WOMEN'S HEALTHCARE PROVIDERS SERVING PORTLAND, OREGON:

FACTORS INFLUENCING PATIENTS' CHOICE OF THE WOMEN'S HEALTHCARE ASSOCIATES, LLC

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Executive Summary

This document describes an analysis that attempts to determine the effect of various factors upon patients' choice of provider. This is done through the lens of the Women's Healthcare Associates, LLC using a combination of publicly available data sources and tabulations of patient history from the practice's electronic medical records.

This work begins with a literature review, surveying readily available research for theories regarding various influences of a patient's choice of provider. Type of provider, fiscal status of the patient, and the distance to available providers are found to be the leading factors of patients' decisions in the search. These elements are incorporated in a regression analysis to determine their effect upon market penetration of the Women's Healthcare Associates throughout the Portland metropolitan area.

The analysis attempts to model the patient population in several complex ways before determining that a simple model that accounts for fiscal status of zip codes, the distance to and number of Women's Healthcare Associate providers, and the distance to and number of competing providers is the most predictive. Other factors identified in the literature search were found to be insignificant, or caused our results to be less predictive than the simpler model that was used. Based upon our analysis, four strategic guidelines are presented for the consideration of the Women's Healthcare Associates.

First, clinics should always be placed, contingent upon other resource considerations not included in this analysis, in the middle of discrete population centers if the practice is considering expansion into an area with two comparable centers, such as Newberg and McMinnville. This is a mathematical conclusion based upon our understanding of the effects of distance.

Second, the practice should be aware of competitors moving into areas that provide a large number of patients as a result of little competition. A large number of patients could be quickly drawn away from the practice if a competitor were to set up a clinic nearby. In particular, we are referring to the areas southeast of the Oregon City clinic, and the I-5 corridor between Portland and Salem.

Third, the practice is most competitive relative to competing providers when they are within six miles of the area they are targeting. If the Women's Healthcare Associates wish to compete for a patient population within a specific area, these analyses suggest placement of a clinic within this distance will provide the greatest benefit in terms of market penetration relative to competitors.

Fourth, fiscal status has a direct relationship to market penetration for gynecology patients, but this relationship is less clear for obstetrics patients. This means that a difference in fiscal status has a measureable effect upon a gynecology population's chance of selecting the practice for their care. The inability of our model to find a direct relationship between obstetric patients and fiscal status means that it may be possible to operate an obstetric clinic in an area that otherwise does not provide many gynecology patients due to low fiscal status, and the practice should be sensitive to this possibility.

A variety of examples, figures, and tables are provided throughout the report to aid the practice. All data references in this written report can be explored in the companion data file. This file is written to display information in a geographic format, providing users with an intuitive sense of distance –which is a key factor in this analysis and recommendations – and the ability to explore specific areas of the market.

Background

The impetus behind this project is the recent changes occurring at the Women's Healthcare Associates LLC (WHA), including an increase of clinical practice locations following a recent merger. The WHA is a private obstetrics and gynecology practice operating in the greater metropolitan area of Portland, Oregon. The most recent iteration of the organization was formed in 1999, although many of the providers that make up the practice have been involved in precursory clinics to the WHA as early as 1978. The practice provides a full range of clinical women's health services such as annual examinations, in-office surgery and pregnancy care, as well as childbirth education classes, genetic counseling, and family planning services.

The WHA is home to a wide array of women's health providers, including obstetric and gynecological physicians, Maternal-Fetal Medicine specialists (perinatologist), Certified Nurse Midwives, Women's Health Certified Nurse Practitioners, and Genetic Counselors. These staff members provide care to a wide range of individuals with a variety of different circumstances; teenage girls transferring from a primary care provider, retired Medicare beneficiaries in need of minimally invasive surgery, first time pregnant women who want every test available, and fourth time mothers who want as little care as possible.

Despite being a very mature organization by private practice standards, the WHA devotes considerable effort towards keeping their appearance and operations up to date. Clinical locations are renovated on a regular basis, and have a very comfortable and modern appeal with each location customized to reflect the needs of patients; obstetrical offices provide a play area for children and reading material for both men and women, while the gynecology specialists provide a more reserved, "spa-like" atmosphere.

The practice has kept pace with technology, despite its rapid advance over the last decade. The WHA has completely committed to the use of Electronic Medical Records (EMR), and continues to improve the system to better suit their providers and patients. The organization website is simple to use, and shows a clear dedication to quality with its sleek design and quick response times.[1] The website includes a link to pay bills online, as well as a patient portal to request appointments, complete health history forms in advance of an appointment, and receive normal test results. The WHA goes even further by publishing a semi-weekly "Wellness Journal" that covers a wide array of women's health topics, with articles written by various members of the clinical staff. These things show dedication not only to aesthetic outcomes – though these are important to the patient experience - but also to health and wellness through meaningful use of new technologies

On October 1st, 2011, the WHA merged with two formerly competing practices, The Women's Clinic, and The Women's Health Center of Oregon. This process took place only after extensive talks with other women's health providers in the Portland area, and only after the WHA was convinced that all three organizations could share a common culture. With the completion of this merger the WHA drastically expanded its geographic presence to include the east and far southern sides of Portland, where they were previously limited to the west side of the river. The practice also drastically increased the number of providers on staff, from fewer than 50 full time equivalent providers to over 75. Brian Kelly, CEO of the WHA, estimates that with the addition of the two new organizations the WHA's providers will deliver somewhere between 10-15% of births in the Portland area next year. With such a large

[1] www.whallc.com

geographic presence and share of the provider market, WHA is capable of enacting strategic planning on a scale that is unavailable to most practice groups.

In anticipation of impending changes in the healthcare system due to the Patient Protection and Accountable Care Act (PPACA), the WHA hired a consultant to provide recommendations for the organization regarding the Accountable Care Organizations (ACO) in development by the Centers for Medicare & Medicaid Services (CMS). One of the most notable differences of ACOs is payment reform, substituting fee-for-service models for a variety of more outcome-dependent reimbursement structures including capitation and global payments (both for individual patients and patient populations as a whole). The recommendation by the consultant was to develop stronger ties with primary care providers, as these were likely to become the "gatekeepers" of care under the new ACOs.

A key difference of ACOs from the Health Maintenance Organization (HMO) model is that a patient does not need a referral to see a specialist. Therefore even if ACOs and their state sponsored counterpart, Community Care Organizations (CCO), are successful in creating a network of "gatekeepers" for their patient population, some portion of these could ignore these gatekeepers entirely and base their decisions upon other factors. Additionally, ACOs will not represent the entire patient population and it will be quite some time before they are widely implemented, if at all.[2] Therefore, it is prudent for the WHA to continue to be actively catering to their patients in order to be a successful and effective provider of women's health services.

An analysis of primary care providers serving the Portland metropolitan area displayed WHA's patient population in a geographic format, and this prompted questions about influences on the population. One of the areas which prompted these questions was downtown Beaverton (97005). This area seemed to defy the intuitive visual pattern of market penetration; five of the six zip codes surrounding 97005 provided the WHA with more patients relative to population. What was the explanation for this difference? Was it because this zip code had a far lower income per capita than the surrounding areas? Or was this difference caused by the presence of a large Kaiser Permanente clinic? Or is it perhaps the Planned Parenthood clinic centrally located in downtown Beaverton?

Another visually interesting area was to the southeast of the Oregon City clinic, where distance seemed to have a much smaller effect upon a patients' choice of the WHA; the cities of Molalla (97038), Canby (97013), Mullino (97042) and Beavercreek (97004) seemed to furnish an extraordinarily high number of patients relative to population with little obvious decline as distance to a WHA clinic increased. Is this due to an even distribution of income in the area? Or is this caused by a lack of competitors?

This analysis seeks to answer these, and other similar question about the Portland metropolitan market.

Research Question

What factors that can be observed and influenced by the WHA have an effect upon the number of patients that seek out the organization for their care? How can these factors be used to guide strategic decision making which is supported by a rigorous analysis of the market?

[2] There is currently no timeline for the rollout of ACOs beyond the demonstration level, although Oregon has mandated that all state assistance will be delivered in CCOs by 2017 at the latest.

Literature Review

As the first step of this analysis, a literature search was conducted in order to identify the thoughts and theories already present in the field. This search attempted to find research articles that used econometric models to describe patient choice of provider. It was determined that scholars have previously considered quality information, provider type, provider gender, fiscal status and distance to providers.

Quality Information on Providers

The first factor we will consider for our model is quality information. Specifically, we want to know if research supports the use of quality indicators in an econometric model of provider selection. In most cases this would only include *indicators* of quality rather than measures of actual quality *outcomes*,[3] as it is generally very difficult for consumers to obtain the latter. However, the literature search revealed studies that have considered both sorts of quality information.

A study by Haas-Wilson and Savoca pursued a measure of the effect of quality of outcomes upon choice of provider (1990). A survey of contact lens wearers conducted by the Federal Trade Commission was used in conjunction with a representative sample of eye examination performed by three specialists. The examinations noted the presence of pathological conditions and transformed these into a single score for each participant. This served as a direct measure of quality rather than a proxy such as years of practice experience or licensure level (e.g., optometrist vs. ophthalmologist). The interesting result of this study is that quality of care, as measured by an outcome rather than an indicator, had little effect upon patient choice. This is not terribly surprising, as gathering quality information required an extensive study of multiple factors on a large sample of patients, and this seems like far too great a barrier for a consumer to incorporate quality outcomes into their decision making. This notion is supported by several studies that consider human decision-making and measured the effects of the complexity of provider quality information (Hibbard and Peters, 2003; Peters et al., 2007). These studies assert that simple presentation of quality information is crucial to its usefulness, and the later of the two found that quality information that included fewer indicators and more intuitive interpretations (e.g., a 5-star system versus an array of outcome statistics) of the information were more likely to be used by consumers when choosing a provider.

However, even readily available and accessible indicators of quality, such as quality "tiers" which are set by insurers, often do not have a strong effect upon patient choice. One study sought to determine the strength of differential copayments as compared to recommendations from physicians or friends, while controlling for factors such as gender, race, age, household income and self-reported health status (Sinaiko, 2011).The study found that without any other information to base a decision, such as a recommendation, individuals were responsive to rather ambiguous indicators of quality; patients were

[3] This distinction is important as most indicators of quality that are considered by consumers are culturally based, rather than empirically based. For something as nebulous as health, these culturally-based indicators of quality can have little relation to actual outcomes.

more likely to choose a 'Tier 1' provider than a 'Tier 2' with all other things held constant.[4] However, this quality indicator was found to be quite weak in comparison to even moderate differences in copayment. Furthermore the subjects of the study were forced to make an "either or" decision which does not accurately model choice of provider for many patients.

In a separate work, Hoerger and Howard conducted a survey on search-behavior of pregnant women in Florida (1995). The authors found that quality information plays a very small role in the selection of a provider, primarily because few women bothered to seriously consider more than one physician (i.e., very little searching was actually done). The authors felt confident in generalizing this result because pregnancy affords considerably more time to select a provider than many other medical needs, so pregnant women should search the most out of all patients. The authors suggested that most pregnant women will have either (1) a direct connection or recommendation to a particular provider or (2) a convenient relationship based on geographic proximity or health insurance guidance. An interesting result of a survey administered in this study found 55.7% of women claiming that physician expertise was the most important factor in their selection of a physician, yet the search-behavior data did not support this claim.

A study by the Robert Wood Johnson Foundation posits that the information which is publicly available is not accessible enough to be worth seeking in a provider search (2008). Additionally, this information often includes quality indicators that are not meaningful to the general public. Most individuals will rely upon personal recommendations in lieu of accessible quality information.

Given the body of evidence above, the literature seems quite clear in its indication that quality information is not a strong predictor of patient choice of provider. Although some models propose that seriousness of condition makes patients more responsive to quality indicators, our study excludes the most high-risk pregnancies of the WHA, and therefore we will not attempt to incorporate quality information into our model.

Provider Type

A study by Schmittdiel et al., on the preferences of women for basic gynecology care used multivariate analysis to determine the factors which influenced the odds of selecting certain providers (1999). The results of particular interest to this analysis were the factors which predict preference of a medical doctor (MD) over a nurse practitioner (NP). This is interesting because it helps to build a theory of the difference in effect between certain types of providers. The study found that the strongest predictor of a patient choosing an MD was whether or not they saw an MD at their previous obstetric or gynecological visit. However, the second strongest predictor (although considerably less strong) was race, with non-white patients being almost half as likely to choose an NP for their care.[5]

[4] Insurers often rate providers in tiers, and charge differential copayments. The purpose of this practice is to encourage patients to choose providers that are more cost-effective for insurers. Although there are other factors which may make a provider a more cost-effective choice for an insurer, the primary mechanism is long-term quality of care. Therefore, the tier system will indicate a relative quality between providers.

[5] There is considerable evidence in support of race being a strong predictor of patient choice of provider, particularly when one considers perceptions of discrimination (Malat and Hamilton, 2006; Schofield et al., 2007). We will not use race in our analysis because of the limitations of our aggregate data, but this would be a useful factor to consider in future studies.

