 (20.5%)	165 (27.7%)
Closed facility Total	1245 (100%)	449 (36.1%)	461 (37.0%)	335 (26.9%)
% of left the field to total closed facility	47.9%	68.8%	26.5%	49.3%

Table 5.4 shows that 70% and 50% of each of the CNI type and the other state type physicians had left the field in response to facility closings instead of the relocation to other active facilities. There is difference between the left the field at active facilities and at closed facilities. The left the field at active facilities is resulted from a discretionary decision of a physician. However, the left the field at closed facilities is the consequence of the coerced choice due to closure of the workplace. Why did they not consider a relocation to other facilities in the state? The study asserts that the left the field by the physicians of the CNI type and the other state type at closed facilities is the most serious challenge to be relieved urgently in the state.

The deficiency of primary care physicians due to high rate of relocation toward other states is repeating itself every year. Table 5.5 shows annual variation of facility closings and newly opens. There is a gap between the total number of facility and the number of closing and opening every year since some facilities did not send the report every year. But, the number of closings and openings are exact.

Table 5.5 Annual variation of facilities in Nebraska

		1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Total		**420**	**589**	**564**	**567**	**575**	**576**	**584**	**590**	**589**	**606**	**619**	**626**
Newly Open		420	234	50	45	42	46	42	53	37	43	53	38
Closed			51	58	40	31	35	32	38	43	31	41	33
	Urban		31	45	20	20	20	18	20	25	19	22	20
	Rural		20	13	20	11	15	14	18	18	12	19	13

		2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	Total
Total		**620**	**619**	**597**	**587**	**592**	**614**	**589**	**580**	**576**	**571**	**1446**
Newly Open		40	39	25	28	42	55	35	23	24	32	1446
Closed		51	48	40	42	38	42	66	36			796
	Urban	33	31	30	27	27	32	52	23			515
	Rural	18	17	10	15	11	10	14	13			281

Remarks 1. 1998, 1999: HPTS started to input data.
2. 2017,2018, 2019: Faicilities of no yearly reporting are regarded as Active

In average, there have been 41.9 closings and 39.6 new openings of facilities every year in the state. Every year, 14% of the total facilities get changed by the closings and openings. As discussed above, the closing and new opening generate the left the field, the relocation, or new employments of physicians from inside and outside the state.

Table 5.6 Annual variation of physicians in Nebraska

		1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Total		**760**	**1373**	**1347**	**1377**	**1414**	**1426**	**1454**	**1475**	**1462**	**1499**	**1528**	**1559**
The Left		82	117	78	72	85	60	75	112	66	70	59	87
	Complete	19	36	27	25	24	13	24	35	12	11	14	22
	Left the Field	63	81	51	47	61	47	51	77	54	59	45	65
The New		760	718	122	115	113	98	98	101	116	107	92	81
	NE	400	380	42	44	38	32	30	37	31	32	34	24
	CNI	174	158	44	35	41	35	50	47	47	47	38	35
	OTHER State	186	180	36	36	34	31	18	17	38	28	20	22

		2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	Total
Total		**1573**	**1617**	**1594**	**1571**	**1580**	**1590**	**1588**	**1581**	**1584**	**1589**	
The Left		76	78	112	98	99	95	90	42	56	3	
	Complete	22	18	22	32	41	24	32	25	40	3	521
	Left the Field	54	60	90	66	58	71	58	17	16		1191
The New		90	106	70	92	98	93	92	80	95	74	
	NE	22	31	27	29	27	31	28	37	38	17	1411
	CNI	44	54	34	39	48	41	41	27	37	46	1162
	OTHER State	24	21	9	24	23	21	23	16	20	11	838

Remarks 1. 1998, 1999: HPTS started to input data.
2. 2017,2018, 2019: Physicians of no yearly reporting are regarded as Active

Table 5.6 shows that in average, 84.8 physicians complete or leave the field, and 96.7 new physicians begin their practices every year in the state. On average, 6% of the total physicians are changed every year. The change means that the physicians who were acquainted with community members had left and new physicians come to the communities. The 6% is the scale which the whole physicians in the state can be entirely changed by new physicians in 12 years. As the physicians of the CNI type and the other state type are the major profession group who can meet the demand of new physicians every year with more than 67%, it is necessary to find ways to let them serve prolongedly in the state. Without it, it seems difficult to achieve more stable healthcare system in the state.

5.2 Rurality and Disparity

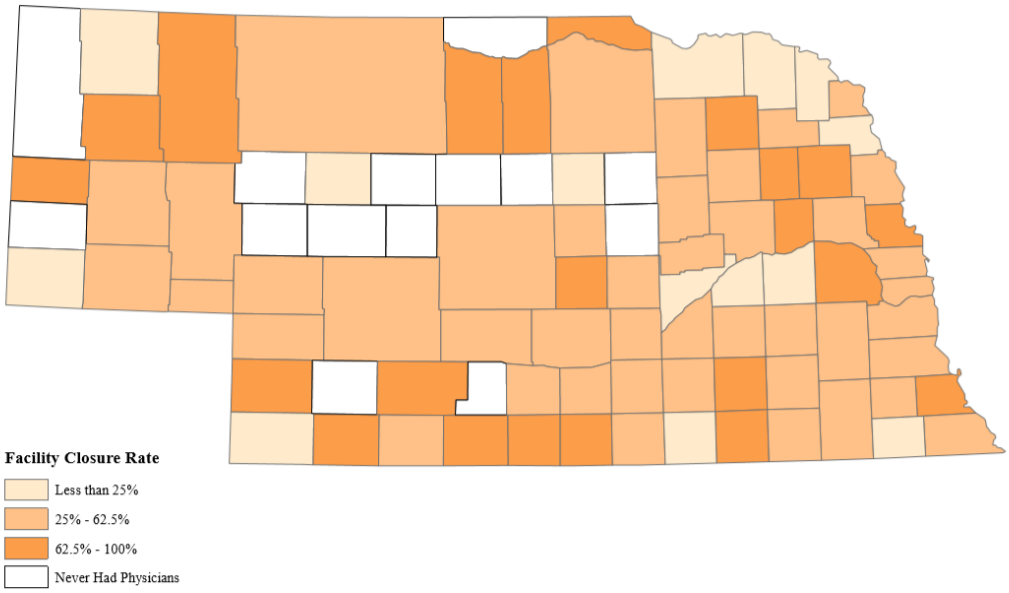
There is slight difference between rural and urban areas in the impact factors of facility closing, the left the field and the relocation. Also, there is just minor relocations from rural to urban areas. The rural physicians show more stable behaviors than the urban physicians in aspects of tenure, movement, and attachment. Especially physicians who have rural high school background in the state shows remarkable stability in the rural practicing in comparison to other physician types. Also, the physicians with urban high school background in the state show that once they choose rural practicing, they also show stable behaviors in rural areas like those of rural high school background in Nebraska.

On the other hand, the physicians of the CNI type and the other state high school background show relatively unstable behaviors toward the rural practicing regardless of the rurality of high school background. It shows that it is difficult to decisively say that the rurality of high school background could be the determinant of a physician's choosing the rural practicing at least in Nebraska. It is worth further studying why two groups of the NE type physicians and the CNI and the other state type physicians show different behaviors and responses. To understand relevant factors to cause the non-NE type physicians to choose the left the field can help facilities to nestle them in the perspective of a human resource management.

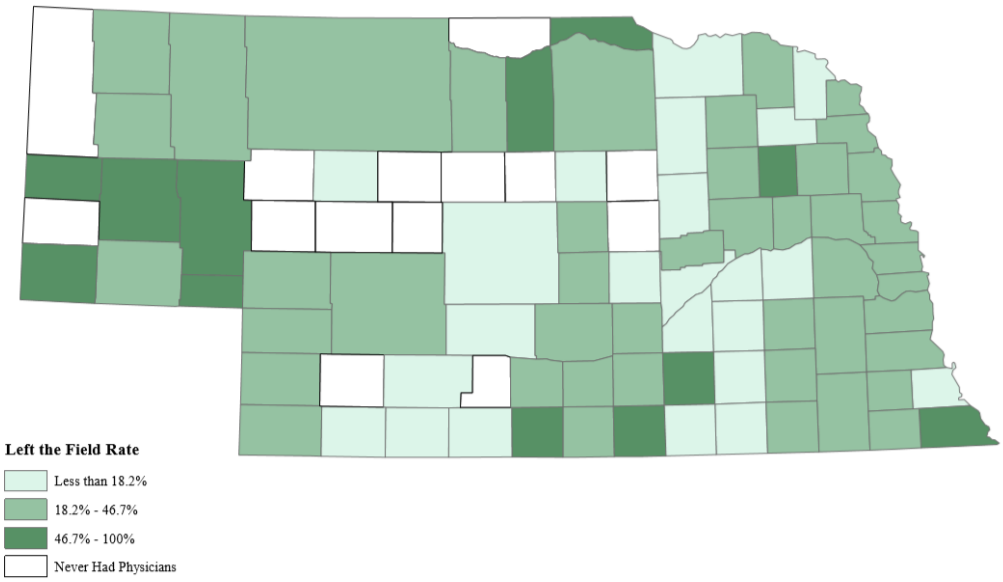
The findings also imply that it could be a consequence of specific context in Nebraska. Since the state has relatively small size of population, there can be a limit to rear physicians and meet the demand of physicians at the fields although the state has two medical schools. This can be a fundamental reason that the other state type physicians are essential to meet the demand of new physicians. The states where there are plenty of in-state medical students to satisfy the demand can show different aspects from the physician distribution and movements of Nebraska. Thus, it is difficult to say that this study can be the general model to explain the nationwide situation. As Grobler and his colleagues warned (Grobler, et al., 2009) (Globler, Marais, & Mabunda, 2019), more joint studies among states are necessary to develop more elaborated model which is based on various population scales and contexts.