Provider Gender

To consider the influence of provider gender upon patient choice, we begin with the Schmittdiel et al article. In referring to provider gender, we are getting at the stated preference by women for *female* providers of women's health services. Only half of the women surveyed stated a preference for provider gender, with five times as many women preferring female providers to male. The remaining half of women stated that they have no preference for provider gender (Schmittdiel et al., 1999). A more recent survey confirmed that a little over half of women express a preference for a female provider (Zuckerman et al., 2002). However, the question that remains is whether or not this actually influences patient choice, or if this is a part of a constructed consumer preference in the same way that quality information is a constructed preference (Bettman et al., 1998).

The first study found in its multivariate model that just like preference for provider type, the strongest predictor of a preference for a female provider was the patient having a female provider at their previous visit (Schmittdiel et al., 1999). This further drives home the notion that much of patient choice is driven primarily by past experience, as patients seem to prefer familiar circumstances rather than particular ones. Zuckerman et al. also confirms the effect of past experience, with the most significant independent predictor of actually choosing a female provider being patients that currently have a female provider (2002).

Unfortunately the methods used to build our database of providers did not allow me to identify the gender of each individual provider, and therefore we will not make use of this factor in our model. However, this would certainly be a useful to consider in future analysis.

Fiscal Status

One of the recurring themes in the literature on patient choice of provider is price (Sharma et al., 2003; Sugerman et al., 2000; Zuckerman et al., 2002). Specifically, the (perception of) price has a measurable influence upon consumer choice of provider, with most patients making some cost-benefit decisions based upon the price of services provided. However, our data source constrains us from accounting for specific services, and therefore it is difficult to incorporate price per say. Instead, we will make use of average income levels to account for *sensitivity* to price. "Price elasticity of health care is higher for the poor than the rich" (Borah, 2006). For our purposes this means that if the services of the WHA are too expensive for some patients, then the decisions of patients with lower incomes should be more affected than those with higher income.

Distance

A study of patient choice of provider in India used a complex method and a wide range of individual data obtained from the socio-economic survey by the National Sample Survey Organization of India (Borah, 2006). One of Borah's written conclusions was that "people generally do not want to travel greater distance to a provider" (page 929, 2006). This is a logical influence of decision-making models, as increasing distances are associated at the very least with greater investment of time, and typically increase the financial cost as well due to travel. A separate study sought to determine the effects of distance upon utilization of Veteran's Administration (VA) services (Burgess and DeFiore, 1994). Although the results of this study are not greatly applicable to our research question, as a VA beneficiary has little choice of provider, the results did find that greater distances reduced utilization of services. This supports the conclusion of the Borah study.

An early study by Bronstein and Morrisey does provide some useful guidance on modeling patient choice according to several factors including distance (1990). The authors attempted to model the effects of distance by monitoring the changes in utilization of obstetric services in rural hospitals after the closure of several obstetric departments throughout the area. Unfortunately the study was not able to model distance with great accuracy, as their study was forced to use linear measures of distance instead of actual measures of travel distance due to technology constraints. Their conclusions, though, seem to suggest that the willingness of women to travel is very fluid, and responds to their perceptions of service in the surrounding areas. This indicates that our results in regard to distance will most likely be limited to the Portland market, and not applicable other metropolitan markets.

Family Planning Clinics

Family Planning Clinics affect the patient populations in a number of ways, including type of provider, distance to provider, and fiscal status. These first two are intuitive, and would not necessarily require that we consider family planning clinics in a different way than other providers of women's health. However, the relationship with fiscal status makes this influence somewhat more complicated. A study of Planned Parenthood patients in Los Angeles found that many women cited cost as driver behind their use of the subsidized service (Sugerman et al., 2000). Some patients were simply uninsured and therefore more sensitive to price than the insured, and sought out the most affordable care possible. Many others were insured, but were there because of a need for confidentiality and paid for their services out of pocket, which we would also expect to make them more sensitive to price. We expect that the presence of county health centers and free family planning services (such as Planned Parenthood) in the Portland area establish an inferior-normal good market with other providers. What this means is that even though some women's health services might be unavoidable, there is a low-cost alternative to the WHA. Therefore we expect that as fiscal status decreases, consumption of free and low cost centers increases and the consumption of other providers, including the WHA, decreases.

Summary of Review

Our literature search revealed that quality indicators have long been a factor of interest in patient choice of provider, but have failed to stand up to the scrutiny of multivariate modeling. Provider gender has also been heavily investigated (particularly female providers of women's health), and has been found to be a significant influence on choice, but the effect is quite small.

The type of provider, specifically physicians versus non-physicians, has been substantiated as an influential factor on patient choice of provider. The literature regarding patient choice has found evidence to support price and fiscal status as influencing choice of provider, and this is intuitively a reasonable finding. In conjunction with price, we will attempt to incorporate the presence of family planning clinics. Distance is also found to be a highly influential factor, and the evidence supports this notion. However the specific effects of distance appear to be rather fluid depending upon the individual market. The analysis will attempt to incorporate all of these factors into the regression model in some fashion.

Model Framework

In order to determine which factors actually influence a patient's choice of provider - as opposed to those which they believe influence their choice but in fact do not - we will construct an econometric model using public data sources and WHA records.

Scope

Before beginning to collect data for a regression model, we first have to define the unit of analysis and the scope of our data. Our unit of analysis is zip code areas. What this means is that all of the data which is put into our regression will be descriptive of a zip code (e.g., the number of WHA patients which live within the zip code area). Our unit of analysis was chosen based upon information constraints, as it would require considerably more effort to build a model using individual data, both for legal and technical reasons. Aggregate data satisfies HIPAA requirements because it includes no individually identifiable information, and tabulating counts of individuals according to zip codes allows for a simple survey of WHA's EMR to collect the necessary data.

For this analysis, our scope includes both a geographic and temporal component. The patient population of the WHA is considered to be all women who had one or more appointments with the organization (excluding those who received care from the Northwest Perinatal Center) between November 2009 and November, 2011. [6] Each woman is counted by the first appointment that falls within the period of analysis. The selection of the time period was difficult, as we wanted to include as many patients of the WHA as possible (even those who don't schedule annual appointments as recommended) without including too many individuals that have long since stopped considering the WHA as their provider. After discussing the matter with staff, two years was decided as the best period of analysis to accurately represent the WHA's patient population. It should be noted for any future analysis that market penetration will always increase with longer periods of analysis, but at least some of the increase is a sampling effect and should not be confused with actual changes in market penetration.

In addition to the temporal restriction, this analysis will include only areas which provide 30 or more patients within the period of analysis and are contiguous to the zip codes in which WHA clinics reside. The former is chosen for statistical purposes as thirty is commonly considered a rule of thumb for the smallest possible sample for use in statistical analysis.[7] The latter is used to avoid a cumbersome definition of the relevant market, as without it we would have to include zip codes far to the west on the Oregon coast, and far to the east in Hood River.

These two criteria leave us with a total of 110 zip codes in the relevant market, which accounts for 69,542 or approximately 92.7% of all unique patients of the WHA (excluding the Northwest Perinatal Center patients) during this period.

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[6] Marketing staff requested this exclusion because the patients of the Northwest Perinatal Center are high-risk pregnancies. These kinds of patients make up a small portion of the WHA's total patient population, and are generally referred to the practice by another provider. Therefore, the influences of these patients choosing the WHA are very different from the rest of the population and should be analyzed separately.

[7] Although this project does not attempt to derive statistics on individual zip code areas, it would be entirely possible that this could be done in the future and it seems prudent to position our dataset for this possibility.

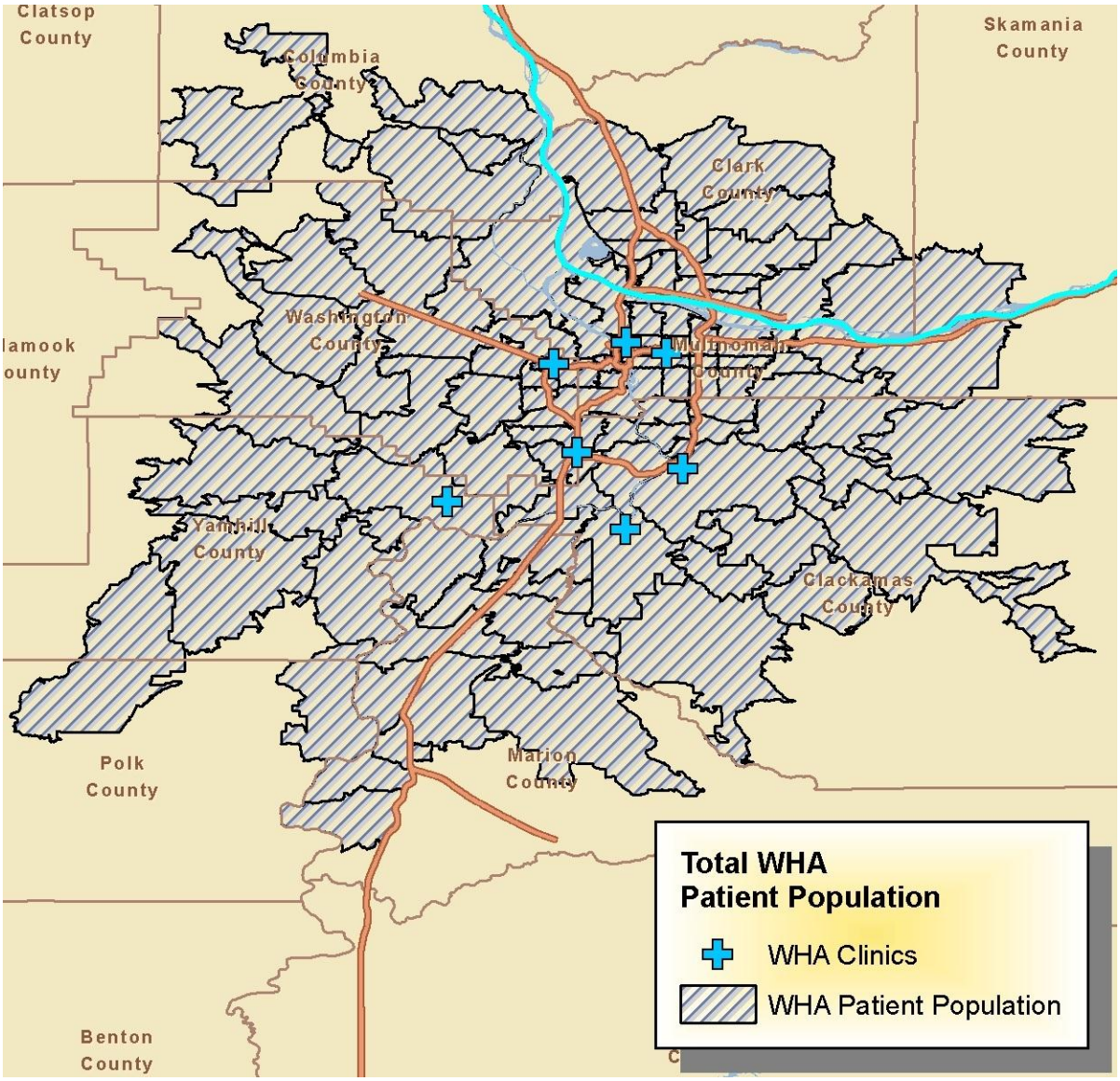

Figure 1

Figure 1 provides an outline of the qualifying zip code areas and the extent of the entire relevant market for this analysis. The relevant market to the west includes McMinnville and the surrounding areas. The east includes Gresham. The North includes both Vancouver and Battleground. South includes only a portion of Salem, as the southern area did not provide enough patients during the period of analysis to satisfy our minimum patient criterion.

Patients per Thousand – The Outcome Variable

Patients per Thousand (PPT) will serve as our outcome variable in this analysis. From a short-term financial perspective absolute patient volume is probably most useful. For long-term strategic planning PPT seems more appropriate because (1) establishing high market penetration in a developing area can lead to a large increase in volume if PPT is constant and (2) PPT gives an intuitive sense of diminishing returns in market penetration. Figure 2 shows the absolute patient volume, and one can see that the vast majority of WHA patients are centrally located in the market.