Figure 5.2 The difference in Counties

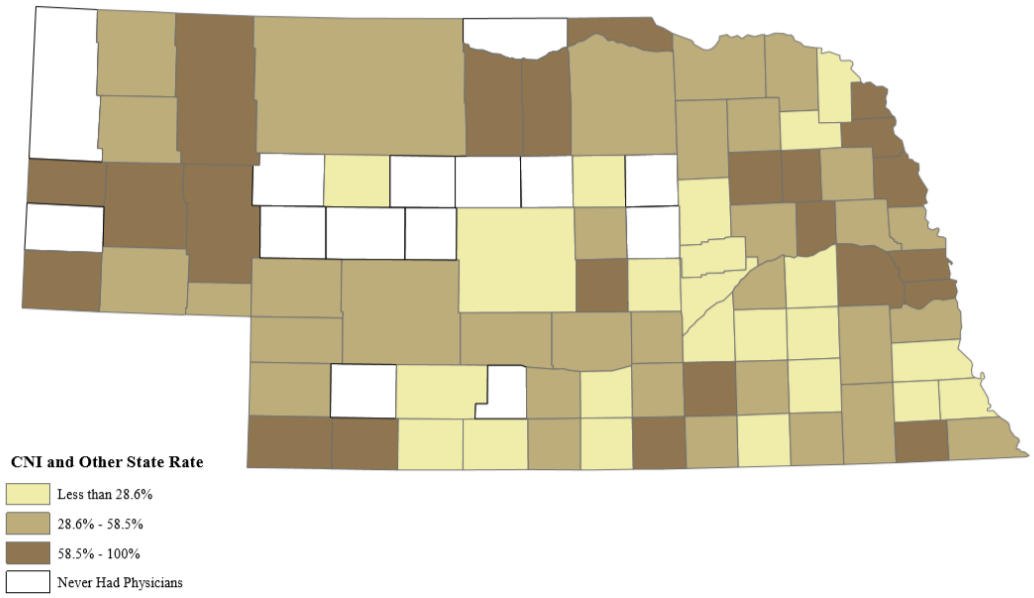
(a) Facility Closure



(b) Physicians of Left the Field



(c) Physician type of CNI and Other State



Although overall statistics shows there is little difference between rural and urban areas in socioeconomic condition or population variation, the county level analysis in Figure 5.2 presents a disparity among counties in relation to decrease in population. The 14 counties which have a population of less than 1,000 have never had facilities to care for the people, and 5 counties had lost all the facilities. They have diminishing populations with 8% to 9% between 2000 and 2010. Altogether, 30,000 people in the 19 counties are currently under lack of healthcare service. Although it is difficult to prejudge the trend, at least these counties would continue to lose the population on 2020 census if they could not recover the healthcare capability.

Another fundamental disparity is a disproportion in the number of primary care physicians between rural and urban areas. While rural population is 47% to the totals of Nebraska in 2010, proportion of physicians in rural areas is 36%. The analyses

demonstrate that there are a few relocations of physicians from rural to urban facilities, and the rural physicians show high stability in the area. Thus, it can be inferred that the disproportionality comes from inferiority in locational choices by the physicians who begin the practicing in the state. This implies that there could be two ways to improve the disproportion. One way is to increase supply of physicians to the rural areas and another one is to decrease the number of the left the field physicians.

5.3 Planning Implication

The study shows that there are two fundamental points to be improved in the healthcare service in Nebraska. The one is the high rate of the left the field physicians and the other is the disparity of the number of physicians between rural and urban areas. To reduce the number of the left the field physicians could be a prompt strategy for health planners, which have an effect on both improving stability in healthcare service and preventing the loss of healthcare capability.