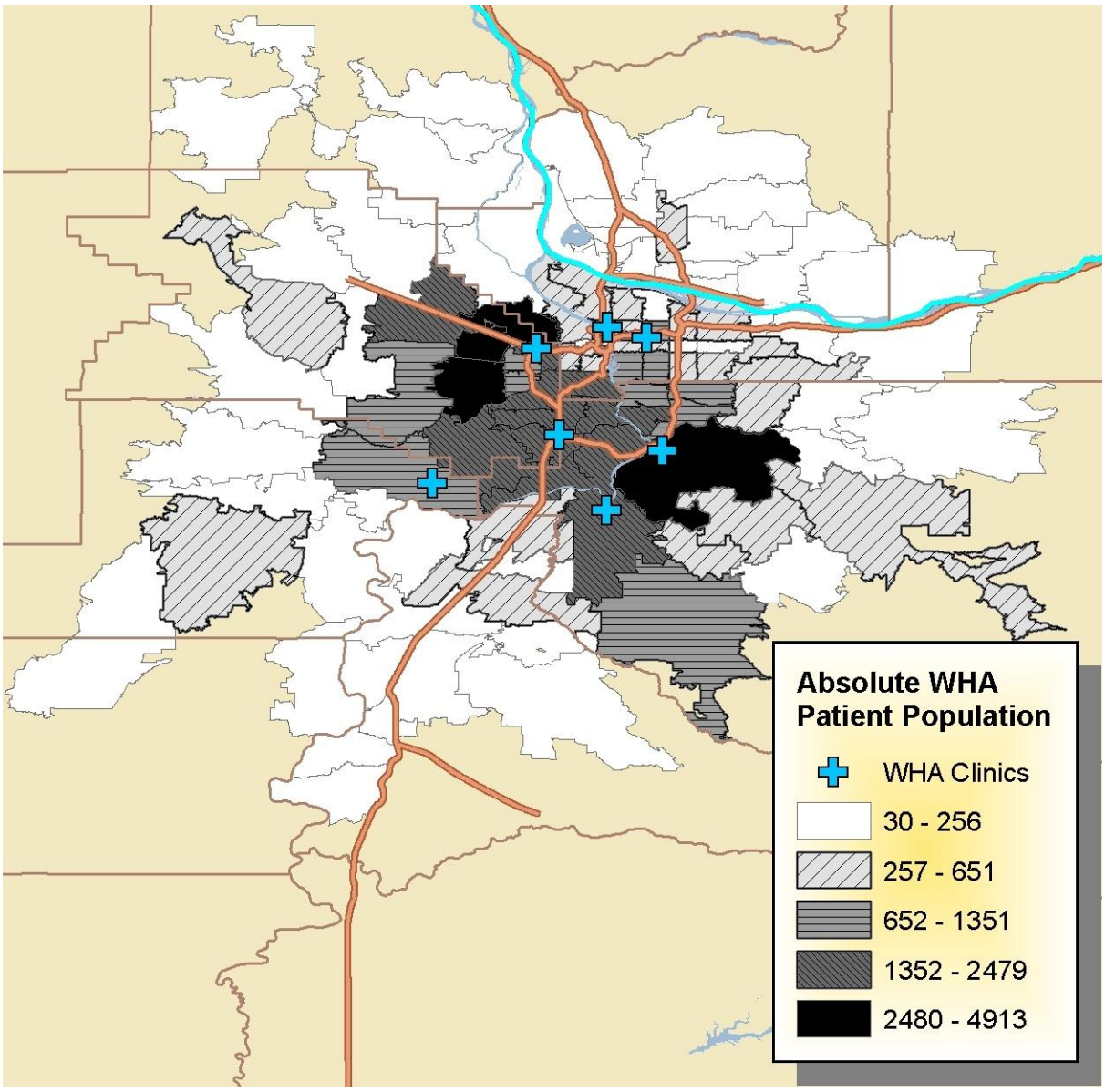

Figure 2

When we adjust our graph to show PPT instead of absolute patient volume, we see a slightly different distribution. Figure 3 shows that our patient population is not quite as concentrated in the Beaverton-Tualatin-Oregon City area when viewed from the perspective of market penetration. However, this

figure also reveals that our market penetration in east Portland is almost negligible. In order to calculate PPT, we first take the absolute value of patients from each zip code (depicted in Figure 2) and divide by the potential patients living in the zip code. Potential patients were deemed to be females more than 15 year's old living in the zip code area according to the 2010 Census.[8]

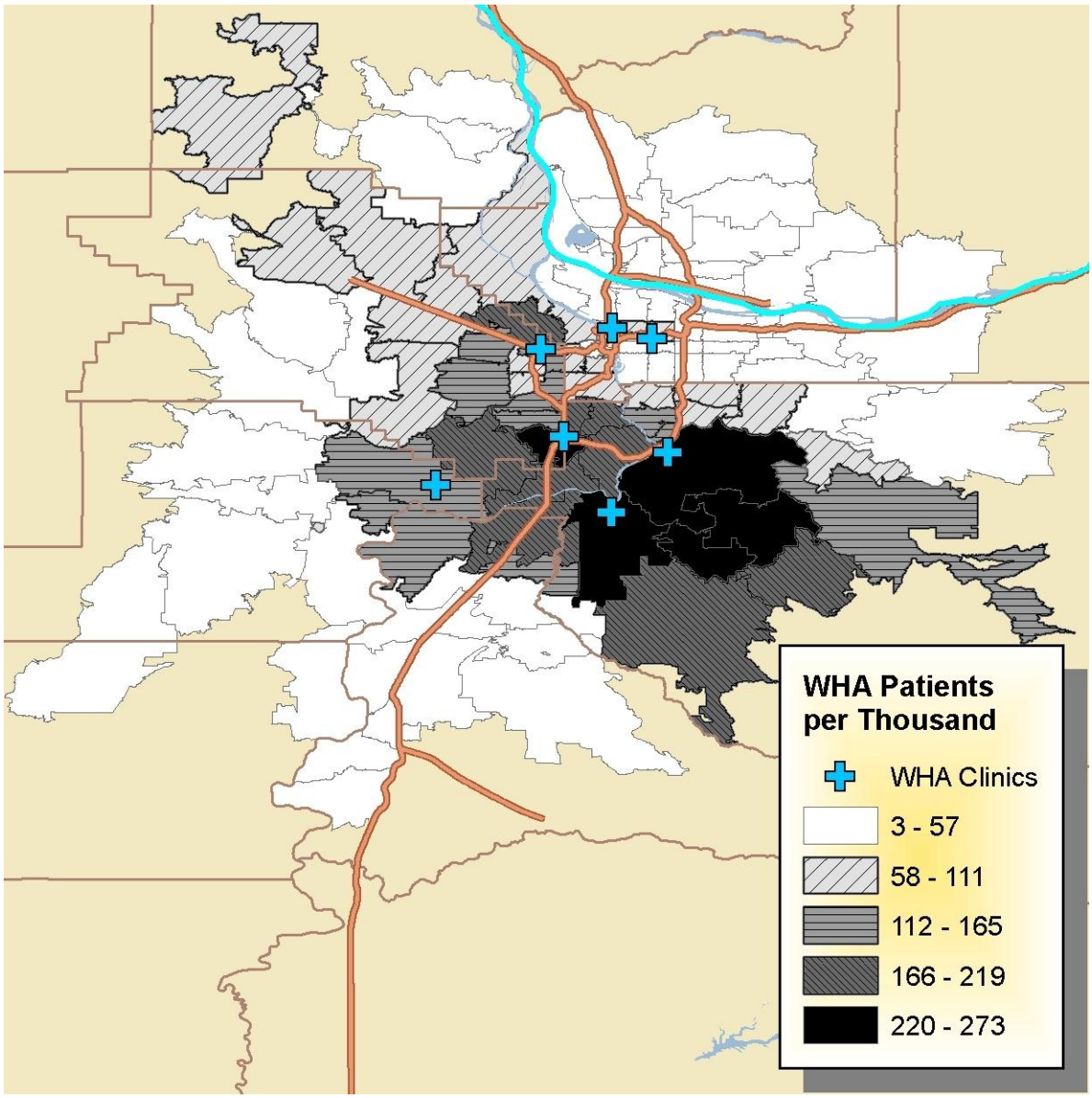

Figure 3

[8] There is a potential methodological problem here, as the best estimate of potential patients would be the average number of potential patients throughout the period of analysis, Nov. 2009 to Nov. 2011. However, because this data is not readily available at the zip code level, we must approximate with the 2010 Census figures. This estimate will be most inaccurate in areas of extreme population change or atypical age distribution that would drastically vary the number of potential patients over the course of two years.

Figure 3 shows the market penetration of the WHA. We can now see both of the visual anomalies discussed in the background section; downtown Beaverton sits near the bottom of our scale despite being very close the clinics located near St. Vincent's hospital, and the area southeast of Oregon City shows remarkably high penetration despite considerable distance from our clinic.

For our regression analysis, we will split the WHA patient population into two groups: gynecology PPT, and obstetric PPT. These two groups are shown in Figure 4 and Figure 5, respectively. We make this delineation because we expect the relative differences of market penetration between these groups will be explained by different factors, and will indicate multiple strategies to make the WHA more attractive to both gynecology and obstetric patients. In particular, we notice that relative market penetration on the east side of the river is much better for gynecology patients than for obstetric.

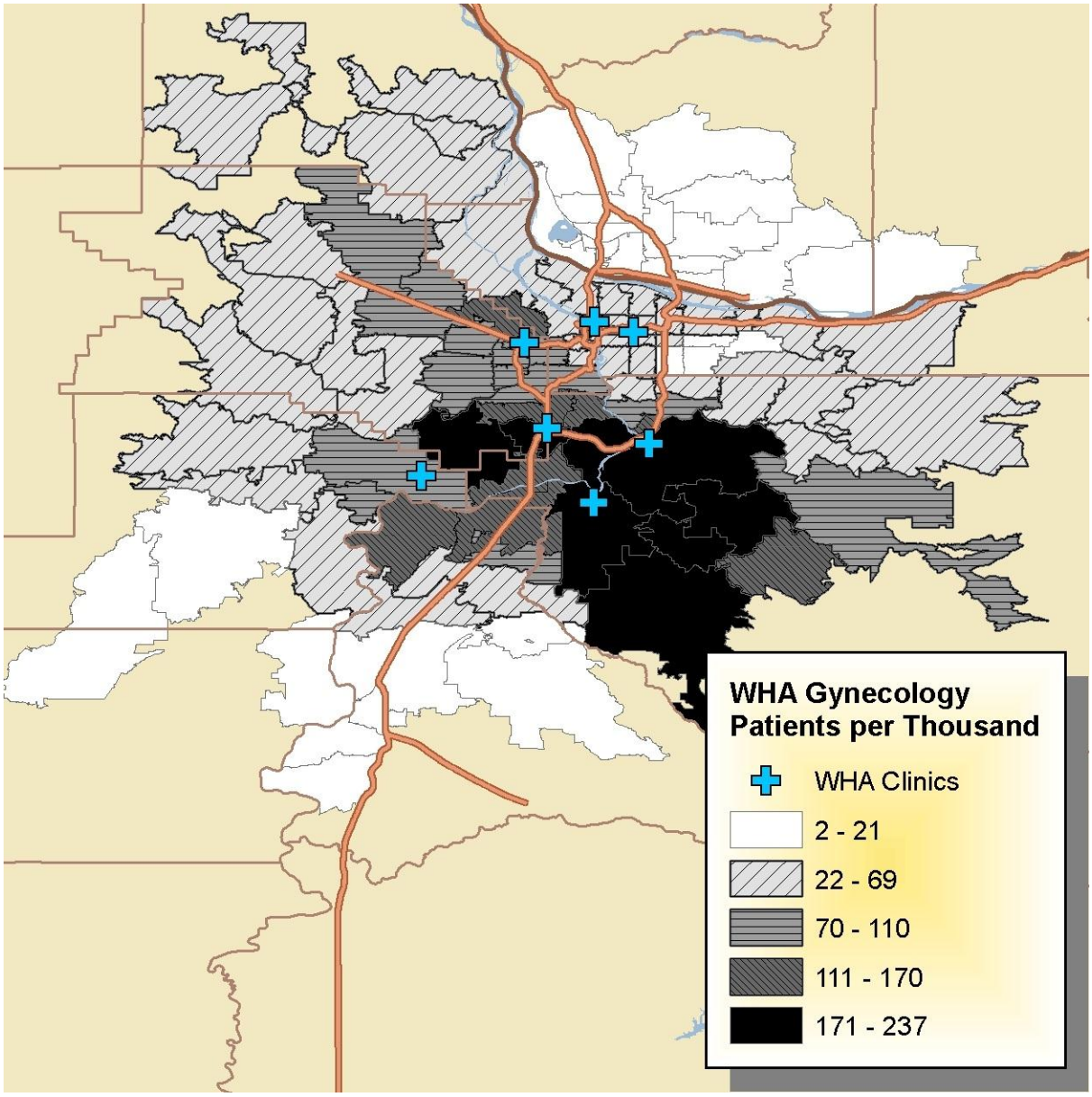

Figure 4

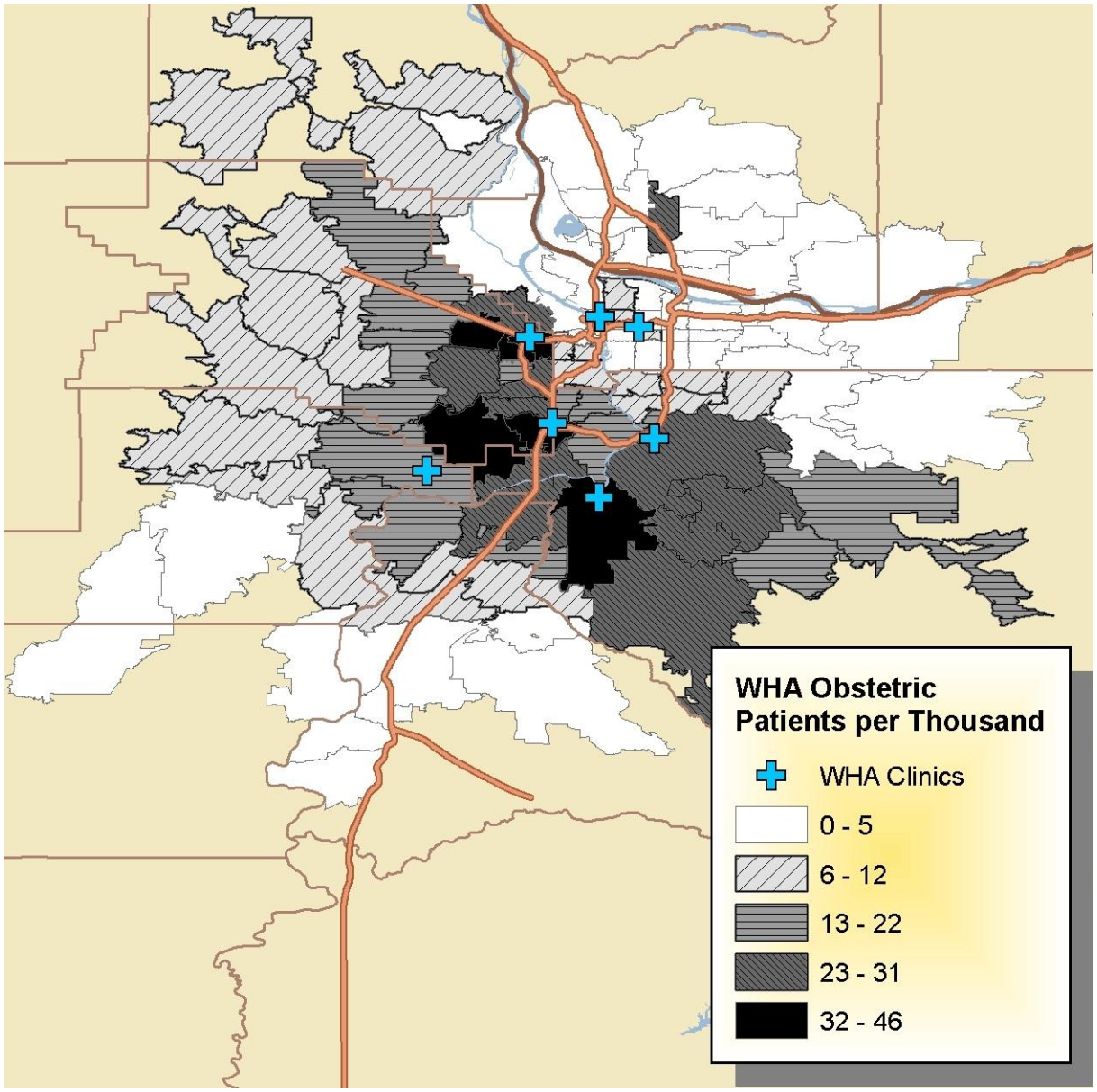
WHA Obstetric
Patients per Thousand
WHA Clinics
0 - 5
6 - 12
13 - 22
23 - 31
32 - 46

Figure 5

Explanatory Variables

In this section I describe the operationalization of the various factors expected to influence a patient's choice of the WHA as their provider, including Adjusted Gross Income per Capita, family planning centers, distance to providers, and types of providers.

Adjusted Gross Income per Capita (AGIPC)

As indicated during the literature search section, fiscal status is considered an important factor in access to health care. Although there are many possible ways to measure this concept, the one that we choose for this analysis is income per capita. Income per capita is chosen in lieu of household income, because household income varies drastically according to family size; a family of 8 may make $120,000 annually, but this is certainly a different fiscal status than a family of 2 that makes $120,000. Because of a procedural issue with the 2010 Census, income per capita is not available at the zip code level and we are forced to compute it using a different public data source.

The Internal Revenue Service makes records of individual tax returns, as tabulated by zip code area, publicly available on their website with the most recent year being 2008. These records include a sum total of the adjusted gross income for each zip code. Adjusted gross income is the gross income of an individual minus specific deductions. Most of these deductions are non-health related and, therefore, make this figure a more accurate representation of an individual's ability to spend upon health related services. The only exception to this is the deduction of a Health Savings Account (HSA). However, we find this to be small enough as to not be problematic for our purposes.[9]

We then take the aggregate adjusted gross income for each zip code and divide it by the total number of individuals living there using 2010 Census data (unfortunately there is no public data source which includes population information at the zip code level in 2008). The result is an estimate of the average adjusted gross income of each individual, or Adjusted Gross Income per Capita in 2008.

For the purpose of interpretation, AGIPC is adjusted for inflation to 2011 values.[10] For our model we will transform AGIPC in a standard econometric way, using the natural log of AGIPC for our income variable. This technique models decreasing elasticity for women's health services as fiscal status increases.

We expect that AGIPC will have a positive coefficient, indicating that as fiscal status increases in an area, potential patients are more likely to choose the WHA for their care.

[9] In 2008 the HSA deduction could have been as high as $2900 per individual. However, these accounts were very much in their infancy during 2008. According to a study by the American Health Insurance Plans advocacy group, there were approximately 6 million individuals covered by an HSA in January 2008, which was less than 2% of the American population at that time. Because this percentage is small, I assume that the impact on AGIPC is small as well. For future studies, it may be necessary to re-consider this assumption.

[10] The Bureau of Labor Statistics inflation calculator states that $1.00 in 2008 is equivalent to $1.04 in 2011.

Family Planning Centers

We established in the literature review that we would like to use fiscal status as part of an interaction effect rather than in addition to a direct way. To do this, we will create an interaction variable between AGIPC and the distance to Family Planning clinics. Unfortunately, there is little data regarding the number and types of providers at these locations. In the case of Planned Parenthood this is partly for security reasons. For the county clinics, this dearth of information is unexplained.

Because we cannot easily account for the number and type of providers at each family planning clinic, we will only use distance to each clinic, and consider all family planning centers to have an equivalent effect. In order to construct an interaction effect between the distance of these clinics and fiscal status, we will divide our family planning variables by the natural log of AGIPC, because we expect lower fiscal status to increase the use of these clinics.

We expect that the Family Planning-Fiscal Status interaction variable will have a negative coefficient, indicating that lower fiscal status and proximity to family planning clinics will decrease the likelihood of patients choosing the WHA for their care.

Provider Quantity

It goes without saying that the number of patients that a clinic attracts is directly related to the number of providers. What we are attempting to determine with this information is the effect of a WHA provider as compared to the effect of a competing provider on patient populations (i.e., how many patients will a WHA provider attract to the organization versus how many patients will a competing provider pull away). This requires two separate variables to model: one for WHA providers and one for competing providers. The types of providers which are counted in these variables include obstetricians, gynecologists, Women's Health Care Nurse Practitioners (WHCNP), Certified Nurse Midwives (CNM), Certified Professional Midwives (CPM), and lay midwives.[11]

The quantity of competing providers was determined using a list of individuals and organizations registered with the CMS in the National Provider Identifier (NPI) database. Provider types with an exclusive focus upon women were considered to be competitors and the respective Healthcare Provider Taxonomy Codes were used to search the NPI database. The list of provider types and their taxonomy codes are listed in Appendix A. This process generated a list of competing individual providers and practice locations that fell within 50 miles of the edge of our relevant market. The process of building a complete list of competing providers in the relevant market is detailed in Appendix B.

It is expected that the coefficient for WHA providers will be positive, while the coefficient for competing providers will be negative. This would indicate that the presence of a WHA provider increases the likelihood of patients choosing the WHA, while the presence of competitors decreases this chance.

[11] Maternal-fetal medicine specialists and their patients are excluded from the analysis as they operate under a very different kind of business model. Specifically, their patients are driven more by physician referral based upon risk, rather than other factors that can be readily influenced. Furthermore, the patient population of a perinatologist is far more widespread and difficult to model than low-risk women's health populations.

Provider Type

In order to account for differing effects by provider type, we will attempt to build several models in stages. The first will count the provider types equally, separating competitors from the WHA as indicated above; all relevant providers will be summed providing one value for WHA providers and another for competing providers.

The next model will separate physicians from non-physicians to see if different provider types have a different effect upon our patient populations. This will provide us with twice as many variables as the first model. It is expected that the coefficients for WHA providers will all be positive while competitors will be negative, but that the coefficient strength for different types of providers will vary. This would indicate that different types of women's health provider have different effects on the likelihood of patients choosing the WHA for their care. At this point we do not have a theory as to whether physicians or non-physicians will have a greater effect upon our patient population.

Provider Distance

The third component necessary to account for the effects of providers is their distance to the patient population. To calculate distance to each zip code, we use delivery based centroids. US Postal Office delivery weighted centroids are essentially geographic points that represent the "average" location where deliveries are made in a zip code based upon the distribution of deliverable addresses. Because deliverable addresses closely mirror population density, centroids serve as a specific point to represent the average location of any given person in a zip code area. Using centroids as our starting point, we can determine the driving distance to the practice address of all the providers on our list. This information will help us to understand the willingness of patients to travel as represented by the market penetration in an area in relation to its distance from providers' offices.

Intuitively it would seem that the effect of distance on patient populations is unlikely to be linear (e.g., one provider one mile away does not have an identical effect as 100 providers 100 miles away). This prevents us from using a simple interaction between distance and number of providers, such as division or multiplication. Our solution to this is to create multiple variables to represent providers at various distance ranges, allowing our model to adjust the strength of each coefficient independently of the others. We will use five distance variables for each provider variable that we have described so far.

To imagine a brief example of this method pick a zip code area and count the number of providers (either WHA or competing, but not both) less than 1 mile away. Then count the number of providers 1 to 2 miles away, 2 to 3 miles away, and so forth. The count of each of these separate ranges will serve as an individual variable in the model, and this method is repeated for all 110 zip codes. An example of this method may be found in Appendix C.

We expect that as distance increases, the coefficient will decrease in magnitude. This indicates that providers further away from a patient population have less of an influence upon the likelihood of choosing the WHA for their care.

Regression Model Analysis

In our regression model, the coefficients (β) of each variable describe the change in PPT of a given zip code when the associated variable changes by a value of one, holding the other variables in the model constant. Our statistical method is ordinary least squares which does not make use of robust standard error. This method is chosen based upon the belief that the variation which is not predicted by the model is evenly distributed, and does not suffer from heteroscedasticity. Put another way, our model does not account for sub-populations of zip codes that have different variability than others. By tradition, variables that have a p-value larger than .05 are typically considered insignificant although this is a somewhat arbitrary threshold.[12]

The model describes the current market system as is and provides no guarantee that the effects and the relationships will remain static. For example, if fuel prices were to double in the next five years it is very likely that the effects of distance would become much stronger. Alternatively, if all of the roads in the Portland market were widened and traffic decreased, then we might expect the effects of distance to become weaker. If a competitor were subjected to a well-publicized lawsuit, the effects of competing providers would likely become weaker. The point of these examples is to assert that our model describes a *closed* system, and the moment that conditions begin to change we must expect the strength of the relationships assessed in the model to change as well.

However, with strong theories and careful understanding, the WHA can use this model to assist in their strategic planning. These econometric interpretations can serve as a solid base for quantifying responses by the market, making reasonable margins of adjustment based upon experience and knowledge of the reader. It is expected and encouraged that the executive staff will continue to make the same kinds of careful strategic decisions they have made in the past, while using the findings of this analysis to more precisely quantify their expectations.

The reader should bear in mind that our regression model is run twice – once for obstetric patients and once for gynecology patients – and therefore there are two sets of results to interpret. Additionally, the types of providers which are counted in each analysis differ. Modeling of obstetric patients will account for ob/gyns, obstetricians, CNMs, CPMs, and lay midwives in its variables. Modeling of gynecology patients will account for ob/gyns, gynecologists, and WHCNPs in its variables. In order to present the results of our analysis in a logical way, we will separate the discussion by the two patient types.

Although we discussed the use of an interaction variable between family planning clinics and income in the framework section, alternative models that attempted to incorporate this variable were less predictive than those which made use of fiscal status as a standalone variable.[13] Also, models which attempted to determine the effects of differing types of provider were highly insignificant. Though this

[12] This means that the chance of an explanatory variable only appearing to have a relationship to our outcome variable is too high for us to accept without strong justification; said relationship has a greater than 5% chance of being the result of random variation, which is considered a standard threshold. When the p value is greater than .05, we cannot reject the null hypothesis that the variable has no effect on the outcome of interest.

[13] The model which included the interaction variables did seem to be influenced by the family planning in a structured way, with the strength of the coefficient declining as distance increases, and the p value increasing as variation between zip codes decreases with increasing distance. Additionally, all but one of the interaction variables were insignificant, and the attempt to account for the effects of family planning clinic was abandoned for a simpler model of Income Effects.

does not allow us to say that all women's health providers are equivalent to one another, it forces us to run our model as if they were. Our model ultimately made use of 11 variables.

The first ten variables in each regression model are grouped into two general categories: Organization Effects which describe the change in PPT as a result of WHA providers at various distances, and Competitor Effects which describe the change in PPT as a result of competing providers at various distances. The values of distance variables are a simple count of the number of providers within the listed distance to a zip code.[14] The method of calculating the distance variable for each zip code is described in Appendix C.

The 11th variable in each model is an indicator of fiscal status, calculated as the natural log of AGIPC. The use of a logarithmic function allows a linear regression to account for different elasticity of demand at different income levels. Although this transformation is more accurate than a linear account of fiscal status, it also makes interpretation more difficult.[15]

[14] The array of distances was subjected to a series of "robustness" tests for both obstetric and gynecology populations, where distances for each variable were adjusted and recalculated. These tests found that variables greater than 20 miles for both the Competitor and Organizations effects were insignificant. It is suspected that this is primarily a result of little variation between zip codes at this distance, rather than providers between 20 miles away having no effect. The robustness tests also found that variables of 0-2 miles or less were insignificant, likely due to the fact that few zip codes have many providers within this distance. Ultimately, a series of equal interval variables were selected as these are the most likely to provide a meaningful best-fit curve to describe the effects of distance.