As seen in Table 5.6, to increase supply of new physicians in the current way could have limited effects. It might have the possibility to repeat the high rate of physicians' leaving at both active and closed facilities again. A policy cannot realistically control the complete and the facility closing because they are the natural choices by the physicians. The core of this planning might be to find a way of how to change the physicians' decision of the left the field to the relocation to other facilities in the state. If an effort to turn the left the field to the relocation pays off, the state could quickly increase the total number of physicians. Also, the effort could play a positive role to

balance the disproportion in the number of physicians between rural and urban areas. Because the physicians of the NE type tend to make a prolonged practicing in rural areas, the most effective way to increase the number of physicians in the rural might be to keep the CNI and the other state type physicians from relocating outside the state.

Most of the left the field are done by the physicians of the CNI type and the other state type, and these types are the majority in the number of physicians in the state. Thus, it is important to concretely understand who the CNI type physicians are. To understand the background and why they are more likely to decide the left the field might be the first step to improve the situation. In addition, if the healthcare administration can catch the closures of facilities in advance, the administration could have a chance to change the physicians' choice to move to active facilities nearby. A new study for finding out the causes of the left the field are necessary in planning perspectives. Health planning officers could guide the facilities about what the facilities need to do for nestling the physicians in.

According to primary dataset of HPTS, among all 93 counties in Nebraska, 47% of the total population live in 90 counties, and there are 19 counties which have no facility and physician as of 2019. An ideal situation might be that many small clinics are distributed all round. In reality, it might be difficult to invite new facilities to the severe health profession shortage areas such as the 19 counties without any compensation. Thus, healthcare service planners are called for finding a way to increase accessibility to facilities for the underserved rural people.

Currently, a few physicians in adjacent counties might serve the severely underserved counties through the satellite practicing by part time or nonscheduled

serving to care the people more closely. It could be more realistic to reinforce more physicians around the counties to care for them more regularly. For this intentional placement of physicians to the isolated rural areas, the loan repayment programs of state and federal governments could be an effective means. For 22 years, among the 285 participants who began their obligation in rural areas, a total of 70% physicians are still practicing in the rural areas as of 2019. The incentive programs can be an effective vehicle to invite physicians nearby or to the counties with higher benefits including financial support or provision of opportunities for self-development.

Increase of the accessibility to facilities can improve quality of life of the people in the underserved areas. The people in rural areas show lower life expectancy and higher mortality by comparison with those of urban counterparts (Pedley, 2018). The physicians in the vicinity of a community could benefit the people who have diseases like diabetes, asthma, Chronic Obstructive Pulmonary Disease (COPD) or heart disease by regular diagnosis. A prompt emergency treatment can be possible when people are injured from traffic accident, workplace, or home. The shorter driving distance or walking time to physicians could increase the frequency to see a doctor for the elderly and children by themselves or by caregivers. All benefits can improve the life expectancy and mortality of the people in the communities. A necessary condition for a healthy community might be described as there exist healthcare service and living conditions which contribute to keep people healthy and proactively prevent diseases in the community (American Academy of Family Physicians, 2020). When the basic needs of the condition are satisfied, the community can be more livable, and the decline of population could halt or be slow in the underserved counties.

Chapter 6 Conclusion

The study aims to research physicians' movements in rural practicing with the information of all primary care physicians in Nebraska from 1998 to 2019. Owing to the reliable dataset in HPTS of the University of Nebraska Medical Center, the study could determine the underlying framework which explains the physicians' movements in both rural and urban areas. The physician type and facility closure typify the way of interacting within the framework. The factors could more concretely explain the changes in geographical distribution of the physicians in the state than any other variables.

The study could also recognize a disparity between rural and urban areas in the physicians' locational choices which is unproportionate to the population ratio between the areas. Furthermore, there exists an uneven distribution of the physicians within rural areas. The disparity distresses the people by absence, instability, or deficiency of healthcare service in the communities. The troubles of the communities call for an active intervention of the planning and the healthcare administration to relieve the intensity. The study proposes a few directions, but they might be mere ideas. More exigent and concrete responses of policy are needed.

There are limitations on the study in examining relation of socioeconomic conditions and physician's job satisfaction due to the deficiency of diverse information. More studies on this subject could supply a clue to understand motivational causes of physician's leaving or managemental causes of facility closing in detail. For that, the study proposes some future subjects and recommendations for reinforcement of data collection.