[15] We interpret this variable by selecting certain values of AGIPC to compare, then transforming them with the natural log. For example, to compare two zip codes with $20,000 and $25,000 AGIPC, we take the natural log of both and subtract the value of the lower from the higher. This difference is then multiplied by the coefficient of Fiscal Status to determine the difference in PPT that is accounted for by differing Fiscal Status.

Obstetric Population

Our model of the obstetric patient population finds that distance reduces the magnitude of effect for both WHA providers and our competitors. The model also finds that fiscal status of an area does not have a direct relationship to a patient's choice of the WHA for their care, though it is unlikely that fiscal status has no effect whatsoever. Instead, there is probably a more complicated relationship between low wealth areas and the competing providers that establish themselves there. I detail the results below using tables and examples to draw out the implications of the findings.

Regression Model for Obstetric Patient Population[16]

	Model Summary Statistics[17]	R	R^2	Adj. R^2	N	
		0.837	0.7	0.666	110	
	Independent Variables	β	Std. Error	Beta	t-score	p
Organization Effects						
1	Providers 0 to 4 miles from centroid	1.476	0.144	0.697	10.267	0.000
2	Providers 4 to 8 miles from centroid	0.741	0.087	0.814	8.493	0.000
3	Providers 8 to 12 miles from centroid	0.612	0.073	0.740	8.441	0.000
4	Providers 12 to 16 miles from centroid	0.435	0.064	0.563	6.809	0.000
5	Providers 16 to 20 miles from centroid	0.274	0.063	0.312	4.334	0.000
Competitor Effects						
6	Providers 0 to 4 miles from centroid	-0.182	0.025	-0.562	-7.191	0.000
7	Providers 4 to 8 miles from centroid	-0.136	0.020	-0.659	-6.951	0.000
8	Providers 8 to 12 miles from centroid	-0.109	0.018	-0.542	-5.917	0.000
9	Providers 12 to 16 miles from centroid	-0.047	0.017	-0.202	-2.741	0.007
10	Providers 16 to 20 miles from centroid	-0.028	0.019	-0.101	-1.473	0.144
11	Fiscal Status	-0.293	2.157	-0.010	-0.136	0.892

Table 1

Table 1 shows the results of our regression model, using obstetric PPT as our outcome variable. The variables of the Organization Effect and the Competitor Effect confirm the notion that "people generally do not want to travel greater distances to a provider". WHA providers at increasing distances are less likely to cause patients in an area to choose the WHA, and competitors at increasing distances are less likely to cause patients in an area not to choose the WHA. Our model states that a WHA provider within four miles of a zip code area will increase WHA obstetric PPT by 1.476 from that area, while a provider four to eight miles away will increase only .741 obstetric PPT from that area. Alternatively, a competing

[16] The providers included in this model are ob/gyns, obstetricians, CNMs, CPMs, and lay midwives

[17] Not included in this table is statistics on "goodness-of-fit" indicators such as multicollinearity and heteroscedasticity measures. However, these things were considered and found to be well within traditional statistical limits. Heteroscedasticity was considered particularly important, as it was measures of this effect that led to the use of a series of distance ranges rather than a linear function of distance.

provider within four miles of a zip code will decrease WHA obstetric PPT by .182, while a provider four to eight miles away will decrease it only by .136 PPT.

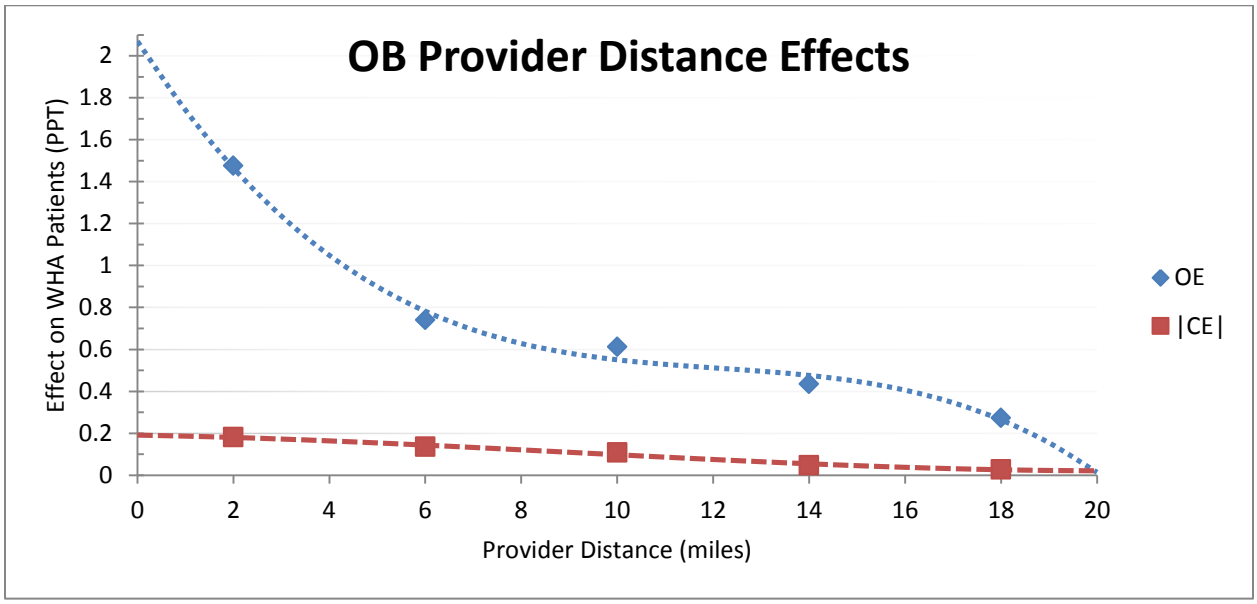

Figure 6

For ease of interpretation, we have converted the series of coefficients from the regression model into a graph in Figure 6. Although the Competitor Effect at 16 to 20 miles in the obstetric model was found to be insignificant at the .05 level, this is not necessarily problematic as the coefficient follows a pattern set by the four other distance variables, and it is expected that the p value will increase with distance as variation between zip codes is reduced. For this reason we will not reject the coefficient of this variable.

To generate the graph, the coefficient of each variable is plotted on the vertical axis, and the middle of each distance category becomes our horizontal axis (e.g., the 0 to 4 mile range is represented as 2 miles, while the 12 to 16 mile range is represented as 14 miles).[18] A "best fit" curve can be used to estimate the effect of a provider at any distance up to 20 miles. Figure 6 allows us to easily see the "s-shape" of a WHA provider's effect at various distances,[19] and to compare it to that of competitor's.[20] It is worth noting that the WHA seems to be far more effective than their competitors in attracting patients at a distance of less than 6 miles, based upon the number of competitors required to nullify the effect of a WHA provider (e.g., it would take 8 competitors to nullify the effects of a single WHA provider at 2 miles from a zip code area, but only 6 competitors at a distance of 6 miles).

[18] We display the *absolute value* of the Competitor Effect coefficients for ease of visualization and comparison of the relative strength to the Provider Effect. However, the reader should keep in mind that competing providers have a *negative* effect on the WHA's PPT, rather than a positive one.

[19] The equation for the Organization Effect on obstetric populations is $y = 2.069 - .355x + .028x^2 - .001x^3$

[20] The equation for the Competitor Effect on obstetric populations is $y = .191 - .004x - .001x^2 + .00003x^3$

To demonstrate the usefulness of the information in Figure 6, will perform two kinds of interpretations. The first interpretation will help to determine the ideal placement of a clinic when faced with two discrete population centers. The second will map the Competitor Effect onto each zip code in order to account for the influence of competitors throughout the Portland metropolitan market.

Clinic Placement

Let us imagine two zip code areas with centroids approximately 10 miles apart from one another, each with 10,000 potential patients. For this example, there are not any areas with a large number of potential patients in between, so we are concerned only with the two population centers 10 miles apart. A real-world example of this might be the cities Newberg and McMinnville, which each have a little over 10,000 potential patients.

One possible decision would be to "split the difference", and place a WHA provider in the middle between these two areas, exactly 5 miles away from each centroid. According to our best-fit curve in Figure 6, the placement of one provider in this location would cause the WHA to receive .9 PPT from each zip code area, for a total of 18 obstetric patients. Alternatively, if we were to place the WHA provider directly next to one centroid instead of splitting the difference our model predicts that we would receive 2 PPT from the closer zip code and .6 PPT from the further zip code, for a total of 26 patients. Clearly the better strategy in this case is to focus upon one area instead of trying to split both.

However this strategy is not limited to two points 10 miles away. The model predicts that for two points with equal numbers of potential patients at any distance apart, the best strategy is focusing on one area instead of trying to split the distance between them. In the case of two isolated population centers, it is recommended that the WHA always concentrate their efforts on a single area.

The mathematics become somewhat more complicated when the areas are unevenly served by competitors, or when one considers an area such as downtown Portland with varying numbers of potential patients in all directions. In these situations, there is no rule of thumb for best placement of a clinic. However, this can be imprecisely calculated for the placement of a clinic within range of a reasonable number of zip codes.

Using the companion data file, the reader could place a theoretical WHA clinic at any point in the relevant market, plot the distance to nearby centroids, and make an "envelope" calculation using the equation in Footnote 19 and the number of potential patients in the area. This calculation is an estimate of the number of patients that will be drawn to the WHA by the presence of a new provider. Alternatively, this could be performed for a theoretical competitor clinic at any location as well using the equation in Footnote 20.

Competitor Map

Figure 7 is a map of the relevant market with each zip code displaying the influence of competing providers upon the obstetric population. These values are calculated using the best fit line of Competitor Effects in Figure 6 to transform the distance of each provider to each respective zip code into a cumulative number of obstetric PPT lost as a result of competition. The resulting value is an estimate of the obstetric PPT in each zip code that do not choose the WHA as a result of competition. The map tells us that we lose more than 40 obstetric PPT in downtown Portland due to competition, while we lose only 2 PPT due to competition in the Newberg area.

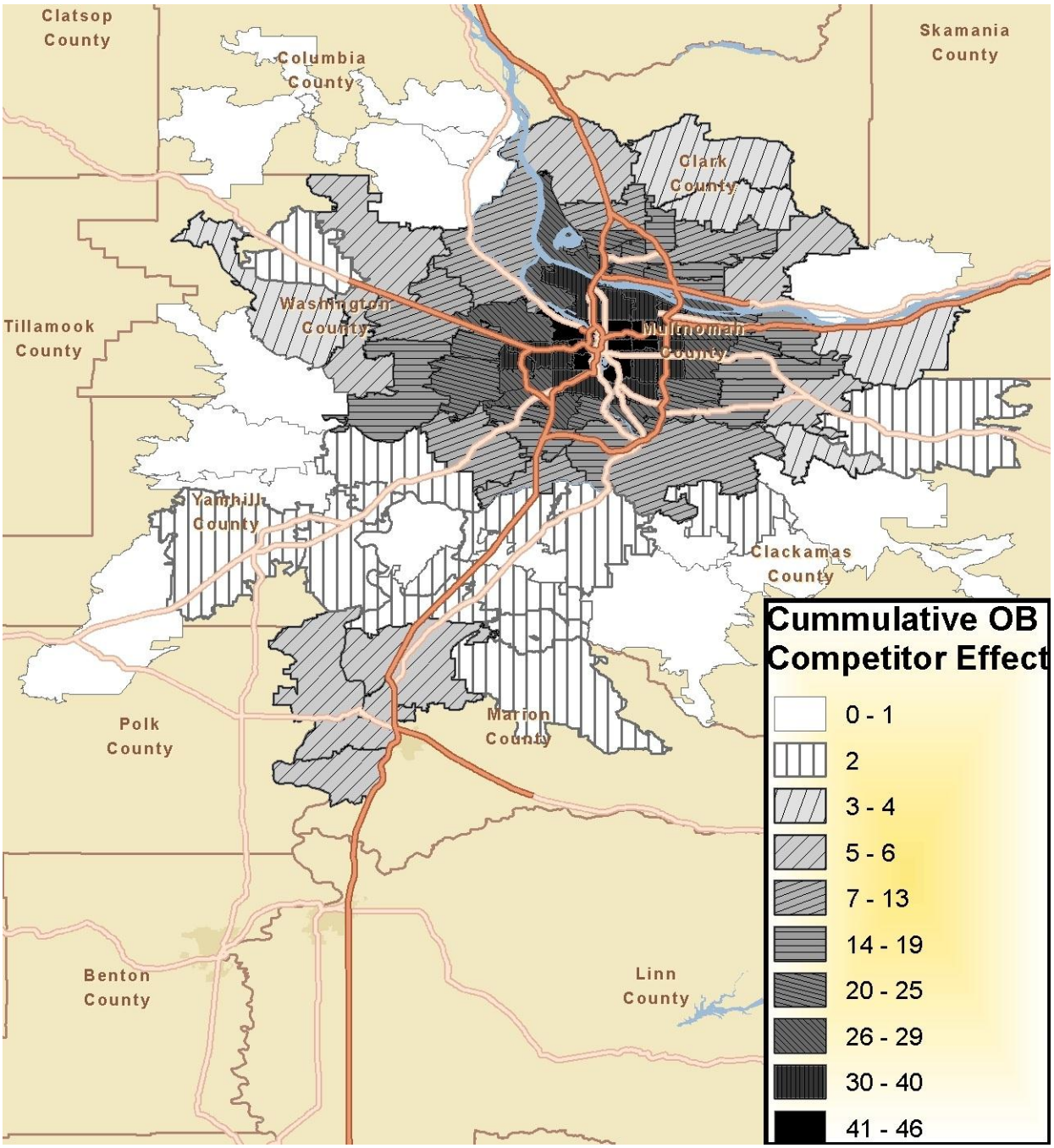

Figure 7

We find that Figure 7 offers a reasonable explanation for one of our initial questions in this analysis; why is the area southeast of the Oregon City clinic so successful in spite of distance. We can quickly see on our map that the effect of competitors decreases as we move further to the southeast from the Oregon City clinic. This decreasing amount of competition is strong enough to compensate for the loss of PPT due to distance to the clinic from the very edges of the relevant market.

The WHA would do well to pay close attention to areas with a low competitor effect, as these are likely to be very attractive areas for new competitors to establish themselves. This includes the nearly uncontested territory near the Oregon City clinic and the Woodburn area in the I-5 corridor between Portland and Salem. The latter area has expanded rapidly over the last decade and may demand a considerable number of providers in the next. Although the WHA does not currently receive a great number of patients from this area it could be prime candidate for further expansion of the practice in the future.

Gynecology Population

Our model of the gynecology patient population shows a similar "s-shape" effect of provider distance as our obstetric population, although the magnitude in PPT is much greater for this population. In contrast to the obstetric population, this model does find a significant relationship between fiscal status of an area and the number of patients that choose the WHA for their care as is shown in Table 2.

Regression Model 2 for Gynecology Patient Population[21]

	Model Summary Statistics[22]	R	R^2	Adj. R^2	N	
		0.86	0.739	0.71	110	
	Independent Variables	β	Std. Error	Beta	t-score	p
Organization Effects						
1	Providers 0 to 4 miles from centroid	6.601	0.939	0.471	7.027	0.000
2	Providers 4 to 8 miles from centroid	4.379	0.503	0.734	8.697	0.000
3	Providers 8 to 12 miles from centroid	4.172	0.494	0.698	8.450	0.000
4	Providers 12 to 16 miles from centroid	3.809	0.415	0.704	9.179	0.000
5	Providers 16 to 20 miles from centroid	2.757	0.399	0.458	6.907	0.000
Competitor Effects						
6	Providers 0 to 4 miles from centroid	-1.227	0.162	-0.555	-7.560	0.000
7	Providers 4 to 8 miles from centroid	-1.012	0.119	-0.730	-8.522	0.000
8	Providers 8 to 12 miles from centroid	-0.732	0.115	-0.539	-6.349	0.000
9	Providers 12 to 16 miles from centroid	-0.425	0.110	-0.271	-3.874	0.000
10	Providers 16 to 20 miles from centroid	-0.504	0.126	-0.258	-3.990	0.000
11	Fiscal Status	25.952	11.174	0.154	2.323	0.022

Table 2

The gynecology model was run in the same manner as the obstetric, and provided highly significant results on the effects of provider distance indicating that the chance of any coefficient being the result of random variation is less than 1 in 1000. There is a somewhat non-intuitive result in the Competitor Effect for providers between 16 and 20 miles away, as the model indicates that these providers are

[21] The providers included in this model are ob/gyns, gynecologists, and WHCNPs

[22] Indicators of heteroscedasticity and multicollinearity were found to be within tolerable levels for this model.

more likely to pull away potential patients of the WHA than those only 12 to 16 miles away. However, given the size of the standard error it is very likely that this still supports our theory of distance.

With this one exception accounted for, we can again support the notion that people generally do not wish to travel greater distances for their care. If we graph the coefficients of distance effects for the gynecology population as we did for the obstetric population, we see a difference in magnitude, but an interesting similarity in the shape of the curves for both Competitor Effects and Organization Effects.

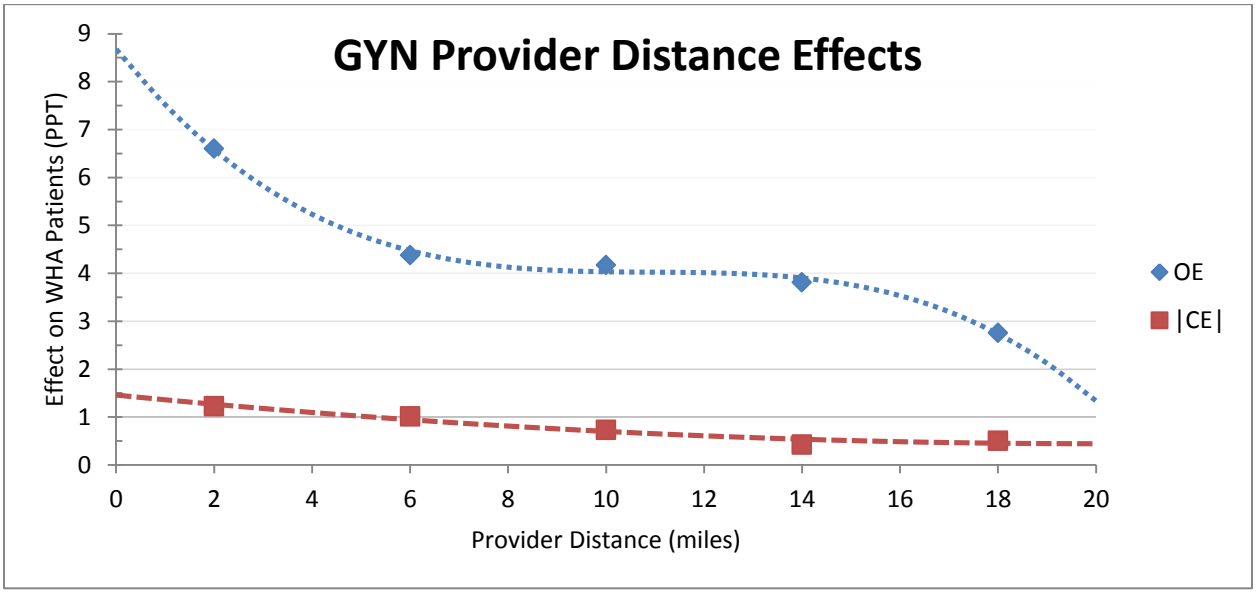

Figure 8

We can see a graph of the distance coefficients for WHA gynecology patients in Figure 8.[23,24] While the obstetric model peaks with a coefficient strength of 1.476, the effect of WHA providers on the closest range of a gynecology population is 6.601 PPT. This is expected, as the overall volume of gynecology patients in the market is higher; most women are not pregnant at any given point in their life and a gynecology patient may only have one appointment annually while a single pregnant woman is often seen a dozen times before delivery.

The first thing that we should point out is that the rule of thumb for placement of an obstetric clinic holds for the placement of a gynecology clinic as well. Our model indicates that in the case of two discrete population centers with similar numbers of potential patients, such as McMinnville and Newberg if we refer to our earlier example, placing a clinic directly in the center of one population center rather than attempting to split the distance between the two will result in a higher volume of patients for the WHA.

[23] The equation for the Organization Effect on gynecology populations is $y = 8.677 - 1.266x + .115x^2 - .004x^3$

[24] The equation for the Competitor Effect on gynecology populations is $y = 1.298 - .028x + .004^2 - .0001x^3$

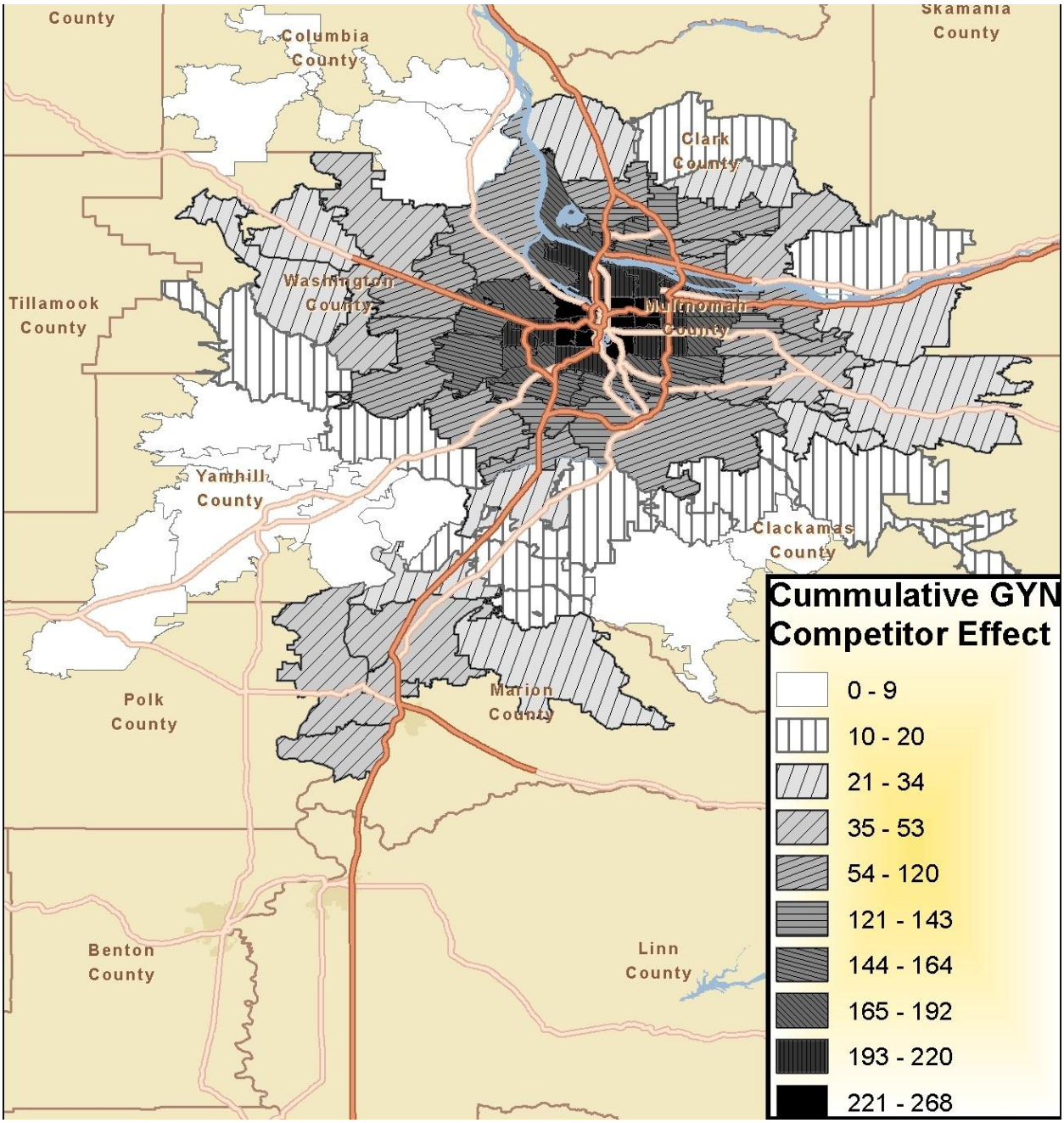

Figure 9

Figure 9 is a map of the competitor effect for the WHA's gynecology population, generated in the same manner as Figure 7, and the values represent the number of gynecology PPT that the WHA does not receive from an area as a result of competition. Comparing these two maps reveals a relatively similar distribution of competition between obstetric and gynecology populations. This includes the area of interest to the southeast of the Oregon City clinic, where competition decreases as we move further to the southwest.

The Rule of Six

Despite the difference in magnitude between our obstetric and gynecology models, we do see a similar pattern of strength in relation to distance. For both patient populations WHA providers have the most effect relative to competitors at a distance of less than 6 miles. This is made evident by calculating a ratio of competitors required to neutralize the effect of a single WHA provider at various distances. For both the obstetric and gynecology populations, this ratio is lowest at a distance of six miles. This similarity in relative strength is useful because it simplifies the strategic planning process in regard to distance, as we do not have to account for gynecology and obstetric patients separately.

A rule of thumb that we might suggest for future strategic planning is that the WHA will be most competitive at a distance of less than 6 miles from a patient population. Beyond this distance, the WHA seems to be less attractive to patients even if they must drive just as far to reach a competitor.

Fiscal Status

Our regression models revealed rather interesting results in regard to fiscal status. In contrast to the model for our obstetric population which was unable to determine the relationship between wealth and PPT, fiscal status for the gynecology population was highly significant. We should remind the reader that fiscal status was calculated using the natural log of AGIPC because this transformation scales our values in a way that emulates higher elasticity (i.e., patients more responsive to changes in price) for areas with lower fiscal status.