Further subject could be to investigate a psychological factor of the CNI and the other state type physicians such as motivations to choose a job or the reflection of their vocational lives in Nebraska. This analysis could supply the clues why they show such a high rate of leaving the field. A study of facility in business management and performance might be essential to determine the causes of facility closures. The business performance or relationship to communities where they run could be linked to physicians' income or job satisfaction which may cause physicians' leaving. On county analysis, an accessibility study might be necessary which bases real population distribution statewide rather than current policy basis on county. This study could enable planners to assess the amount of healthcare service and the easiness of access for the people across contiguous areas regardless of county boundary.

There is a recommendation for UNMC to get more diverse information from facilities and physicians. A straightforward question with private and sensitive issues within the current report could degrade the quality of the responses. Regarding the issues raised in this study, it is necessary to have extra surveys on the target groups periodically. Especially, to identify possible facility closure or physician leaving in advance might be crucial to plan a policy to alleviate the impacts. The most urgent task may recognize the high school background of the CNI type for fully understanding of who they are.

Although the study presents a framework in the state level, it could be restricted to the specific conditions or contexts of Nebraska. Other states could have a difference in definition of variables, or have additional new variables depending on more factors such as population size, rate of rural counties, or self-sufficiency rate of physicians. If more joint studies are possible among states with distinctive characteristics, more general

models could be developed. The collaborative effort could help health administrators in improving the state healthcare service more effectively, and the fruition would benefit people with more stable and reliable service.

Appendix 1. Regression Summary Tables

Table 4.9 The relationship between rural practicing and high school background

```
Optimization terminated successfully.
         Current function value: 0.602904
         Iterations 5
                           Logit Regression Results
==============================================================================
Dep. Variable:     RURALITY_LAST_PRAC   No. Observations:                 3411
Model:                          Logit   Df Residuals:                     3406
Method:                           MLE   Df Model:                            4
Date:                Sat, 14 Mar 2020   Pseudo R-squ.:                 0.07612
Time:                        11:50:16   Log-Likelihood:                -2056.5
converged:                       True   LL-Null:                       -2225.9
Covariance Type:            nonrobust   LLR p-value:                 4.439e-72
================================================================================
                     coef    std err          z      P>|z|      [0.025      0.975]
--------------------------------------------------------------------------------
Intercept        -0.6293      0.062    -10.215      0.000      -0.750      -0.509
HS_LOC2[T.NE_R]   1.1034      0.096     11.502      0.000       0.915       1.291
HS_LOC2[T.NE_U]  -0.8260      0.119     -6.942      0.000      -1.059      -0.593
HS_LOC2[T.OTHER_R]  -0.3209      0.166     -1.928      0.054      -0.647       0.005
HS_LOC2[T.OTHER_U]  -0.4483      0.110     -4.063      0.000      -0.665      -0.232
================================================================================
                      2.5%     97.5%  Odds-Ratio
Intercept         0.472366  0.601376    0.532982
HS_LOC2[T.NE_R]   2.497802  3.638055    3.014488
HS_LOC2[T.NE_U]   0.346721  0.552776    0.437789
HS_LOC2[T.OTHER_R]  0.523540  1.005308    0.725479
HS_LOC2[T.OTHER_U]  0.514516  0.792905    0.638719
```

Table 4.11 The relationship between left the field and high school background

```
Optimization terminated successfully.
         Current function value: 0.581506
         Iterations 6
                           Logit Regression Results
==============================================================================
Dep. Variable:          FS_LEFT_FIELD   No. Observations:                 3411
Model:                          Logit   Df Residuals:                     3406
Method:                           MLE   Df Model:                            4
Date:                Sat, 14 Mar 2020   Pseudo R-squ.:                 0.1011
Time:                        11:32:54   Log-Likelihood:                -1983.5
converged:                       True   LL-Null:                       -2206.7
Covariance Type:            nonrobust   LLR p-value:                 2.731e-95
================================================================================
                     coef    std err          z      P>|z|      [0.025      0.975]
--------------------------------------------------------------------------------
Intercept         0.1899      0.059      3.222      0.001       0.074       0.305
HS_LOC2[T.NE_R]  -2.0427      0.120    -17.030      0.000      -2.278      -1.808
HS_LOC2[T.NE_U]  -1.5742      0.116    -13.600      0.000      -1.801      -1.347
HS_LOC2[T.OTHER_R]  -0.8047      0.157     -5.133      0.000      -1.112      -0.497
HS_LOC2[T.OTHER_U]  -0.6086      0.101     -6.054      0.000      -0.806      -0.412
================================================================================
                      2.5%     97.5%  Odds-Ratio
Intercept         1.077221  1.357181    1.209125
HS_LOC2[T.NE_R]   0.102516  0.164053    0.129684
HS_LOC2[T.NE_U]   0.165122  0.259931    0.207172
HS_LOC2[T.OTHER_R]  0.328903  0.608090    0.447216
HS_LOC2[T.OTHER_U]  0.446806  0.662600    0.544108
```