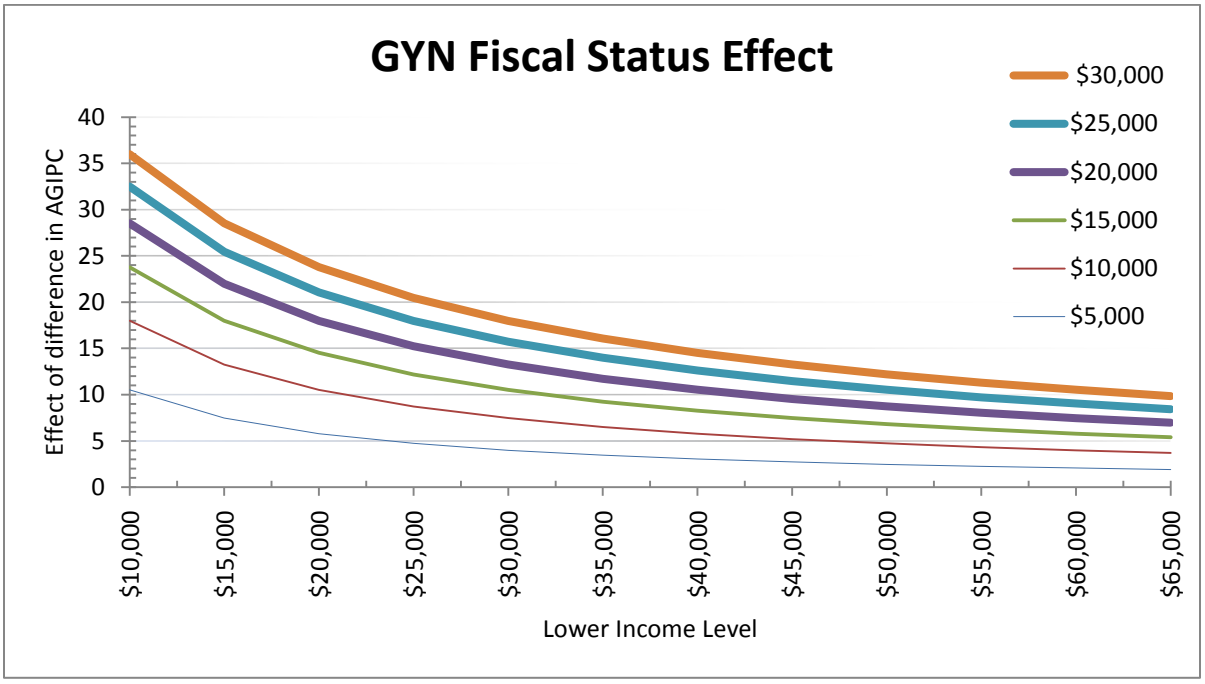

Figure 10

Unfortunately, the use of a logarithmic scale makes the interpretation of the coefficient slightly more complicated. Figure 10 communicates the effect of differences in income (per capita) among zip codes for various levels of AGIPC. This graph can be used to compare two zip codes and determine the number of gynecology PPT that we receive from the zip codes with higher AGIPC as a result of the difference in

fiscal status. The lines on the graph show the effect of the AGIPC difference in $5,000 intervals. The way to read this graph is to select a point along the horizontal axis to represent the zip code area with lower AGIPC, then move up the graph until you reach the line representing the difference in AGIPC between the two zip codes under consideration. The reader then moves to the left to see the number of additional gynecology PPT that the WHA receives from the area of higher fiscal status.

As an example of how to read Figure 10 we will return to one of our initial questions that began this analysis, attempting to explain why 97005 (downtown Beaverton) has surprisingly low PPT. It turns out that fiscal status almost entirely explains why we achieve a market penetration of 108 gynecology PPT in 97225, but only 74 gynecology PPT in 97005. The 97225 zip code has an AGIPC value of $45,000 while the 97005 area has a value of $20,000. If we start at the $20,000 mark on Figure 10 and travel upward to the line representing a $25,000 difference, we see that our model predicts that this difference accounts for approximately 20 additional gynecology PPT from 97225. This leaves only a difference of 14 gynecology PPT to be explained by the distance to competitors and WHA providers, which our model summarily does.

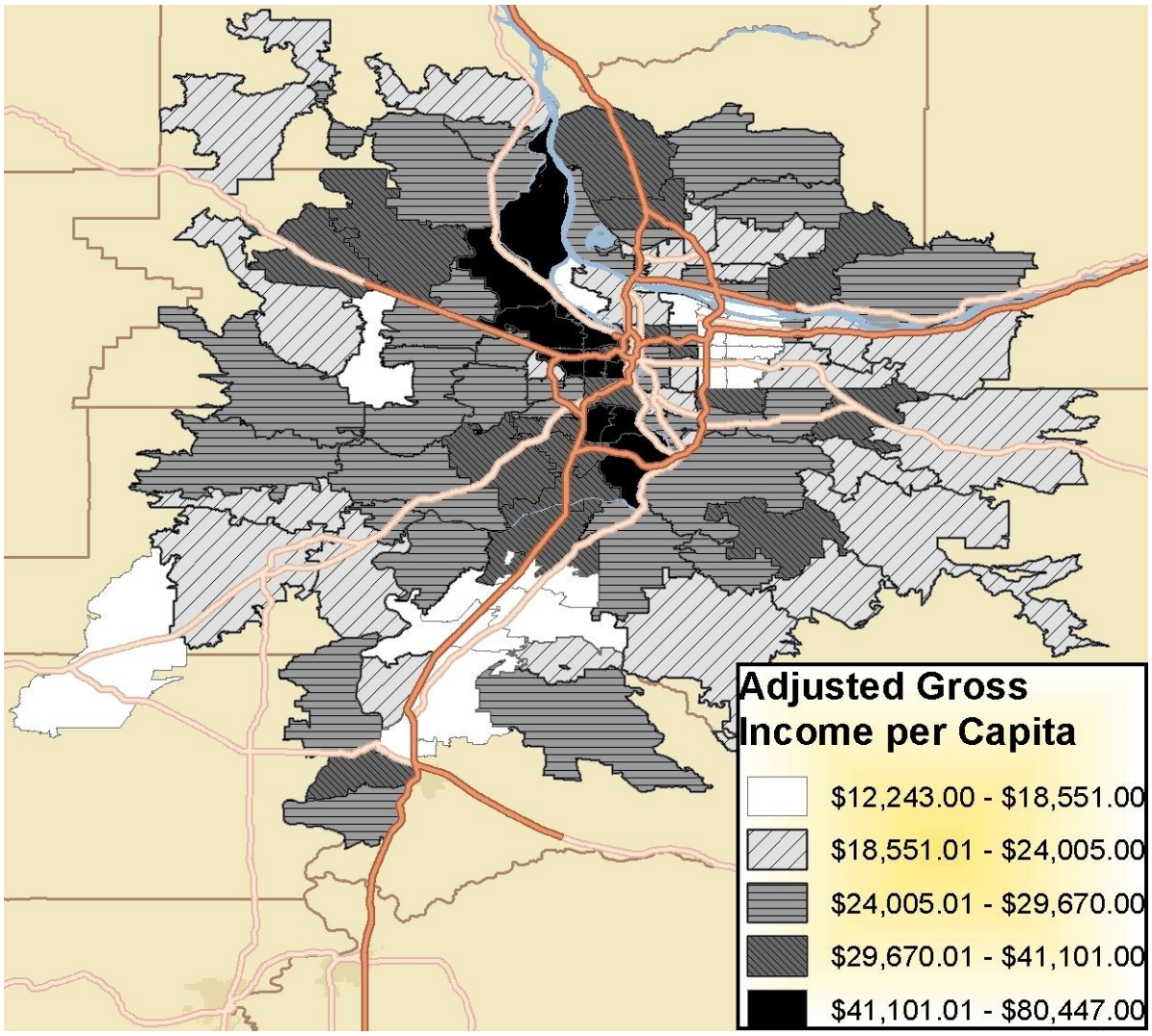

Figure 11

Companion Data File

This analysis can be better understood by exploring the companion data file, entitled WHADT_4.0.kml. This acronym represents the name of a prior project which first developed this tool, the Women's Healthcare Associates Demographic Tool.

The file is written in Keyhole Markup Language (kml), developed for the Google Earth GIS product. Specifically, this file was written for Google Earth version 6.1. There are currently a variety of different products which are capable of reading kml, including ArcGIS 10 and MapWindow, and this list is likely to grow into the future. However, these products have not perfectly interpreted the companion file in the past and if the reader has any technical problems, or suspects that there may be problems, it is recommended that they read the file using Google Earth version 6.1.

The file includes a visual display of all 110 zip codes in the relevant market on an 8-color scale. This scale can be used to show the respective values of absolute total patients, total PPT, absolute obstetric patients, obstetric PPT, absolute gynecology patients, and gynecology PPT. Additionally, this scale can be used to display AGIPC, the loss of obstetric PPT due to competition (OBCE), and the loss of gynecology PPT due to competition (GYNCE).

The file also includes several extensive lists of points. The list of centroids shows the average starting point of any given individual in a zip code for purposes of determining distances. The list of competing women's health providers indicate the specific locations of all the competitors considered in the analysis, with a small subsample of these including extensive data such as number and type of provider, affiliations, and website URL.

The file incorporates a list of primary care providers throughout the Portland market from an earlier project. Although this analysis does not include specific recommendations or consideration of primary care providers, this information will doubtless be useful to those with market expertise. Finally, the file contains a list of municipality borders (cities), which incorporates public data as available.

Strategic Guidance

In order to keep this analysis within the realm of practical guidance, we will summarize the findings into four recommendations. These recommendations should be considered when the WHA contemplates the placement of new clinics, changes to existing ones, or is attempting to respond to a shift in the competitive market.

Clinic Placement

Clinics should always be placed in the middle of discrete population centers. When the WHA is considering the placement of a new clinic in one of two discrete population centers with comparable conditions, the organization should not attempt to place a clinic in between the two regardless of how close they are to one another. The model predicts that focusing upon one of two centers will result in a higher number of new patients. The model can be used to estimate the actual increase in the number of patients as a result of this strategy by determining the distance from a hypothetical clinic location to each of the population centers in question, and determining the effect of a provider upon PPT at this distance according to Figure 6 and Figure 8. This change in PPT can then be applied to our count of potential patients in each area to determine the change in patient volume.

Although the rule of thumb above works only for scenarios with two discrete population centers, the model can also be used to determine the effect of a new WHA clinic at any point in the relevant market. In areas such as downtown Portland where there are nearly 70 zip codes within a 20 mile radius, this is a lengthy process, but the method is identical to the one above and is entirely accessible to the staff of the WHA. Alternatively, this method can be used to determine the likely effect of a new competitor location on our patient population.

Competitor Effects

The practice should be aware of competitors moving into areas with low Competitor Effect. Figure 7 and Figure 9 reveal the Competitor Effect throughout the entire Portland metropolitan market and clearly indicate the areas in which there is a lack of competitors. These areas will undoubtedly draw new competitors as they develop. In particular, the WHA should be aware of competitor clinics in the area southeast of the Oregon City clinic, as this provides a considerable number of patients to the practice primarily because there is little competition. Additionally, the I-5 corridor between Portland and Salem is likely to attract new competitors soon and the practice should be aware of this if they wish to compete for the burgeoning population.

Generally, we would recommend that the executive staff become familiar with the map of Competitor Effects. These maps show our model's actual calculation of the number of PPT in each zip code that are lost as a result of competition. This seems generally more useful than knowing the precise locations of competitors, as it is not our competitors that we care about, but the effect that they have upon our patient population.

The Rule of Six

WHA providers are most competitive in relation to other providers when they are within six miles of the area that they are targeting. At distances greater than six miles from an area, a WHA provider has less effect in relation to a competitor at that distance. If the practice has an explicit interest in increasing their market penetration within a particular area, placement of a clinic within six miles of the area is advised in order to mitigate the effects of competition as much as possible.

Fiscal Status

Lower fiscal status in an area definitely decreases the likelihood of patients choosing the WHA for gynecology services. We have determined that this is the primary cause of downtown Beaverton (97005) providing surprisingly few gynecology PPT. However, this is a rather extreme example as there is a $25,000 gap in AGIPC between two neighboring zip codes. Generally speaking throughout the Portland market we do not see such extreme income disparities, so fiscal status does not account for a great deal of the variation in our gynecology patients. However, this model can help to predict the gradual changes in gynecology patients that are likely to occur as a result of changing income levels.

The likelihood of obstetric patients choosing the WHA for their care is not directly influenced by their fiscal status. It may be possible for the WHA to obtain sufficient demand to operate a prenatal care clinic successfully in an area that might otherwise be considered unable to support a full service ob/gyn practice. It may be beneficial to the practice to investigate this possibility.

Further Work

The four points above are given in an attempt to distill some of the lessons learned from this work, and more guidance could certainly be given if the author of this analysis were able to work directly with staff members to answer the questions that they find most important.

Furthermore, this analysis was performed in aggregate and considered the whole Portland market as one population, rather than individually analyzing the population of specific WHA clinics. A more careful analysis would separate the patients of each clinic into subpopulations, and this more refined analysis would likely provide even more insights.

However, this work is most significant in its potential to serve as a framework for continual market monitoring. Continual application of this analysis every six to eight months could be used to tell us the effects of specific programs or policies adopted by the WHA (e.g., what is the precise effect upon our patient population as a result of implementing the Pregnancy Care Model?). This would allow the practice to implement different programs in the various clinics and closely monitor their patient population in order to make the most effective choices for the WHA as a whole.