Table 4.12 The relationship between rurality and left the field

```
Optimization terminated successfully.
         Current function value: 0.652159
         Iterations 4
                          Logit Regression Results
==============================================================================
Dep. Variable:     RURALITY_LAST_PRAC   No. Observations:                 3411
Model:                          Logit   Df Residuals:                     3408
Method:                           MLE   Df Model:                            2
Date:                Sun, 29 Mar 2020   Pseudo R-squ.:               0.0006404
Time:                        22:54:06   Log-Likelihood:                -2224.5
converged:                       True   LL-Null:                       -2225.9
Covariance Type:            nonrobust   LLR p-value:                    0.2404
==============================================================================
                    coef    std err          z      P>|z|      [0.025      0.975]
------------------------------------------------------------------------------
Intercept        -0.5155      0.081     -6.397      0.000      -0.673      -0.358
FS_LEFT_FIELD    -0.1394      0.087     -1.599      0.110      -0.310       0.031
TOTAL_YRS        -0.0019      0.005     -0.345      0.730      -0.013       0.009
==============================================================================
                   2.5%     97.5%  Odds-Ratio
Intercept      0.509961  0.699393    0.597213
FS_LEFT_FIELD  0.733251  1.031941    0.869869
TOTAL_YRS      0.987438  1.008897    0.998110
```

Table 4.17 The relationship between facilities closure and final status of physicians

```
Optimization terminated successfully.
         Current function value: 0.557321
         Iterations 5
                           Logit Regression Results
==============================================================================
Dep. Variable:              FS_CLOSED   No. Observations:                 5386
Model:                          Logit   Df Residuals:                     5383
Method:                           MLE   Df Model:                            2
Date:                Sat, 07 Mar 2020   Pseudo R-squ.:                 0.07498
Time:                        23:18:36   Log-Likelihood:                -3001.7
converged:                       True   LL-Null:                       -3245.0
Covariance Type:            nonrobust   LLR p-value:                2.164e-106
================================================================================================
                                   coef    std err          z      P>|z|      [0.025      0.975]
------------------------------------------------------------------------------------------------
Intercept                       -1.5993      0.049    -32.554      0.000      -1.696      -1.503
P_FINAL_STATUS[T.COMPLETE]       1.4722      0.086     17.096      0.000       1.303       1.641
P_FINAL_STATUS[T.LEFT_FIELD]     1.3009      0.070     18.512      0.000       1.163       1.439
================================================================================================
                                   2.5%     97.5%  Odds-Ratio
Intercept                    0.183482  0.222450    0.202028
P_FINAL_STATUS[T.COMPLETE]   3.681707  5.159954    4.358605
P_FINAL_STATUS[T.LEFT_FIELD] 3.199908  4.214732    3.672432
```

Table 4.19 The relationship between facility closure and relocations

```
Optimization terminated successfully.
         Current function value: 0.573546
         Iterations 5
                           Logit Regression Results
==============================================================================
Dep. Variable:              FS_CLOSED   No. Observations:                 5386
Model:                          Logit   Df Residuals:                     5384
Method:                           MLE   Df Model:                            1
Date:                Sun, 15 Mar 2020   Pseudo R-squ.:                 0.04805
Time:                        14:35:54   Log-Likelihood:                -3089.1
converged:                       True   LL-Null:                       -3245.0
Covariance Type:            nonrobust   LLR p-value:                 8.747e-70
==============================================================================
                     coef    std err          z      P>|z|      [0.025      0.975]
------------------------------------------------------------------------------
Intercept         -1.3468      0.042    -31.835      0.000      -1.430      -1.264
M2_RELOCATIONS     1.0871      0.062     17.522      0.000       0.966       1.209
==============================================================================
                    2.5%     97.5%  Odds-Ratio
Intercept       0.239372  0.282550    0.260066
M2_RELOCATIONS  2.626194  3.349281    2.965782
```

Table 4.20 The relationship of facility closure and high mover physicians

```
Optimization terminated successfully.
         Current function value: 0.594107
         Iterations 5
                           Logit Regression Results
==============================================================================
Dep. Variable:              FS_CLOSED   No. Observations:                 5386
Model:                          Logit   Df Residuals:                     5382
Method:                           MLE   Df Model:                            3
Date:                Sat, 07 Mar 2020   Pseudo R-squ.:                 0.01392
Time:                        23:18:36   Log-Likelihood:                -3199.9
converged:                       True   LL-Null:                       -3245.0
Covariance Type:            nonrobust   LLR p-value:                 1.848e-19
===============================================================================================
                                  coef    std err          z      P>|z|      [0.025      0.975]
-----------------------------------------------------------------------------------------------
Intercept                      -1.2074      0.051    -23.664      0.000      -1.307      -1.107
P_RELOCATIONS[T.1-TIME]         0.3285      0.076      4.323      0.000       0.180       0.478
P_RELOCATIONS[T.2-TIMES]        0.5329      0.085      6.254      0.000       0.366       0.700
P_RELOCATIONS[T.MORETHAN3]      0.8008      0.091      8.816      0.000       0.623       0.979
===============================================================================================
                                 2.5%     97.5%  Odds-Ratio
Intercept                    0.270530  0.330426    0.298981
P_RELOCATIONS[T.1-TIME]      1.196720  1.612056    1.388949
P_RELOCATIONS[T.2-TIMES]     1.441806  2.013633    1.703898
P_RELOCATIONS[T.MORETHAN3]   1.864053  2.661276    2.227276
```

Table 4.21 The relationship of facility closure and physician type

```
Optimization terminated successfully.
         Current function value: 0.599641
         Iterations 5
                           Logit Regression Results
==============================================================================
Dep. Variable:              FS_CLOSED   No. Observations:                 5386
Model:                          Logit   Df Residuals:                     5383
Method:                           MLE   Df Model:                            2
Date:                Sun, 15 Mar 2020   Pseudo R-squ.:                0.004734
Time:                        14:01:03   Log-Likelihood:                -3229.7
converged:                       True   LL-Null:                       -3245.0
Covariance Type:            nonrobust   LLR p-value:                 2.127e-07
==============================================================================
                 coef    std err          z      P>|z|      [0.025      0.975]
------------------------------------------------------------------------------
Intercept     -1.0874      0.047    -23.016      0.000      -1.180      -0.995
HS_CNI         0.3549      0.071      5.019      0.000       0.216       0.493
HS_OTHER       0.3139      0.075      4.183      0.000       0.167       0.461
==============================================================================
               2.5%     97.5%  Odds-Ratio
Intercept  0.307272  0.369790    0.337085
HS_CNI     1.241456  1.637975    1.425999
HS_OTHER   1.181518  1.585571    1.368715
```

Table 4.22 The relationship of the physician type of CNI-other state and physician

```
Optimization terminated successfully.
         Current function value: 0.647629
         Iterations 5
                           Logit Regression Results
==============================================================================
Dep. Variable:           HS_CNI_OTHER   No. Observations:                 5386
Model:                          Logit   Df Residuals:                     5381
Method:                           MLE   Df Model:                            4
Date:                Sun, 15 Mar 2020   Pseudo R-squ.:                 0.05621
Time:                        14:35:54   Log-Likelihood:                -3488.1
converged:                       True   LL-Null:                       -3695.9
Covariance Type:            nonrobust   LLR p-value:                1.230e-88
==============================================================================
                           coef    std err          z      P>|z|      [0.025      0.975]
------------------------------------------------------------------------------
Intercept               -0.0196      0.033     -0.594      0.553      -0.084       0.045
M_IMMEDIATE_LEFT         1.4034      0.117     12.036      0.000       1.175       1.632
M_NORMAL_LEFT_FIELD      1.4647      0.102     14.328      0.000       1.264       1.665
M_IMMEDIATE_COMPLETE     0.0879      0.144      0.612      0.540      -0.194       0.369
M_NORMAL_COMPLETE       -0.3911      0.120     -3.272      0.001      -0.625      -0.157
==============================================================================
                            2.5%     97.5%  Odds-Ratio
Intercept               0.919181  1.046108    0.980593
M_IMMEDIATE_LEFT        3.237693  5.113668    4.068966
M_NORMAL_LEFT_FIELD     3.540868  5.286167    4.326386
M_IMMEDIATE_COMPLETE    0.824026  1.446848    1.091898
M_NORMAL_COMPLETE       0.535033  0.854823    0.676283
```