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Appendix A

Relevant Provider Taxonomy Codes

- 207V00000X – Allopathic & Osteopathic Physicians, Obstetrics & Gynecology
- 207VG0400X – Allopathic & Osteopathic Physicians, Gynecology
- 207VX0000X – Allopathic & Osteopathic Physicians, Obstetrics

- 367A00000X – Advanced Practice Nursing Provider, Advanced Practice Midwife

- 363LX0001X – Nurse Practitioner, Obstetrics & Gynecology
- 363LW0102X – Nurse Practitioner, Women's Health

- 175M00000X – Other Service Provider, Lay Midwife
- 176B00000X – Other Service Provider, Midwife

- 261QB0400X – Ambulatory Health Care Facilities, Birthing

Appendix B

Data Collection for Provider Effect

Computing the effect of providers on the WHA's patient population required several pieces of information. First, we needed a complete list of the practice addresses of women's health providers that we consider to be part of the relevant market, and the number and type of providers at these locations. Second, we needed a starting address that best represents any given person in each zip code in the relevant market. Then we must find the distance from all 110 zip code starting addresses to all of our provider addresses.

The first phase relied upon the NPI database, maintained and published by the CMS. The passage of HIPAA mandated the adoption of a unique identifier for all health care providers that do business with CMS, and this is accomplished using a 10-digit identifier. Although we are not particularly interested in the NPI itself, an associated array of information is maintained by CMS in the massive NPI database, which includes organization names, address, fax, provider taxonomy codes, etc. This copious list of providers served as a good starting point to identifying all of the women's health providers in a market.

Use of the NPI database requires considerable expertise because of its size and design. This author attempted to access the database personally in order to ensure the fidelity of the information derived, but was unable do so. However, the self-described "hacktivist" Fred Trotter has developed the DocNPI search tool. Trotter's DocNPI tool periodically downloads the NPI database (most recently in July of 2011) and builds relational tables which can be easily searched by name, address, or provider taxonomy code (PTC). This functionality allows the user to generate a complete list of potential competitors that do business with CMS.

In order to build a comprehensive list of providers in the Portland metropolitan market, the DocNPI search tool was used to identify providers in Washington and Oregon that fell under one of the relevant PTCs,[25] or had the word "Woman" or "Women" anywhere in the organization name. This list of providers was obviously more inclusive than was necessary, as providers in Ashland or Seattle are unlikely to have much of an impact on the Portland market.

In order to refine this list of providers, a buffer zone of 50 miles was created on the outermost edges of the relevant zip codes using ArcGIS 10. This buffer ranged as far west as the Oregon Coast, as far east as Hood River, as far north as Battle Ground, and as far south as Springfield. The complete list of providers was then geocoded,[26] and all those that fell outside of the buffer zone were removed from the list of providers. A 50 mile buffer was selected because this captured competitors in the closest competing metropolitan area, Salem, without making the list of providers so expansive as to make the follow-up research impossible for an individual. Use of the buffer zone reduced the list from approximately 5000 organizations and individuals to less than 300.

The second phase sought to refine the list of individuals and provider organizations that matched our criteria and fell within the buffer zone using an extensive search of Internet sources. The majority of organizations have well-advertised websites that are easily located using a Google search. For these organizations, their website was used to (1) verify that the listed address in the NPI database was the

[25] See Appendix A for a list of taxonomies and their descriptions.

[26] Essentially, this means that each entry on the list was placed as a point on a map according to its listed address.

actual practice address (2) identify any additional locations which provide women's health services that are not listed in the NPI database[27] (3) count the number and type of providers at each location.

For organizations or locations that did not have a website, I crosschecked the Oregon and Washington business registries to determine if they were still in operation. Those who had no record or a record of dissolution were removed from the list of providers. For all other organizations, which did have a business registry entry but did not have a web presence, I defaulted to the address on the NPI entry and the number and types of providers listed at that address in the NPI database

Though this list was expansive, there was still a concern that it was incomplete. It is certainly feasible that a provider could exist without ever accepting a Medicare or Medicaid patient, and if this were the case then said organization would never appear in the NPI database. In an attempt to identify any additional providers of women's health services, a piece of software was developed to make use of the Google Maps API and perform an automated search of each zip code area that fell within the buffer zone according to keywords such as Ob/Gyn, Midwife, Women's Health, etc.

Unfortunately this software was problematic. First, it was limited by the Google server to a few thousand results per day, and it required several days to perform a complete search of the relevant area using one key word. Additionally, the software returned large numbers of results which had to be parsed by hand to determine if they were actually competitors or just a confounding result of the search. The first round, based upon the term Ob/Gyn, returned no providers outside of those identified by the NPI list, and for the purpose of expediency this process was abandoned.

The third phase of computing the competitor effect first requires that we find the distance from all 110 zip code areas to each of the 236 addresses in the list generated above. The starting address of each zip code was based upon US Postal Office delivery weighted centroids, which are essentially geographic points that represent the "average" location where deliveries are made in a zip code based upon the distribution of deliverable addresses. These delivery centroids where checked and determined to closely mirror centroids generated by satellite image calculations based upon building density. The distance from the centroids to all the provider addresses were then calculated using ArcGIS and a modification of the 'Route Find' feature, resulting in a table of slightly less than 26,000 computed distances between the dyads.

The 'provider effect' is calculated using the collected data according to the methods described in Appendix C.

[27] This occurs when the organization chooses to bill CMS for multiple locations under a single NPI number.

Appendix C

Calculating Provider Effect

In addition to the more intuitive and easily quantifiable attributes of a zip code area, a crucial component of this analysis is the type, number, and distance of women's health providers. However, this information is not easily incorporated into the regression model, as these are not descriptive characteristics of a zip code area. In order to use this information in a regression model we must first transform it into what I have dubbed the 'provider effect'. The challenge in creating the provider effect was combining three tables of information into a single descriptive value for each zip code. We will begin with an example to demonstrate the method of creating the provider effect.

Figure 12 contains six zip codes and their average starting location,[28] two WHA clinics (Eastbank and Tabor), and will be used to demonstrate how distance-provider data is generated. We need two particular pieces of data to go along with Figure 12 - Provider Effect Example, (1) the number of providers at each location, and (2) the distance of each office from each starting point. These data are contained in Table 3, and detailed description of how this information is obtained and processed is included in Appendix B.

Figure 12 - Provider Effect Example

[28] Average starting locations are determined using United States Postal Service "Delivery-Weighted Centroids" for 2010. These points essentially represent the "average" point on an x-y axis that the postal service must drive to any time that they deliver to a given zip code. This is useful because it is based upon the distribution of deliverable addresses, and represents the average starting point of a given individual in the zip code. The centroids were checked against a satellite image estimation of density, and the two were found to be similar.

Zip Code	Distance (miles)	Office	Providers (ob/gyn)
97212	1.43	Eastbank	5.5
97212	2.51	Tabor	5.5
97213	3.96	Eastbank	5.5
97213	1.17	Tabor	5.5
97214	3.12	Eastbank	5.5
97214	2.16	Tabor	5.5
97215	5.00	Eastbank	5.5
97215	1.41	Tabor	5.5
97227	0.61	Eastbank	5.5
97227	4.15	Tabor	5.5
97232	2.16	Eastbank	5.5
97232	1.81	Tabor	5.5

Table 3 - Provider Effect Example

Each zip code requires multiple entries to describe its relationship to both providers. However, in order for a regression model to incorporate this information, we must somehow combine the data vertically (each repeated zip code must be combined into a single row).

One method would be to simply divide the Providers column by the Distance column. We would use providers as the numerator because we expect more providers to have a positive correlation with patient volume, and distance serves as the denominator because we expect it to have a negative correlation. This would allow us to simply sum the combined value for each dyad. However, this method is problematic because it assumes that the effect of distance changes in a proportional way (i.e., one provider one mile away has the same effect as 100 providers 100 miles away). An interpretation of one's own consumer behavior would indicate that the effect of distance is more along the lines of a nonlinear curve.

The solution to this is to construct a regression model with a multitude of variables that account for the number of providers while allowing the model to adjust the coefficient for a variety of different distances. For this example the variables will be 1Mi, 2 Mi, 3Mi, 4Mi, and 5Mi. For zip code 97212, we sum all of the providers less than a mile away and this creates the variable 1Mi for 97212. We then sum the providers between one and two miles away, and this creates 2Mi, and so forth. We perform this process for each zip code, leaving us with the table below.

Zip Code	1Mi	2Mi	3Mi	4Mi	5Mi
97212	0	5.5	5.5	0	0
97213	0	5.5	0	5.5	0
97214	0	0	5.5	5.5	0
97215	0	5.5	0	0	5.5
97227	5.5	0	0	0	5.5
97232	0	5.5	5.5	0	0

Table 4 – Provider Effect "Ring" Example

With this information, we can calculate the effect of WHA providers on their patient populations at varying distances. However, this method becomes somewhat problematic when applied to the full analysis, as the number of explanatory variables swells dramatically; for each distance there are two variables, one for the WHA and one for their competitors; for a more detailed analysis which attempts to identify the effects of different *types* of providers, we double the variables once more. An analysis with 20 or 30 variables is exceedingly difficult to interpret, and quickly loses its usefulness.

In order to keep our analysis within the practical realm, we will run a regression of the variables inTable 4, and then graph the coefficients upon a scatterplot. The resulting equation might look something like the one below.

$$PPT_i = 78 + 7.8(1Mi_i) + 5.6(2Mi_i) + 4.8(3Mi_i) + 3.9(4Mi_i) + .98(5Mi_i)$$

In order to simplify this information, we will use a graph. The coefficient of each variable becomes y, and the associated distance becomes x. Figure 13 shows the "shape" of the effect of provider distance upon patient populations. The equation which describes the best fit line can then be used in conjunction with our count of providers to give a standardized weight to competitors according to their distance from a given zip code.

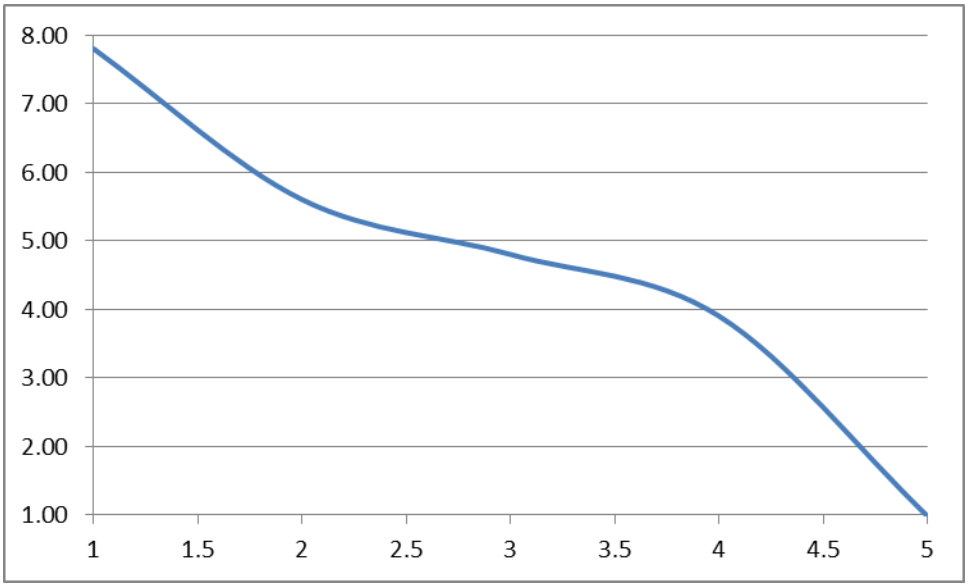

Figure 13 - Distance Effect Example

Appendix D

Acronyms

ACO - Accountable Care Organization: a new arrangement of health care providers proposed by the Centers for Medicare & Medicaid that is meant to incentivize preventive, cost effective care.

AGIPC - Adjusted Gross Income per Capita: a measure of individual fiscal status that is derived through a combination of data from the Internal Revenue Service and the US Census Bureau.

CCO - Community Care Organization: an Oregon state sponsored reform structure that is similar to the Accountable Care Organization.

CMS - Centers for Medicare & Medicaid: the federal administrative agency responsible for the provision of health care to the impoverished, disabled, and individuals over 65.

CNM - Certified Nurse Midwife: an advanced practice nurse specializing in obstetric care.

CPM - Certified Professional Midwife: a non-medical provider of pregnancy care that is certified by the state.

EMR – Electronic Medical Record: a technology meant to replace paper charts by centralizing a clinic's patient history in a single digital file.

HIPAA – Health Insurance Portability and Accountability Act: among other things, addresses the use and disclosure of individuals' health information.

HSA - Health Savings Account: an individual tax-sheltered account used for approved medical expenses.

MD - Medical Doctor: a medically trained professional that is considered to have full scope of practice.

NP - Nurse Practitioner: a medically trained professional with a more limited scope of practice than a medical doctor.

NPI - National Provider Identifier: a unique provider identifier required for doing business with the Centers for Medicare & Medicaid.

PPACA - Patient Protection and Affordable Care Act: also known as the Affordable Care Act (ACA)

PPT - Patients per Thousand: a measure of market penetration used in lieu of percentages.

WHA - Women's Healthcare Associates, LLC: a private Ob/Gyn practice operating in Portland, Oregon.

WHCNP - Women's Health Care Nurse Practitioner: an advanced nurse practitioner specializing in the area of women's health.