Table 4.23 The relatioinship of the physician type of NE and high-movers

```
Optimization terminated successfully.
         Current function value: 0.679522
         Iterations 4
                           Logit Regression Results
==============================================================================
Dep. Variable:                  HS_NE   No. Observations:                 5386
Model:                          Logit   Df Residuals:                     5382
Method:                           MLE   Df Model:                            3
Date:                Sun, 15 Mar 2020   Pseudo R-squ.:                0.009736
Time:                        18:25:16   Log-Likelihood:                -3659.9
converged:                       True   LL-Null:                       -3695.9
Covariance Type:            nonrobust   LLR p-value:                 1.621e-15
================================================================================================
                                   coef    std err          z      P>|z|      [0.025      0.975]
------------------------------------------------------------------------------------------------
Intercept                      -0.5187      0.044    -11.681      0.000      -0.606      -0.432
P_RELOCATIONS[T.1-TIME]         0.4028      0.068      5.931      0.000       0.270       0.536
P_RELOCATIONS[T.2-TIMES]        0.5562      0.078      7.098      0.000       0.403       0.710
P_RELOCATIONS[T.MORETHAN3]      0.4808      0.086      5.591      0.000       0.312       0.649
================================================================================================
                                  2.5%     97.5%  Odds-Ratio
Intercept                     0.545670  0.649423    0.595291
P_RELOCATIONS[T.1-TIME]       1.309541  1.708979    1.495987
P_RELOCATIONS[T.2-TIMES]      1.495753  2.033564    1.744050
P_RELOCATIONS[T.MORETHAN3]    1.366465  1.914189    1.617304
```

Table 4.26 The relationship of facility closing and surrounding conditions

```
                            OLS Regression Results
==============================================================================
Dep. Variable:            CLOSED_PROP   R-squared:                       0.132
Model:                            OLS   Adj. R-squared:                  0.085
Method:                 Least Squares   F-statistic:                     2.336
Date:                Tue, 17 Mar 2020   Prob (F-statistic):             0.0632
Time:                        15:42:08   Log-Likelihood:                -3.8748
No. Observations:                  79   AIC:                             17.75
Df Residuals:                      74   BIC:                             29.60
Df Model:                           4
Covariance Type:                  HC3
================================================================================
                   coef    std err          z      P>|z|      [0.025      0.975]
--------------------------------------------------------------------------------
Intercept          0.6454      0.218      2.961      0.003       0.218       1.073
NON_NE_PROP        0.3134      0.150      2.094      0.036       0.020       0.607
F_SOCIAL_ASSIT    -0.2475      0.305     -0.811      0.417      -0.845       0.350
POP_VAR           -0.3043      0.403     -0.755      0.450      -1.094       0.485
F_WEEKLY_HOURS    -0.5285      0.409     -1.293      0.196      -1.330       0.273
==============================================================================
Omnibus:                        3.784   Durbin-Watson:                   0.254
Prob(Omnibus):                  0.151   Jarque-Bera (JB):                3.607
Skew:                          -0.520   Prob(JB):                        0.165
Kurtosis:                       2.881   Cond. No.                         20.4
==============================================================================
```

Table 4.27 The relationship of left the field physicians and surrounding conditions

OLS Regression Results

Dep. Variable:	LEFT_PROP	R-squared:	0.496
Model:	OLS	Adj. R-squared:	0.469
Method:	Least Squares	F-statistic:	15.10
Date:	Tue, 17 Mar 2020	Prob (F-statistic):	4.52e-09
Time:	15:42:08	Log-Likelihood:	41.438
No. Observations:	79	AIC:	-72.88
Df Residuals:	74	BIC:	-61.03
Df Model:	4		
Covariance Type:	HC3		

	coef	std err	z	P>|z|	[0.025	0.975]
Intercept	0.1368	0.171	0.800	0.424	-0.198	0.472
NON_NE_PROP	0.5547	0.091	6.118	0.000	0.377	0.732
F_SOCIAL_ASSIT	-0.0577	0.120	-0.481	0.630	-0.293	0.177
POP_VAR	-0.1678	0.234	-0.716	0.474	-0.627	0.292
F_WEEKLY_HOURS	-0.1960	0.540	-0.363	0.717	-1.255	0.863

Omnibus:	22.106	Durbin-Watson:	1.906
Prob(Omnibus):	0.000	Jarque-Bera (JB):	70.559
Skew:	-0.756	Prob(JB):	4.77e-16
Kurtosis:	7.376	Cond. No.	20.4

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